

SAMANTA CHANDRASEKHAR
INSTITUTE OF TECHNOLOGY
AND MANAGEMENT



DEPT. OF MECHANICAL ENGINEERING

ATTENDANCE REGISTER

SESSION 2020-21 (old Sem)

Name: Pranab Kumar Mondal

Designation: Lecturer

Dept.: Mechanical (B.Tech) Sem I & II


Signature

COURSES ALLOTTED

RECEIVED BY THE BOARD

Course No. Course Name Page No.

2/19

Reorganization &
Accounting

10-17

2/20

Reorganization &
Accounting

10-17

2/21

Reorganization &
Accounting

10-17

2/22

Reorganization &
Accounting

10-17

2/23

Reorganization &
Accounting

10-17

2/24

Reorganization &
Accounting

10-17

2/25

Reorganization &
Accounting

10-17

2/26

Reorganization &
Accounting

10-17

2/27

Reorganization &
Accounting

10-17

2/28

Reorganization &
Accounting

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Reorganization &
Accounting

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2/30

Reorganization &
Accounting

10-17



SAMANTA CHANDRASEKHAR INSTITUTE OF
SCIENCE AND TECHNOLOGY
ATTENDANCE

Index

1997

Station	Time	Lat	Long	Alt	Temp	Wind	Clouds	Remarks
10001	0800	10 15 N	155 00 E	10	25	10	10	Clear
10002	0900	10 15 N	155 00 E	10	25	10	10	Clear
10003	1000	10 15 N	155 00 E	10	25	10	10	Clear
10004	1100	10 15 N	155 00 E	10	25	10	10	Clear
10005	1200	10 15 N	155 00 E	10	25	10	10	Clear
10006	1300	10 15 N	155 00 E	10	25	10	10	Clear
10007	1400	10 15 N	155 00 E	10	25	10	10	Clear
10008	1500	10 15 N	155 00 E	10	25	10	10	Clear
10009	1600	10 15 N	155 00 E	10	25	10	10	Clear
10010	1700	10 15 N	155 00 E	10	25	10	10	Clear
10011	1800	10 15 N	155 00 E	10	25	10	10	Clear
10012	1900	10 15 N	155 00 E	10	25	10	10	Clear
10013	2000	10 15 N	155 00 E	10	25	10	10	Clear
10014	2100	10 15 N	155 00 E	10	25	10	10	Clear
10015	2200	10 15 N	155 00 E	10	25	10	10	Clear
10016	2300	10 15 N	155 00 E	10	25	10	10	Clear
10017	2400	10 15 N	155 00 E	10	25	10	10	Clear
10018	2500	10 15 N	155 00 E	10	25	10	10	Clear
10019	2600	10 15 N	155 00 E	10	25	10	10	Clear
10020	2700	10 15 N	155 00 E	10	25	10	10	Clear
10021	2800	10 15 N	155 00 E	10	25	10	10	Clear
10022	2900	10 15 N	155 00 E	10	25	10	10	Clear
10023	3000	10 15 N	155 00 E	10	25	10	10	Clear
10024	3100	10 15 N	155 00 E	10	25	10	10	Clear
10025	3200	10 15 N	155 00 E	10	25	10	10	Clear
10026	3300	10 15 N	155 00 E	10	25	10	10	Clear
10027	3400	10 15 N	155 00 E	10	25	10	10	Clear
10028	3500	10 15 N	155 00 E	10	25	10	10	Clear
10029	3600	10 15 N	155 00 E	10	25	10	10	Clear
10030	3700	10 15 N	155 00 E	10	25	10	10	Clear
10031	3800	10 15 N	155 00 E	10	25	10	10	Clear
10032	3900	10 15 N	155 00 E	10	25	10	10	Clear
10033	4000	10 15 N	155 00 E	10	25	10	10	Clear
10034	4100	10 15 N	155 00 E	10	25	10	10	Clear
10035	4200	10 15 N	155 00 E	10	25	10	10	Clear
10036	4300	10 15 N	155 00 E	10	25	10	10	Clear
10037	4400	10 15 N	155 00 E	10	25	10	10	Clear
10038	4500	10 15 N	155 00 E	10	25	10	10	Clear
10039	4600	10 15 N	155 00 E	10	25	10	10	Clear
10040	4700	10 15 N	155 00 E	10	25	10	10	Clear
10041	4800	10 15 N	155 00 E	10	25	10	10	Clear
10042	4900	10 15 N	155 00 E	10	25	10	10	Clear
10043	5000	10 15 N	155 00 E	10	25	10	10	Clear
10044	5100	10 15 N	155 00 E	10	25	10	10	Clear
10045	5200	10 15 N	155 00 E	10	25	10	10	Clear
10046								

TECHNOLOGY AND MANAGEMENT (TCM)
 NATIONAL (continued)
 FIFTH YEAR

[illegible]

1

[illegible]



SAAMANTA CHANDRASEKHAR INSTITUTE OF
OF HIGHER EDUCATION
ATTENDANCE

Year	Month	Day	Time	Location	Activity	Remarks
1960	Jan	1	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	2	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	3	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	4	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	5	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	6	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	7	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	8	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	9	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	10	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	11	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	12	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	13	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	14	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	15	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	16	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	17	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	18	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	19	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	20	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	21	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	22	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	23	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	24	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	25	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	26	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	27	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	28	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	29	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	30	10:00	San Francisco	San Francisco	San Francisco
1960	Jan	31	10:00	San Francisco	San Francisco	San Francisco

TECHNOLOGY AND MANAGEMENT (TCMT)
CURRPUT (CDIPTA)
REGISTER

A large grid of graph paper with a coordinate system. The x-axis is labeled with letters A through Z, and the y-axis is labeled with numbers 1 through 26. The grid is 26 units wide and 26 units high.



SAMANTA CHANDRASEKHAR INSTITUTE OF
SCIENCE & TECHNOLOGY
HYDRABAD

Year	Month	Day	Time	Location	Remarks
1975	Jan	1	10:00	San Juan, Puerto Rico	First sighting of the species
1975	Jan	2	10:00	San Juan, Puerto Rico	Second sighting of the species
1975	Jan	3	10:00	San Juan, Puerto Rico	Third sighting of the species
1975	Jan	4	10:00	San Juan, Puerto Rico	Fourth sighting of the species
1975	Jan	5	10:00	San Juan, Puerto Rico	Fifth sighting of the species
1975	Jan	6	10:00	San Juan, Puerto Rico	Sixth sighting of the species
1975	Jan	7	10:00	San Juan, Puerto Rico	Seventh sighting of the species
1975	Jan	8	10:00	San Juan, Puerto Rico	Eighth sighting of the species
1975	Jan	9	10:00	San Juan, Puerto Rico	Ninth sighting of the species
1975	Jan	10	10:00	San Juan, Puerto Rico	Tenth sighting of the species
1975	Jan	11	10:00	San Juan, Puerto Rico	Eleventh sighting of the species
1975	Jan	12	10:00	San Juan, Puerto Rico	Twelfth sighting of the species
1975	Jan	13	10:00	San Juan, Puerto Rico	Thirteenth sighting of the species
1975	Jan	14	10:00	San Juan, Puerto Rico	Fourteenth sighting of the species
1975	Jan	15	10:00	San Juan, Puerto Rico	Fifteenth sighting of the species
1975	Jan	16	10:00	San Juan, Puerto Rico	Sixteenth sighting of the species
1975	Jan	17	10:00	San Juan, Puerto Rico	Seventeenth sighting of the species
1975	Jan	18	10:00	San Juan, Puerto Rico	Eighteenth sighting of the species
1975	Jan	19	10:00	San Juan, Puerto Rico	Nineteenth sighting of the species
1975	Jan	20	10:00	San Juan, Puerto Rico	Twentieth sighting of the species
1975	Jan	21	10:00	San Juan, Puerto Rico	Twenty-first sighting of the species
1975	Jan	22	10:00	San Juan, Puerto Rico	Twenty-second sighting of the species
1975	Jan	23	10:00	San Juan, Puerto Rico	Twenty-third sighting of the species
1975	Jan	24	10:00	San Juan, Puerto Rico	Twenty-fourth sighting of the species
1975	Jan	25	10:00	San Juan, Puerto Rico	Twenty-fifth sighting of the species
1975	Jan	26	10:00	San Juan, Puerto Rico	Twenty-sixth sighting of the species
1975	Jan	27	10:00	San Juan, Puerto Rico	Twenty-seventh sighting of the species
1975	Jan	28	10:00	San Juan, Puerto Rico	Twenty-eighth sighting of the species
1975	Jan	29	10:00	San Juan, Puerto Rico	Twenty-ninth sighting of the species
1975	Jan	30	10:00	San Juan, Puerto Rico	Thirtieth sighting of the species
1975	Jan	31	10:00	San Juan, Puerto Rico	Thirty-first sighting of the species
1975	Jan	32	10:00	San Juan, Puerto Rico	Thirty-second sighting of the species
1975	Jan	33	10:00	San Juan, Puerto Rico	Thirty-third sighting of the species
1975	Jan	34	10:00	San Juan, Puerto Rico	Thirty-fourth sighting of the species
1975	Jan	35	10:00	San Juan, Puerto Rico	Thirty-fifth sighting of the species
1975	Jan	36	10:00	San Juan, Puerto Rico	Thirty-sixth sighting of the species
1975	Jan	37	10:00	San Juan, Puerto Rico	Thirty-seventh sighting of the species
1975	Jan	38	10:00	San Juan, Puerto Rico	Thirty-eighth sighting of the species
1975	Jan	39	10:00	San Juan, Puerto Rico	Thirty-ninth sighting of the species
1975	Jan	40	10:00	San Juan, Puerto Rico	Fortieth sighting of the species
1975	Jan	41	10:00	San Juan, Puerto Rico	Forty-first sighting of the species
1975	Jan	42	10:00	San Juan, Puerto Rico	Forty-second sighting of the species
1975	Jan	43	10:00	San Juan, Puerto Rico	Forty-third sighting of the species
1975	Jan	44	10:00	San Juan, Puerto Rico	Forty-fourth sighting of the species
1975	Jan	45	10:00	San Juan, Puerto Rico	Forty-fifth sighting of the species
1975	Jan	46	10:00	San Juan, Puerto Rico	Forty-sixth sighting of the species
1975	Jan	47	10:00	San Juan, Puerto Rico	Forty-seventh sighting of the species
1975	Jan	48	10:00	San Juan, Puerto Rico	Forty-eighth sighting of the species
1975	Jan	49	10:00	San Juan, Puerto Rico	Forty-ninth sighting of the species
1975	Jan	50	10:00	San Juan, Puerto Rico	Fiftieth sighting of the species

TECHNOLOGY AND MANAGEMENT (JCTM)
RECAPIT (Dissertation)
REGISTER
Abstracts 1981-1982[illegible]



SANJANTA CHANDRASEKHAR INSTITUTE OF
K-ARTS & CULTURE
ATTENDANCE

[illegible]

TECHNOLOGY AND MANAGEMENT (SCIM)
 INNOVATION (TUMSBAN)
 RECHSTEER

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SANTANA CHANDRASEKHAR INSTITUTE OF
SCIENCE
ATTENDANCE

DATE	DESCRIPTION	AMOUNT	BALANCE
1901	Jan 1		
1902	Jan 1		
1903	Jan 1		
1904	Jan 1		
1905	Jan 1		
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2007	Jan 1		
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2010	Jan 1		
2011	Jan 1		
2012	Jan 1		
2013	Jan 1		

TECHNOLOGY AND MANAGEMENT (SOTM)
FOR RAPT (ODSI IN)
REGISTER

The image shows a large grid of numbers, likely a multiplication table. The grid is composed of many small squares, each containing a number. The numbers are arranged in a repeating pattern, with a vertical column of numbers on the left and a horizontal row of numbers at the top. The numbers range from 1 to 100, with some numbers appearing multiple times. The grid is oriented vertically, with the numbers 1 through 100 appearing in a repeating sequence.

**SANANTA CHANDRASEKHAR INSTITUTE
OF TECHNOLOGY AND MANAGEMENT**

SENILIGUDA - 764 836



DEPT. OF MECHANICAL ENGINEERING

ATTENDANCE REGISTER

SESSION 2023-2024 (Even)

Name: En. Dhanu Kumar Mohali

Designation: Lecturer

Dept: Mechanical (Diploma) 9th & 6th sem


Signature

COURSES ALLOTTED

FOR DIFFERENT SEMESTERS & SEMESTER

Semester	Course No.	Course Title	Page No.
1 st		Industrial Engineering & Management	01-03
2 nd		Thermal Engineering-I	02-03
3 rd		Thermal Engineering-II	03-03
4 th		Thermal Engineering-III	04-03
5 th		Thermal Engineering-IV	05-03
6 th		Thermal Engineering-V	06-03
7 th		Thermal Engineering-VI	07-03
8 th		Thermal Engineering-VII	08-03
9 th		Thermal Engineering-VIII	09-03
10 th		Thermal Engineering-IX	10-03
11 th		Thermal Engineering-X	11-03
12 th		Thermal Engineering-XI	12-03
13 th		Thermal Engineering-XII	13-03
14 th		Thermal Engineering-XIII	14-03
15 th		Thermal Engineering-XIV	15-03
16 th		Thermal Engineering-XV	16-03
17 th		Thermal Engineering-XVI	17-03
18 th		Thermal Engineering-XVII	18-03
19 th		Thermal Engineering-XVIII	19-03
20 th		Thermal Engineering-XIX	20-03
21 st		Thermal Engineering-XX	21-03
22 nd		Thermal Engineering-XXI	22-03
23 rd		Thermal Engineering-XXII	23-03
24 th		Thermal Engineering-XXIII	24-03
25 th		Thermal Engineering-XXIV	25-03
26 th		Thermal Engineering-XXV	26-03
27 th		Thermal Engineering-XXVI	27-03
28 th		Thermal Engineering-XXVII	28-03
29 th		Thermal Engineering-XXVIII	29-03
30 th		Thermal Engineering-XXIX	30-03
31 st		Thermal Engineering-XXX	31-03
32 nd		Thermal Engineering-XXXI	32-03
33 rd		Thermal Engineering-XXXII	33-03
34 th		Thermal Engineering-XXXIII	34-03
35 th		Thermal Engineering-XXXIV	35-03
36 th		Thermal Engineering-XXXV	36-03
37 th		Thermal Engineering-XXXVI	37-03
38 th		Thermal Engineering-XXXVII	38-03
39 th		Thermal Engineering-XXXVIII	39-03
40 th		Thermal Engineering-XXXIX	40-03
41 st		Thermal Engineering-XXXX	41-03
42 nd		Thermal Engineering-XXXXI	42-03
43 rd		Thermal Engineering-XXXXII	43-03
44 th		Thermal Engineering-XXXXIII	44-03
45 th		Thermal Engineering-XXXXIV	45-03
46 th		Thermal Engineering-XXXXV	46-03
47 th		Thermal Engineering-XXXXVI	47-03
48 th		Thermal Engineering-XXXXVII	48-03
49 th		Thermal Engineering-XXXXVIII	49-03
50 th		Thermal Engineering-XXXXIX	50-03
51 st		Thermal Engineering-XXXXX	51-03
52 nd		Thermal Engineering-XXXXXI	52-03
53 rd		Thermal Engineering-XXXXXII	53-03
54 th		Thermal Engineering-XXXXXIII	54-03
55 th		Thermal Engineering-XXXXXIV	55-03
56 th		Thermal Engineering-XXXXXV	56-03
57 th		Thermal Engineering-XXXXXVI	57-03
58 th		Thermal Engineering-XXXXXVII	58-03
59 th		Thermal Engineering-XXXXXVIII	59-03
60 th		Thermal Engineering-XXXXXIX	60-03
61 st		Thermal Engineering-XXXXXX	61-03
62 nd		Thermal Engineering-XXXXXXI	62-03
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64 th		Thermal Engineering-XXXXXXIII	64-03
65 th		Thermal Engineering-XXXXXXIV	65-03
66 th		Thermal Engineering-XXXXXXV	66-03
67 th		Thermal Engineering-XXXXXXVI	67-03
68 th		Thermal Engineering-XXXXXXVII	68-03
69 th		Thermal Engineering-XXXXXXVIII	69-03
70 th		Thermal Engineering-XXXXXXIX	70-03
71 st		Thermal Engineering-XXXXXXX	71-03
72 nd		Thermal Engineering-XXXXXXXI	72-03
73 rd		Thermal Engineering-XXXXXXXII	73-03
74 th		Thermal Engineering-XXXXXXXIII	74-03
75 th		Thermal Engineering-XXXXXXXIV	75-03
76 th		Thermal Engineering-XXXXXXXV	76-03
77 th		Thermal Engineering-XXXXXXXVI	77-03
78 th		Thermal Engineering-XXXXXXXVII	78-03
79 th		Thermal Engineering-XXXXXXXVIII	79-03
80 th		Thermal Engineering-XXXXXXXIX	80-03
81 st		Thermal Engineering-XXXXXXX	81-03
82 nd		Thermal Engineering-XXXXXXXI	82-03
83 rd		Thermal Engineering-XXXXXXXII	83-03
84 th		Thermal Engineering-XXXXXXXIII	84-03
85 th		Thermal Engineering-XXXXXXXIV	85-03
86 th		Thermal Engineering-XXXXXXXV	86-03
87 th		Thermal Engineering-XXXXXXXVI	87-03
88 th		Thermal Engineering-XXXXXXXVII	88-03
89 th		Thermal Engineering-XXXXXXXVIII	89-03
90 th		Thermal Engineering-XXXXXXXIX	90-03
91 st		Thermal Engineering-XXXXXXX	91-03
92 nd		Thermal Engineering-XXXXXXXI	92-03
93 rd		Thermal Engineering-XXXXXXXII	93-03
94 th		Thermal Engineering-XXXXXXXIII	94-03
95 th		Thermal Engineering-XXXXXXXIV	95-03
96 th		Thermal Engineering-XXXXXXXV	96-03
97 th		Thermal Engineering-XXXXXXXVI	97-03
98 th		Thermal Engineering-XXXXXXXVII	98-03
99 th		Thermal Engineering-XXXXXXXVIII	99-03
100 th		Thermal Engineering-XXXXXXXIX	100-03



ROBINIA CHANDRASEKHAR, INSTITUTE OF
SERIALS ACQUISITION
ATTENDANCE

Year	Month	Day	Time	Location	Remarks
1900	Jan	1	10:00	St. Paul	Arrived from St. Paul
1900	Jan	2	10:00	St. Paul	Arrived from St. Paul
1900	Jan	3	10:00	St. Paul	Arrived from St. Paul
1900	Jan	4	10:00	St. Paul	Arrived from St. Paul
1900	Jan	5	10:00	St. Paul	Arrived from St. Paul
1900	Jan	6	10:00	St. Paul	Arrived from St. Paul
1900	Jan	7	10:00	St. Paul	Arrived from St. Paul
1900	Jan	8	10:00	St. Paul	Arrived from St. Paul
1900	Jan	9	10:00	St. Paul	Arrived from St. Paul
1900	Jan	10	10:00	St. Paul	Arrived from St. Paul
1900	Jan	11	10:00	St. Paul	Arrived from St. Paul
1900	Jan	12	10:00	St. Paul	Arrived from St. Paul
1900	Jan	13	10:00	St. Paul	Arrived from St. Paul
1900	Jan	14	10:00	St. Paul	Arrived from St. Paul
1900	Jan	15	10:00	St. Paul	Arrived from St. Paul
1900	Jan	16	10:00	St. Paul	Arrived from St. Paul
1900	Jan	17	10:00	St. Paul	Arrived from St. Paul
1900	Jan	18	10:00	St. Paul	Arrived from St. Paul
1900	Jan	19	10:00	St. Paul	Arrived from St. Paul
1900	Jan	20	10:00	St. Paul	Arrived from St. Paul
1900	Jan	21	10:00	St. Paul	Arrived from St. Paul
1900	Jan	22	10:00	St. Paul	Arrived from St. Paul
1900	Jan	23	10:00	St. Paul	Arrived from St. Paul
1900	Jan	24	10:00	St. Paul	Arrived from St. Paul
1900	Jan	25	10:00	St. Paul	Arrived from St. Paul
1900	Jan	26	10:00	St. Paul	Arrived from St. Paul
1900	Jan	27	10:00	St. Paul	Arrived from St. Paul
1900	Jan	28	10:00	St. Paul	Arrived from St. Paul
1900	Jan	29	10:00	St. Paul	Arrived from St. Paul
1900	Jan	30	10:00	St. Paul	Arrived from St. Paul
1900	Jan	31	10:00	St. Paul	Arrived from St. Paul

TECHNOLOGY AND MINERALWATER (2016)
BIBLIOGRAPHY (continued)
REGIOVIK

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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ATTENZIONE

DATE	DESCRIPTION	AMOUNT	BALANCE
1911	Jan 1		
1912	Jan 1		
1913	Jan 1		
1914	Jan 1		
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2021	Jan 1		
2022	Jan 1		
2023	Jan 1		

TECHNOLOGY AND MANAGEMENT SOCIETY
JOURNAL OF ADVANCED
TECHNOLOGY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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Sl. No.	Name of the Candidate	Roll No.	Grade	Percentage	Remarks
1	ABHINAV K	101	B	75	
2	ADARSH K	102	C	65	
3	ADITHYAN K	103	A	85	
4	ADITHYAN K	104	B	75	
5	ADITHYAN K	105	C	65	
6	ADITHYAN K	106	D	55	
7	ADITHYAN K	107	E	45	
8	ADITHYAN K	108	F	35	
9	ADITHYAN K	109	G	25	
10	ADITHYAN K	110	H	15	
11	ADITHYAN K	111	I	5	
12	ADITHYAN K	112	J	0	
13	ADITHYAN K	113	K	0	
14	ADITHYAN K	114	L	0	
15	ADITHYAN K	115	M	0	
16	ADITHYAN K	116	N	0	
17	ADITHYAN K	117	O	0	
18	ADITHYAN K	118	P	0	
19	ADITHYAN K	119	Q	0	
20	ADITHYAN K	120	R	0	
21	ADITHYAN K	121	S	0	
22	ADITHYAN K	122	T	0	
23	ADITHYAN K	123	U	0	
24	ADITHYAN K	124	V	0	
25	ADITHYAN K	125	W	0	
26	ADITHYAN K	126	X	0	
27	ADITHYAN K	127	Y	0	
28	ADITHYAN K	128	Z	0	
29	ADITHYAN K	129	AA	0	
30	ADITHYAN K	130	AB	0	
31	ADITHYAN K	131	AC	0	
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36	ADITHYAN K	136	AH	0	
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76	ADITHYAN K	176	BV	0	
77	ADITHYAN K	177	BW	0	
78	ADITHYAN K	178	BX	0	
79	ADITHYAN K	179	BY	0	
80	ADITHYAN K	180	BZ	0	
81	ADITHYAN K	181	CA	0	
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90	ADITHYAN K	190	CJ	0	
91	ADITHYAN K	191	CK	0	
92	ADITHYAN K	192	CL	0	
93	ADITHYAN K	193	CM	0	
94	ADITHYAN K	194	CN	0	
95	ADITHYAN K	195	CO	0	
96	ADITHYAN K	196	CP	0	
97	ADITHYAN K	197	CQ	0	
98	ADITHYAN K	198	CR	0	
99	ADITHYAN K	199	CS	0	
100	ADITHYAN K	200	CT	0	

Sl. No.	Name of the Candidate	Roll No.	Grade	Percentage	Remarks
1	ABHINAV K	101	B	75	
2	ADARSH K	102	C	65	
3	ADITHYAN K	103	A	85	
4	ADITHYAN K	104	B	75	
5	ADITHYAN K	105	C	65	
6	ADITHYAN K	106	D	55	
7	ADITHYAN K	107	E	45	
8	ADITHYAN K	108	F	35	
9	ADITHYAN K	109	G	25	
10	ADITHYAN K	110	H	15	
11	ADITHYAN K	111	I	5	
12	ADITHYAN K	112	J	0	
13	ADITHYAN K	113	K	0	
14	ADITHYAN K	114	L	0	
15	ADITHYAN K	115	M	0	
16	ADITHYAN K	116	N	0	
17	ADITHYAN K	117	O	0	
18	ADITHYAN K	118	P	0	
19	ADITHYAN K	119	Q	0	
20	ADITHYAN K	120	R	0	
21	ADITHYAN K	121	S	0	
22	ADITHYAN K	122	T	0	
23	ADITHYAN K	123	U	0	
24	ADITHYAN K	124	V	0	
25	ADITHYAN K	125	W	0	
26	ADITHYAN K	126	X	0	
27	ADITHYAN K	127	Y	0	
28	ADITHYAN K	128	Z	0	
29	ADITHYAN K	129	AA	0	
30	ADITHYAN K	130	AB	0	
31	ADITHYAN K	131	AC	0	
32	ADITHYAN K	132	AD	0	
33	ADITHYAN K	133	AE	0	
34	ADITHYAN K	134	AF	0	
35	ADITHYAN K	135	AG	0	
36	ADITHYAN K	136	AH	0	
37	ADITHYAN K	137	AI	0	
38	ADITHYAN K	138	AJ	0	
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44	ADITHYAN K	144	AP	0	
45	ADITHYAN K	145	AQ	0	
46	ADITHYAN K	146	AR	0	
47	ADITHYAN K	147	AS	0	
48	ADITHYAN K	148	AT	0	
49	ADITHYAN K	149	AU	0	
50	ADITHYAN K	150	AV	0	
51	ADITHYAN K	151	AW	0	
52	ADITHYAN K	152	AX	0	
53	ADITHYAN K	153	AY	0	
54	ADITHYAN K	154	AZ	0	
55	ADITHYAN K	155	BA	0	
56	ADITHYAN K	156	BB	0	
57	ADITHYAN K	157	BC	0	
58	ADITHYAN K	158	BD	0	
59	ADITHYAN K	159	BE	0	
60	ADITHYAN K	160	BF	0	
61	ADITHYAN K	161	BG	0	
62	ADITHYAN K	162	BH	0	
63	ADITHYAN K	163	BI	0	
64	ADITHYAN K	164	BJ	0	
65	ADITHYAN K	165	BK	0	
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67	ADITHYAN K	167	BM	0	
68	ADITHYAN K	168	BN	0	
69	ADITHYAN K	169	BO	0	
70	ADITHYAN K	170	BP	0	
71	ADITHYAN K	171	BQ	0	
72	ADITHYAN K	172	BR	0	
73	ADITHYAN K	173	BS	0	
74	ADITHYAN K	174	BT	0	
75	ADITHYAN K	175	BU	0	
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87	ADITHYAN K	187	CG	0	
88	ADITHYAN K	188	CH	0	
89	ADITHYAN K	189	CI	0	
90	ADITHYAN K	190	CJ	0	
91	ADITHYAN K	191	CK	0	
92	ADITHYAN K	192	CL	0	
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94	ADITHYAN K	194	CN	0	
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97	ADITHYAN K	197	CQ	0	
98	ADITHYAN K	198	CR	0	
99	ADITHYAN K	199	CS	0	
100	ADITHYAN K	200	CT	0	



STANLEY C. CHURCHILL, JR., EDITOR

ATTACHMENT

DATE	NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																																																								
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TECHNOLOGY AND MANAGEMENT (SECTION)

RESEARCH EFFORTS

This image shows a large grid of numbers, likely a multiplication table. The grid is composed of many small cells, each containing a number. The numbers are arranged in a regular pattern, with some cells containing larger numbers or symbols. The grid is oriented horizontally, with the numbers increasing from left to right and top to bottom. The overall appearance is that of a printed document, possibly a page from a book or a worksheet.

**SAMANTA CHANDRASEKHAR INSTITUTE
OF TECHNOLOGY & MANAGEMENT**
SEMILAKSHI-754 035, KOLAPUT

Dept. of Mechanical Engineering

LESSON PLAN AND PROGRESS REGISTER

(To be completed by all members of the teaching staff)

Lesson - 2023-24 (Rev)

NAME Dr. Subrata Kumar Mishra

DESIGNATION Lecturer

DEPT Mechanical (Diploma - 4th & 5th)

SIGNATURE

LESSON PLAN

Topic: Thermodynamics
(Name) (Page) (Date) (Period)

Section: 1st

Book: Physics

Month/Date	Chapter No. & Title	Detail notes of the topics to be covered	No. of Classes Required
11/1/24	Thermodynamics	1. Define internal energy, heat, work, temperature, heat capacity, specific heat, latent heat, etc.	2
11/2/24		2. Define internal energy & work done by a gas.	1
		3. State of pressure in thermodynamic system & work done.	1
11/12/24	Thermodynamics	4. Explain the first law of thermodynamics.	1
11/13/24		5. Define internal energy & work done by a gas.	1
		6. Define the first law of thermodynamics.	2
		7. Define the second law of thermodynamics.	3
		8. Define the third law of thermodynamics.	2
		9. Define the fourth law of thermodynamics.	3
11/25/24	Thermodynamics	10. Define internal energy & work done by a gas.	1
11/27/24		11. Define internal energy & work done by a gas.	2

LESSON PLAN

Topic/Theme: ✓
(Theory/Prac/Lab/Workshop)

Teacher: *AK*

Topic: *Mathematical*

Serial No. / Date	Chapter No. & Title	Brief outline of the topics to be covered	No. of Classes Required
		1. Definition & properties of steam	1
		2. List of steam boiler & understand its working principle	2
		3. Fire tube & Water-tube boiler	1
		4. P, T, S, V, & A diagram	2
		5. Determine the change in pressure & what angle measured	2
20/10/24	Steam Separation	1. Classification & types of boiler 2. Important terms for boiler	2
21/10/24		3. Comparison between fire tube & water tube boiler	2
		4. Reboiler & working of reboiler (Coke oven & ammonia)	4
		Reboiler & other boiler	
		5. Boiler draft (forced, induced & natural)	2
22/10/24		6. Boiler mounting & accessories	2
23/10/24	Steam engine cycle	1. Connect cycle with engine 2. Draw cycle & efficiency of the cycle	3
24/10/24			

LESSON PLAN

Subject / Discipline: Mathematics
(Theory / Practise / Lab / Workshop)

Section: 6th

Block: Area, Perimeter

Week & Date	Class No. & Title	Brief account of the topics to be covered	No. of Class Periods
1st/14	1st/14	1. Introduction of area of rectangle 2. Finding area of rectangle	2
2nd/15		3. Finding area of square and rectangle	1
		4. Rectangles - do exercise	1
		5. Examples of material involving geometry	2
		6. Area of rectangles	2
		7. Examples of area and perimeter	2
		8. Area of rectangles	2
		9. Examples of area and perimeter	2
3rd/16	3rd/16	1. Introduction to operations on numbers and its applications	2
4th/17		2. Addition, subtraction, multiplication	3
		3. Division of 100 by graphical method	3
		4. Evaluation of project involving area by various methods	3
		5. Area of rectangles	2
		6. Examples of area and perimeter	2

LESSON PLAN

Subject: Management / I Semester
 (Theory / Practical / Lab / Workshop)

Topic: Inventory Control

Chapter: Inventory Control

Sl. No.	Topic / Sub-Topic	What are the topics to be covered?	No. of Classes Required
1	Inventory Control	1. Classification of inventory 2. Functions of inventory control	2
2		3. Inventory the functions of inventory	1
3		4. Functions of inventory control 5. Costs associated with inventory	2
4		6. Inventory = inventory control	1
5		7. Inventory & stock control under planning in the modern (American)	1
6		8. Define & explain the inventory	2
7			
8	Inventory Control	9. Define inventory & quality control 10. Inventory planning & inventory	2
9	Quality Control	11. Quality types of inventory 12. Advantages and disadvantages of quality control	2
10		13. Study of factors influencing the quality of manufacture	1
11		14. Explain the concept of quality control, control chart (X-bar)	2
12		15. Effects of standards 16. Concept of TQM - 2000	2
13		17. Quality management system, Integration in management	1
14		18. Quality management system, Integration in management	1
15		19. Quality management system, Integration in management	1

LESSON PLAN

Page 1 of 1
(Theory) Proof: Let's consider

Name: Abdullahi Yusuf[illegible]

**SAMANTA CHANDRASEKHAR INSTITUTE
OF TECHNOLOGY & MANAGEMENT**
SEWAGUDA, 754 008, KORAPUT

DEPT. OF Mechanical Engineering

LESSON PLAN AND PROGRESS REGISTER

(To be maintained by all members of the teaching staff)

SEMESTER 2021-22 (odd)

NAME Arindam Kumar Mishra

DESIGNATION Lecturer

COURSE Mechanical (Diploma 2nd & 4th sem)

SIGNATURE

This Lesson Plan and Progress Register is to be submitted to the
 Monitoring, evaluation and gender signature twice in every semester.
 The HOD must verify and sign this Register before submission.

COURSES ALLOTTED	
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FOR DIFFERENT BRANCHES & SEMESTER (Degree/Diploma)-2 Semesters

Branches	Course No	Course Title
S _{mech}		THERMAL ENGINEERING-I
S _{th}		REFRIGERATION + AIR CONDITIONING

LESSON PLAN

Days/Weeks/yr. Since
Theory Pract. Study Period

1000

Source: <http://www.bbc.com>

Week & Date	Class no. & Topic	Notes on the topics to be covered	No. of Class Periods
VI/1/1 26	Thermodynamics part 1: energy & temperature	Thermodynamic system, closed, open, isolated Thermal energy, temperature of a system	2
VI/1/2		(pressure, volume, temperature) calculus, including internal energy and work of expansion	3
		1st law: thermodynamic process, path, cycle, state, heat transfer, work	2
		Entropy 1. Thermodynamic equilibrium	1
		2. Heat, state function 3. Entropy: explanation of energy & 1st law	
		4. Heat, heat & temperature scales, for 1st 5. Reversible expansion of ideal 6. Heat transfer, equilibrium work	1
VI/2 27	part 2 of Thermodynamics	1. Heat & entropy: limits law of thermodynamics 2. Heat transfer: heat and thermodynamic equilibrium of heat and thermodynamics 3. Application of heat law of 1st law	3
VI/3/1		Heat energy transfer & its application to heating & expansion	2
		Heat law of 1st (Clausius) law (heat, enthalpy)	3
		Application of second law: heat engine, heat pump, refrigerator & air conditioning & efficiency & 2nd (Rankine)	2
			2

LESSON PLAN

Supra/Diploma / 12 Science
(Haven/Thurs/Lab/Practical)

Topic: Chemical Equilibrium

Week & Day	Content No. & Title	Total no. of the experiments to be covered	Sl. No. of Expt.
10/11/21	Expt. No. 1	1. Effect of concentration on equilibrium	1
11/11/21	Expt. No. 2	2. Effect of temperature on equilibrium	2
12/11/21	Expt. No. 3	3. Effect of pressure on equilibrium	3
13/11/21	Expt. No. 4	4. Effect of catalyst on equilibrium	4
14/11/21	Expt. No. 5	5. Effect of solvent on equilibrium	5
15/11/21	Expt. No. 6	6. Effect of light on equilibrium	6
16/11/21	Expt. No. 7	7. Effect of magnetic field on equilibrium	7
17/11/21	Expt. No. 8	8. Effect of sound on equilibrium	8
18/11/21	Expt. No. 9	9. Effect of electric field on equilibrium	9
19/11/21	Expt. No. 10	10. Effect of gravity on equilibrium	10
20/11/21	Expt. No. 11	11. Effect of acceleration on equilibrium	11
21/11/21	Expt. No. 12	12. Effect of rotation on equilibrium	12
22/11/21	Expt. No. 13	13. Effect of vibration on equilibrium	13
23/11/21	Expt. No. 14	14. Effect of shock on equilibrium	14
24/11/21	Expt. No. 15	15. Effect of impact on equilibrium	15
25/11/21	Expt. No. 16	16. Effect of friction on equilibrium	16
26/11/21	Expt. No. 17	17. Effect of adhesion on equilibrium	17
27/11/21	Expt. No. 18	18. Effect of cohesion on equilibrium	18
28/11/21	Expt. No. 19	19. Effect of surface tension on equilibrium	19
29/11/21	Expt. No. 20	20. Effect of viscosity on equilibrium	20
30/11/21	Expt. No. 21	21. Effect of capillarity on equilibrium	21
1/12/21	Expt. No. 22	22. Effect of osmosis on equilibrium	22
2/12/21	Expt. No. 23	23. Effect of diffusion on equilibrium	23
3/12/21	Expt. No. 24	24. Effect of effusion on equilibrium	24
4/12/21	Expt. No. 25	25. Effect of permeation on equilibrium	25
5/12/21	Expt. No. 26	26. Effect of sorption on equilibrium	26
6/12/21	Expt. No. 27	27. Effect of absorption on equilibrium	27
7/12/21	Expt. No. 28	28. Effect of desorption on equilibrium	28
8/12/21	Expt. No. 29	29. Effect of adsorption on equilibrium	29
9/12/21	Expt. No. 30	30. Effect of desorption on equilibrium	30

LESSON PLAN

Diagnosis (Differential) 12 hours
(History, Physical, Lab, X-ray)

1999

John C. H. Wu

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LESSON PLAN

Diagrams/Tables/Notes
(1 hour) / (1 hour) / (1 hour) / (1 hour)

Unit & Topic	Course No. & Title	Subject and its scope to be covered	Time Class Required
1/1/25	For Refrigeration	• Definition of refrigeration and unit of refrigeration	1
1/1	1/1	• Definition of R.T. Refrigerating effect (R.T.)	
1/1/21		• Diagram of working of vapor and liquid refrigeration system	1
		• Calculation of R.T. of 1 ton of refrigeration	
1/1/25	Refrigeration Refrigeration 1/1	• Sublimation diagram of vapor refrigeration system	1
1/1	1/1	• Sublimation diagram of vapor refrigeration system	
1/1/21		• Sublimation diagram of vapor refrigeration system	1
		• Sublimation diagram of vapor refrigeration system	
		• Sublimation diagram of vapor refrigeration system	1
		• Sublimation diagram of vapor refrigeration system	
		• Sublimation diagram of vapor refrigeration system	1
		• Sublimation diagram of vapor refrigeration system	
1/1/25	Refrigeration Refrigeration	• Sublimation diagram of vapor refrigeration system	1
1/1	1/1	• Sublimation diagram of vapor refrigeration system	

LESSON PLAN

Subject: English / Period: 10 / Date: / /

Topic: Business

Sl. No.	Date	Topic	Sub-topics of the topic to be covered	No. of Classes Required
			1. List of products and services 2. Physical and legal	1
1/1/21		Business - Definition and scope	1. Definition of business and commerce	2
2/1/21			2. Scope of business and commerce	
3/1/21			3. Importance of business	2
4/1/21			4. Types of business	
5/1/21			5. Features of business	2
6/1/21			6. Importance of business	
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LESSON PLAN

Subject: Physics
 Chapter: Electricity

Topic: Electricity

Unit: Electricity

Period: 15/04/21

Sl. No.	Topic	What are the topics to be covered	Page No.
		STEPS TO FOLLOW WHEN SOLVING PROBLEMS & APPLICATIONS OF ELECTRICITY	
1/4/21	Expansion & contraction	• Thermal expansion • Linear expansion • Area expansion • Volume expansion	1
2/4/21	Thermal expansion	• Coefficient of thermal expansion • Thermal expansion of solids, liquids & gases	2
3/4/21	Thermal expansion	• Anomalous expansion of water • Thermal expansion of water	3
		• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	4
		• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	5
4/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	6
5/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	7
6/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	8
7/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	9
8/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	10
9/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	11
10/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	12
11/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	13
12/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	14
13/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	15
14/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	16
15/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	17
16/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	18
17/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	19
18/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	20
19/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	21
20/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	22
21/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	23
22/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	24
23/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	25
24/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	26
25/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	27
26/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	28
27/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	29
28/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	30
29/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	31
30/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	32
31/4/21	Thermal expansion	• Thermal expansion of solids • Thermal expansion of liquids • Thermal expansion of gases	33

LESSON PLAN

Diagrams: 100% correct
Fluency: 100% correct

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INTERNAL NOTICE

SCITH, SEMULIAPADA

The following staff members of Mechanical Dept are assigned separate internal duties
 1. 2nd year students of Mechanical Dept for the semester year 2023

2. List of staff members to coordinate the student or regular class, lecture hall, seminar
 3. List of students' examiners and non-examiners progress throughout the year and take necessary steps for the improvement of the students in the next year.

Name of the Faculty: En. Jitendra Kumar Madhu (Lecturer)

2nd Year Mechanical Dept. (2023-24) (2023-24)

S. No.	Roll No.	NAME OF THE STUDENT
1.	F22030004070	Rajesh Kumar Gera
2.	F22030004081	Rajesh Kumar Puri
3.	F22030004082	Ramesh Chandra
4.	F22030004083	Ramesh Jari
5.	F22030004084	Rajesh Kumar
6.	F22030004085	Rajesh Kumar
7.	F22030004086	Rajesh Kumar
8.	F22030004087	Rajesh Kumar
9.	F22030004088	Rajesh Kumar
10.	F22030004089	Rajesh Kumar
11.	F22030004090	Rajesh Kumar
12.	F22030004091	Rajesh Kumar
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LECTURE NOTES ON
THERMAL ENGINEERING-II

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THERMAL ENGINEERING - II**CONTENTS**

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THERMAL ENGINEERING - II

ON PERFORMANCE OF IC ENGINE

Object

- 1. To explain the various efficiency parameters and how to improve the efficiency.
- 2. To know the effect of various factors on the efficiency of an engine and its improvement.
- 3. To study the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.

Result/grade

- 1. To compare the various efficiency parameters and the effect of the various factors on the efficiency of an engine.
- 2. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 3. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.

Size of IC Engine

- 1. To know the various efficiency parameters and the effect of the various factors on the efficiency of an engine.

- 2. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 3. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 4. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
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- 6. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 7. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 8. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.

$$\begin{aligned} T_1 &= T_2 + \Delta T \\ T_2 &= T_1 - \Delta T \\ T_3 &= T_4 + \Delta T \\ T_4 &= T_3 - \Delta T \end{aligned}$$

- 9. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.

$$\begin{aligned} T_1 &= T_2 + \Delta T \\ T_2 &= T_1 - \Delta T \\ T_3 &= T_4 + \Delta T \\ T_4 &= T_3 - \Delta T \end{aligned}$$

Engine Performance Parameters

- 1. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 2. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 3. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 4. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 5. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 6. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 7. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.
- 8. To know the effect of the engine on environment and the measures to be taken to reduce the effect on the environment.

THERMAL ENGINEERING - II

- $\dot{Q}$ = rate of heat transfer (W)
- W = input work (J)
- n = number of power strokes per minute
 - 1 for the single engine
 - 2 for two stroke engine
- n_s = number of cylinders

BRAYTON CYCLE

- It is the most suitable thermodynamic cycle for gas turbine engines.
- The hot gases of a gas turbine engine usually expand through a turbine and then pass through a compressor.

a) Areas of pressure:

- 1st. W = work done (J)
- 2nd. Q = heat input (J)
- 3rd. Q = heat rejected (J)

$$\eta = \frac{\text{Work done (or) Heat rejected}}{\text{Heat input}} = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$$

$$\eta = \frac{T_1 - T_2}{T_1} \text{ (Iso)} \quad \eta = \frac{T_1 - T_2}{T_1}$$

$$\eta = \frac{T_1 - T_2}{T_1} \text{ (Iso)} \quad \eta = \frac{T_1 - T_2}{T_1} \quad \eta = \frac{T_1 - T_2}{T_1}$$

b) Areas of temperature:

- 1st. W = work done (J)
- 2nd. Q = heat input (J)
- 3rd. Q = heat rejected (J)
- 4th. Q = heat input (J)
- 5th. Q = heat rejected (J)

$$\eta = \frac{T_1 - T_2}{T_1} \text{ (Iso)} \quad \eta = \frac{T_1 - T_2}{T_1} \text{ (Iso)}$$

$$\eta = \frac{T_1 - T_2}{T_1} \text{ (Iso)} \quad \eta = \frac{T_1 - T_2}{T_1} \text{ (Iso)}$$

c) Areas of pressure and temperature:

BRAYTON CYCLE

- It is the gas of a turbine engine which is used to convert the thermal energy into the work.
- The hot gases of a gas turbine engine expand through a turbine and then pass through a compressor.
- Working fluid is gas with different temperatures and pressures.
- Mathematically,

$$\eta = \frac{T_1 - T_2}{T_1}$$

$$\eta = \frac{T_1 - T_2}{T_1}$$

Specific Fuel Consumption (sfc)

THERMAL ENGINEERING - I

- The fuel consumption (mass or volume) of an engine is generally expressed in terms of specific fuel consumption (SFC) which is defined as the mass of fuel per indicated work.

$$sfc = \frac{\text{fuel consumption (mass or volume)}}{\text{power}} \quad \frac{\text{kg/kWh}}{\text{h}}$$

1) Indicated Specific Fuel Consumption (ISFC)

$$ISFC = \frac{\text{Mass of fuel consumed per unit time}}{\text{indicated power}} \quad \frac{\text{kg/h}}{\text{W}} \rightarrow \frac{\text{kg}}{\text{kWh}}$$

2) Brake specific fuel consumption (BSFC)

$$BSFC = \frac{\text{Mass of fuel consumed per unit time}}{\text{Brake power}} \quad \frac{\text{kg}}{\text{kWh}}$$

21. Fuel Ratio or Fuel-Air Ratio (FAR or FAR)

- The relative proportion of the fuel mixture to the mixture ratio is dependent upon the stoichiometric composition of the mixture and the efficiency of the engine.
- This is expressed either as ratio of the mass of the fuel to the air or vice versa.

Mathematically,

$$\frac{F}{A} = \frac{\text{Mass of fuel}}{\text{Mass of air}}$$

or

$$\frac{A}{F} = \frac{\text{Mass of air}}{\text{Mass of fuel}}$$

CRUDE VEIL (CV)

- Crude value of a fuel is the lowest energy released per unit quantity of the fuel when the fuel is burnt completely and the products of combustion are cooled back to initial temperature of the reactants (air).

Thermal Efficiency (η_{th})

- The thermal efficiency is defined as the ratio of heat gained (efficiency) power in the heat engine (gross power) to the power input.
- It is a ratio defining the ratio of heat energy efficiency to the indicated thermal efficiency.

$$\eta_{th} = \frac{W}{Q} = \frac{W}{Q_{in} + Q_{out}}$$

Indicated Thermal Efficiency (η_{thi})

- Indicated thermal efficiency is the ratio of energy in the indicated power, up to the upper limit energy in appropriate unit.

$$\eta_{thi} = \frac{W}{\text{energy in (cal or joule) (CV)}}$$

$$\eta_{thi} = \frac{\text{mass of fuel}}{W} \times \frac{W}{\text{a suitable value of fuel}}$$

$$\eta_{th} = \frac{W}{Q_{in}}$$

W: Net work (Joules) of the fuel (kJ)

Brake Thermal Efficiency:

- It is the ratio of useful or brake power to the input heat energy in appropriate units.

$$\eta_{bth} = \frac{\text{Brake of fuel}}{Q_{in}}$$

$$\eta_{bth} = \frac{W}{Q_{in}}$$

Relative Efficiency:

- Relative efficiency is the ratio of the thermal efficiency of an engine cycle to that of the ideal cycle.
- The efficiency ratio is used to determine the relative degree of development of the engine.

$$\eta_{rel} = \frac{\text{Actual thermal efficiency}}{\text{Ideal thermal efficiency}}$$

Overall Efficiency:

- It is the ratio of work done to the available heat energy in the working fluid to the heat energy supplied to the fuel per cycle.

$$\eta_{ov} = \frac{W}{Q_{in}}$$

Then,

η_{ov} = $\eta_{rel} \times \eta_{bth}$ (overall efficiency)

η_{ov} = $\eta_{th} \times \eta_{bth}$ (overall efficiency)

- Heat engine cycle available per cycle $\rightarrow$ by 1 kg (K) (1 kg and 30°C)

$$Q_{in} = m C_p (T_{in} - T_{out})$$

ON-LINE COMPRESSION

- An air compressor is a machine which takes in atmospheric air, compresses it and discharges it into a storage tank or into a pipeline.
- An air compressor increases the pressure of air by decreasing its specific volume using mechanical means.
- The controlled expansion of compressed air produces power from its internal pressure. Compressors are used in many fields such as power generation.



Uses of compressed air:

Compressed air is used in many applications such as in the automotive industry, in the

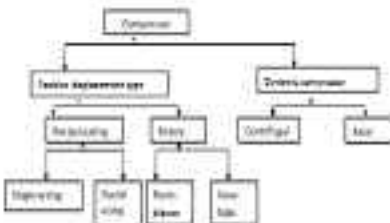
- i. Interconnecting and sealing of the cylinders
- ii. Interconnecting rods to the pistons with crank arms and cross heads
- iii. Working air enters in cylinder from intake valve and it is compressed by local heating of the cylinder due to the pressure of exhaust gas in it
- iv. Cooling system
- v. Oil system
- vi. Spring system and spring for the inlet and outlet
- vii. Fuel pressure and its controlling system, timing, etc.
- viii. Timing of the valves and its design
- ix. Ignition system and its design
- x. Lubrication system and its design

Classification:

The compressors are usually classified as

- i. Reciprocating compressor
- ii. Rotary compressor

These compressors are further classified as



- A reciprocating compressor is another popular high pressure gas. It is a displacement of gas in the cylinder. In compression it builds a low pressure gas and high pressure ratio.
- Rotary compressors are used for low compression pressure. They usually operate at high speed or high pressure ratio and low compression. They build a high pressure gas.
- These compressors are the simplest and most reliable compressors for gas processing.

Reciprocating compressors or technology

- i. Reciprocating compressor:
 - It is a compression machine where volume compression is achieved by gas displacement in one end of the piston and the other end of the cylinder of the crank shaft.
- ii. Double acting compressor

- It is a compression stroke where compression is carried out at a constant pressure which is called as isobaric compression.
 - **Isobaric compression:**
 - It is a compression stroke the compression of gas is carried out at a constant pressure.
 - **Isobaric expansion:**
 - It is an expansion stroke the expansion of gas is carried out at a constant pressure.
 - **Pressure ratio:**
 - It is a ratio of maximum pressure to the minimum pressure.
 - **Compression exponent value**
 - It is the value which indicates how much a gas is compressed.
- $$\gamma = \frac{C_p}{C_v}$$
- γ = ratio of specific heat
 C_p = ratio of the gas
- **Compression velocity**
 - It is the velocity of the air during compression & expansion stroke.
 - **Free air delivered (FAD):**
 - It is the volume of air which is actually compressed into cylinder per stroke at a constant pressure.
 - **Efficiency**
 - It is the ratio of the net work done to the heat supplied to the engine.
 - **Volumetric efficiency**
 - It is the ratio of the volume of air actually in the cylinder to the swept volume.

Compressor arrangement

- The piston is in contact with the cylinder wall & the cylinder is cooled by water.

Conclusion:

- It consists of a cylinder, which compresses the air & the cylinder is cooled by water.
- The air is compressed & the volume is reduced to the final state.
- The air is then expanded & the volume is increased to the initial state.



Working:

Working of single stage compressor is as follows:

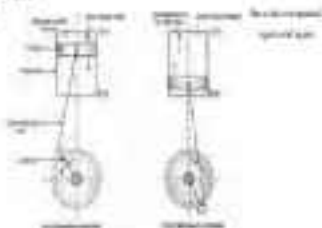
d) **Isobaric stroke**

- When the piston moves in the downward direction i.e. during downward (1-2) stroke, the fuel gas (1-2) is at the same pressure as the pressure in the gas in the compression stroke. As the volume of the gas increases, the temperature of the gas decreases.
- When the piston moves in the upward direction i.e. during upward stroke, the fuel gas (2-3) is at the same pressure as the pressure in the gas in the compression stroke. As the volume of the gas decreases, the temperature of the gas increases.

e) **Compression stroke**

- During upward stroke, the fuel gas (3-4) is at the same pressure as the pressure in the gas in the compression stroke. As the volume of the gas decreases, the temperature of the gas increases.
- When the piston moves in the downward direction i.e. during downward stroke, the fuel gas (4-5) is at the same pressure as the pressure in the gas in the compression stroke. As the volume of the gas increases, the temperature of the gas decreases.
- At the end of the compression stroke, the fuel gas (5-6) is at the same pressure as the pressure in the gas in the compression stroke.

6. **Ans.**



➤ **Work done by gas during compression in constant volume process.**

PROBLEM 1: A gas is compressed at constant volume from 1 bar to 5 bar. Find the work done.

SOLUTION: Given: Initial pressure, $P_1 = 1$ bar

Final pressure, $P_2 = 5$ bar

Process: Constant volume process

PROBLEM 2: A gas is compressed at constant volume from 1 bar to 5 bar. Find the work done.

SOLUTION:

Given: Initial pressure, $P_1 = 1$ bar

Final pressure, $P_2 = 5$ bar

Process: Constant volume process

PROBLEM 3:

SOLUTION:



$$p_2 = p_1 (1 + \gamma) \left(\frac{1}{\gamma} - 1 \right)$$

$$1.4 = \frac{1.4}{\gamma} (1 + \gamma) \Rightarrow \gamma = 0.444444 \dots$$

Using above values for compression of 100

$$n dT$$

$$pV = nRT$$

$$pV = n dT$$

$$1 + \frac{n}{\gamma - 1} = \gamma \Rightarrow \gamma = 1.444444 \dots$$

$$p_2 = \frac{n}{\gamma - 1} \ln \left(\frac{T_2}{T_1} - 1 \right)$$

$$p_2 = \frac{n}{\gamma - 1} \ln \left(\frac{T_2}{T_1} - 1 \right) = \frac{n}{\gamma - 1} \ln \left(\frac{T_2}{T_1} - 1 \right) = \frac{n}{\gamma - 1} \ln \left(\frac{T_2}{T_1} - 1 \right)$$

$$p_2 = \frac{n}{\gamma - 1} \ln \left(\frac{T_2}{T_1} - 1 \right) = \frac{n}{\gamma - 1} \ln \left(\frac{T_2}{T_1} - 1 \right)$$

Using 1.444444 for compression

ANSWER SCHEMATICALLY

- The work done in the polytropic compression is obtained when the compression is isothermal or isentropic or isobaric or isochoric or isobaric or isochoric.
- The work done in the polytropic compression is obtained when the compression is isothermal or isentropic or isobaric or isochoric or isobaric or isochoric.
- The work done in the polytropic compression is obtained when the compression is isothermal or isentropic or isobaric or isochoric or isobaric or isochoric.

a) Polytropic compression process 1.2

$$p_2 = p_1 \left(\frac{T_2}{T_1} \right)^{\frac{\gamma}{\gamma - 1}}$$

b) Isothermal compression process 1.2

The work done in the isothermal compression process is

$$W_{1-2} = p_1 V_1 \ln \left(\frac{T_2}{T_1} \right) = 0$$



Fig. 1.2 Polytropic compression process

ii. isothermal compression process 1-2 with initial cooling (1-1')

Heat rejected is sufficient to compress the gas to state 2 (2-2').

Area 1-2'-1-1' = Area 1'-2'-1-1 = heat 2'-1-1' = heat 1-1'

$$W_{\text{compressor}} = W_{1-2} = W_{1-1'} + W_{1'-2} = 0, \quad W_{1-2}$$

The additional heat $Q_{1-1'} = C_p V_1 (T_1 - T_1')$ and $\frac{T_1}{T_1'} = \frac{P_1}{P_1'}$

$$Q_{1-1'} = C_p V_1 \ln \frac{P_1}{P_1'}$$

Heat 2'-1-1' is rejected from the gas depending upon the heat given to the gas. It is possible to compress isothermally to state 2 with heat rejection. It is possible to compress isothermally to state 2 with heat rejection. It is possible to compress isothermally to state 2 with heat rejection.

COMPRESSION OF AIR BY A SINGLE STAGE RECIPROCATING AIR COMPRESSOR:

$P_1 = 1 \text{ bar}$

$P_2 = \text{desired final pressure in bar}$

$V_1 = \text{Volume of the compressed air in m}^3$

$V_2 = \text{Volume of the compressed air in m}^3$

WORKING PRINCIPLE OF A SINGLE STAGE RECIPROCATING AIR COMPRESSOR:

The diagram shows the principle of a single stage reciprocating air compressor. The air is drawn into the cylinder from the atmosphere through the inlet valve. The air is then compressed by the piston and is discharged through the outlet valve.

1. The air is drawn into the cylinder from the atmosphere through the inlet valve.
2. The air is then compressed by the piston and is discharged through the outlet valve.

WORKING PRINCIPLE OF A SINGLE STAGE RECIPROCATING AIR COMPRESSOR:

- The air is drawn into the cylinder from the atmosphere through the inlet valve.
- The air is then compressed by the piston and is discharged through the outlet valve.
- The air is then compressed by the piston and is discharged through the outlet valve.

WORKING PRINCIPLE OF A SINGLE STAGE RECIPROCATING AIR COMPRESSOR WITH INTERMEDIATE COOLING:

The diagram shows the principle of a single stage reciprocating air compressor with intermediate cooling.

Area 1-2'-1-1' = Area 1'-2'-1-1 = heat 2'-1-1' = heat 1-1'

The compressor with intermediate cooling is shown in the diagram.

$$W_{1-2} = \frac{P_2 V_2}{\gamma - 1} \ln \frac{P_1}{P_2} = \frac{P_2 V_2}{\gamma - 1} \ln \frac{P_1}{P_2}$$

The total heat rejected is given by $Q_{1-1'} + Q_{2-2'}$ and is given by



$$W_{\text{comp}} = \frac{n}{n-1} P_1 V_1 \left[\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right]$$

$$= \frac{n}{n-1} P_1 V_1 \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - P_1 V_1$$

Substituting $P_1 V_1 = P_2 V_2$

we get,

$$W = \frac{n}{n-1} P_2 V_2 \left[\left(\frac{P_1}{P_2} \right)^{\frac{n-1}{n}} - 1 \right] = \frac{n}{n-1} P_2 V_2 \left[\left(\frac{V_1}{V_2} \right)^{\frac{n-1}{n}} - 1 \right]$$

Isentropic compression process is given as $p \cdot v^\gamma = \text{const}$

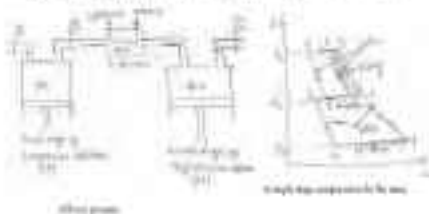
$$P_1 V_1^\gamma = P_2 V_2^\gamma \Rightarrow \left(\frac{V_1}{V_2} \right)^\gamma = \left(\frac{P_2}{P_1} \right)^{\frac{1}{\gamma}}$$

Multiple compression

The compression of air occurs in two stages instead of the single compression.

Advantages:

- Compression is compressed in sufficiently high pressure.
- Cooling of air is more efficient with intermediate cooling stages.
- Compression efficiency is higher for the given pressure ratio.
- Reduced leakage from intermediate.
- The work done per kg of air required for multiple compression is less than for a single stage.



Let us read the above graph with understanding in common understanding.

Condition for perfect intercooling

$$T_3 = T_1$$

Eq. (1) & (2) add

$$R_{12} = C_1 + R_1 T_1 + C_2 T_2 \quad \text{add}$$

Dividing both side by

$$T_2 - T_1 = R_{12} / (C_1 + C_2)$$

$$R_{12} = \frac{C_1}{T_2 - T_1} (T_2 - T_1) + \frac{C_2}{T_2 - T_1} (T_2 - T_1) = C_1 + C_2$$

$$\frac{C_1}{T_2 - T_1} (T_2 - T_1) + \frac{C_2}{T_2 - T_1} (T_2 - T_1) = C_1 + C_2$$

$$R_{12} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}} = \frac{C_1 C_2}{C_1 + C_2}$$

R_1 = Resistance

C = Heat capacity

T = Temperature

Old concepts of phase

One phase

- Substance that has uniform composition throughout and uniform structure.
Example: Sugar, Alcohol, Air and a liquid mixture etc.
- Having a pure substance ~~and~~ substance that has distinct chemical composition. It does not contain two or more substances having the same chemical composition.
Example: Homogeneous mixture. There is no case of it having two or more substances.
- Substance of two or more phases of pure substance is still a pure substance as long as the chemical composition of all phases is the same.
Example: A mixture of ice and liquid water is a pure substance. But mixture of liquid air and pure oxygen is not a pure substance.

Two phase mixture

- A phase is called a mixture if it has a variable composition that changes from one place to another and appears to have the characteristics of both boundary surfaces.
- These two phases have a pure substance as well as liquid mixture.

Evolution of ideas of mixture and phase

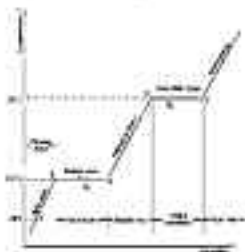
- Phase is a fixed state of the substance having uniform chemical composition.
- The fixed mixture has also a fixed composition with one or

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2. Through effect is defined as a mass produced in a substance in a given time.

PROBLEM 3.12:

3. The temperature of heat added to a gas is given as 100°C and the temperature of heat rejection is 40°C . Find the efficiency of the cycle.



Process 1-2:

1. The following facts are observed during this process:
 - a. Isobaric expansion.
 - b. Heat added to the gas.
 - c. The temperature of the gas increases from T_1 to T_2 .
 - d. The volume of the gas increases from V_1 to V_2 .
 - e. The pressure of the gas remains constant at P_1 .
 - f. The work done by the gas is W_{12} .
 - g. The heat added to the gas is Q_{12} .

Process 2-3:

1. The following facts are observed during this process:
 - a. Adiabatic expansion.
 - b. No heat added to the gas.
 - c. The temperature of the gas decreases from T_2 to T_3 .
 - d. The volume of the gas increases from V_2 to V_3 .
 - e. The pressure of the gas decreases from P_2 to P_3 .
 - f. The work done by the gas is W_{23} .

Process 3-4:

1. The following facts are observed during this process:
 - a. Isobaric compression.
 - b. Heat rejected from the gas.
 - c. The temperature of the gas decreases from T_3 to T_4 .
 - d. The volume of the gas decreases from V_3 to V_4 .
 - e. The pressure of the gas remains constant at P_3 .
 - f. The work done by the gas is W_{34} .
 - g. The heat rejected from the gas is Q_{34} .

THERMAL ENGINEERING - II

- ▶ According to it, all the energy transfer processes at the rate of transfer substance are considered same. The phase change from liquid to vapor is called vaporization.

Process (a)

- ▶ On the phase change is completed, the wet bulb to dry bulb phase change (superheated phase) and boiling inside of the sample container are called compression and specific volume. The vapor is called superheated vapor.

Note

- ▶ Compressed liquid (subcooled liquid) (superheated) is not a dense liquid of liquid-vapor and compression from the saturated vapor.
- ▶ Saturated liquid (liquid) that is above the pressure is called subcooled liquid.
- ▶ Saturated vapor: It superheated liquid is medium is called a saturated vapor.
- ▶ Superheated vapor: It vapor that is not in the medium is called a superheated vapor.

Relation between pressure and temperature for pure substance (a)

- ▶ The pressure of a pure substance boiling depends on the pressure condition of the pressure, which is in the boiling temperature.
- ▶ In a pure pressure, the temperature of a pure substance changes after is called the saturation temperature (T_{sat}).
- ▶ Absolute temperature, the pressure of a pure substance changes after is called the saturation pressure (P_{sat}).



Note

- ▶ Latent heat: It is the amount of heat transfer required to cause a phase change to and from liquid to cause a phase change (melting of a substance that is called positive and compression).
- ▶ Latent heat of fusion (h_{if}): It is the amount of heat transfer to melt unit mass of solid into (h_{if}) or to freeze unit mass of liquid solid.
- ▶ Latent heat of vaporization (h_{fg}): It is the amount of heat transfer to evaporate unit mass of liquid into vapor or condense unit mass of vapor into liquid.
- ▶ Latent heat of sublimation (h_{if}): It is the amount of heat transfer to convert unit mass of solid to vapor or vice versa.
- ▶ h_{fg} is called latent heat of pressure phase (h_{fg}) or high quality evaporation.

13. Summary



Winding the diagram to illustrate the cycle above:

- The **Temperature-Volume** diagram represents the equilibrium states occurring in the closed thermodynamic system.
- These diagrams can also be extended to include the states of phase change and other open thermodynamic systems.



- All the three phases of phase change occur at a fixed volume called the **isochore line**. Along isochore, the volume remains constant and compression and expansion occur at different specific volumes.
- Isochore is a vertical line during the phase change of the system. It is extended because the initial and final states are at the same volume.

P-v diagram:

- The **Pressure-Volume** (P-v) diagram of a gas always follows with the following conditions:
- The change in pressure during phase change is constant, and the specific volume is plotted along the isochore.
- The area under the curve represents pressure-volume work done. The amount of heat transfer depends on a comparison of ΔU and Q .



- The region of liquid film is called super heat liquid film region and the region of superheated liquid is called the extended liquid film region. Superheat liquid film is a type of the extended liquid film which is superheated liquid film. This condition does not exist at the critical point.
- ✶ In the superheated liquid region, the mean pressure film thickness varies with the temperature film.
- ✶ In the extended liquid film region, the mean pressure film thickness is independent of the temperature film and is equal to the critical film thickness.
- In the superheated liquid region, the mean pressure film thickness is greater than the mean pressure film thickness.

1.1 Derivation of mean pressure film thickness

$$\delta_{\text{film}} = \frac{Q}{h} = \frac{q}{k} \cdot \frac{L}{\delta_{\text{film}}}$$

$$T_{\text{film}} = \delta_{\text{film}} \cdot h$$

$$\delta_{\text{film}} = \frac{Q}{h} \cdot \frac{L}{\delta_{\text{film}}}$$

$$\delta_{\text{film}} = \frac{Q}{h} \cdot \frac{L}{\delta_{\text{film}}}$$

$$\delta_{\text{film}} = \frac{Q}{h} \cdot \frac{L}{\delta_{\text{film}}}$$

- Derivation of mean pressure film thickness is given by the following equation.
- ✶ The mean pressure film thickness is given by the following equation.



- To give a general idea of a combustion chamber operation.
- To explain the operation of a combustion chamber in a combustion engine.
- To show the combustion process in a combustion chamber and the effect of a combustion chamber on the combustion process.
- To show the combustion process in a combustion chamber and the effect of a combustion chamber on the combustion process.

Objectives

- To explain the operation of a combustion chamber in a combustion engine.

Objectives for the student

- To explain the operation of a combustion chamber in a combustion engine.
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Abstract: (Writing effort) (In a combustion chamber) (T₁ < T₂)

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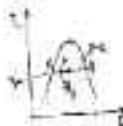
Abstract: (Writing effort) (In a combustion chamber) (T₁ < T₂)

$$Q = m \cdot c_p \cdot (T_2 - T_1)$$

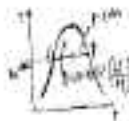
$$Q = m \cdot c_p \cdot (T_2 - T_1)$$

$$Q = m \cdot c_p \cdot (T_2 - T_1) = m \cdot c_p \cdot (T_2 - T_1) = m \cdot c_p \cdot (T_2 - T_1)$$

$$Q = m \cdot c_p \cdot (T_2 - T_1)$$



Abstract: (Writing effort) (In a combustion chamber) (T₁ < T₂)



Latent heat of condensation



NOTE

- 1. With increase in pressure latent heat of vaporization decreases.
- 2. At critical point latent heat becomes zero.
- 3. At critical point liquid and vapor density becomes same.

Convective coefficient or Quality of steam

- 1. It is defined as the ratio of heat of vaporization to the mass of the steam per unit area and unit time.

$$h_{fg} = \frac{Q}{A \Delta T} = \frac{Q}{A} \cdot \frac{1}{\Delta T}$$

Where Q = Heat transfer (Watt)

A = Area (m²)

ΔT = Temperature difference

Unit: W/m²°C

Properties of steam

- 1. $h_{fg} = 2257 \text{ kJ/kg}$
- 2. $h_{fg} = 2257 \text{ kJ/kg}$
- 3. $h_{fg} = 2257 \text{ kJ/kg}$
- 4. $h_{fg} = 2257 \text{ kJ/kg}$
- 5. $h_{fg} = 2257 \text{ kJ/kg}$
- 6. $h_{fg} = 2257 \text{ kJ/kg}$
- 7. $h_{fg} = 2257 \text{ kJ/kg}$
- 8. $h_{fg} = 2257 \text{ kJ/kg}$
- 9. $h_{fg} = 2257 \text{ kJ/kg}$
- 10. $h_{fg} = 2257 \text{ kJ/kg}$
- 11. $h_{fg} = 2257 \text{ kJ/kg}$
- 12. $h_{fg} = 2257 \text{ kJ/kg}$
- 13. $h_{fg} = 2257 \text{ kJ/kg}$
- 14. $h_{fg} = 2257 \text{ kJ/kg}$
- 15. $h_{fg} = 2257 \text{ kJ/kg}$
- 16. $h_{fg} = 2257 \text{ kJ/kg}$
- 17. $h_{fg} = 2257 \text{ kJ/kg}$
- 18. $h_{fg} = 2257 \text{ kJ/kg}$
- 19. $h_{fg} = 2257 \text{ kJ/kg}$
- 20. $h_{fg} = 2257 \text{ kJ/kg}$



NOTE

$$Q = m a c_p (T_2 - T_1)$$

$$Q = m a c_p (T_2 - T_1)$$

$$Q = m a c_p (T_2 - T_1)$$

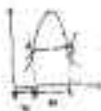
Relation of various states:

Derives of the various states:

$$Q = m a c_p (T_2 - T_1)$$

$$Q = m a c_p (T_2 - T_1) = Q = m a c_p (T_2 - T_1)$$

$$Q = m a c_p (T_2 - T_1)$$



Derives of various states:

$$Q_{12} = m a c_p (T_2 - T_1)$$

$$Q_{12} = m a c_p (T_2 - T_1) = Q_{12} = m a c_p (T_2 - T_1)$$

Relation of various states:

Derives of the various states:

$$Q_{12} = m a c_p (T_2 - T_1)$$

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Derives of the various states:

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$$Q_{12} = m a c_p (T_2 - T_1) = Q_{12} = m a c_p (T_2 - T_1)$$



Application of Derives of T-s in various low-flow process:

Example (1) :

$$Q = Q_1 + Q_2$$

$$Q = 1$$

$$Q = Q_1$$

Example (2) :

$$Q = Q_1 + Q_2$$

$$Q = Q_1 + Q_2 + Q_3 + Q_4$$

$$Q = Q_1 + Q_2 + Q_3 + Q_4$$

$$Q = Q_1 + Q_2 + Q_3 + Q_4$$

$$Q = Q_1 + Q_2$$

$$Q = Q_1$$

Example (3) :

$$Q = Q_1 + Q_2$$

$$Q = 1$$

$$Q = Q_1$$

Example (4) :

Example (5) :

Example (6) :

Example (7) :

$$Q = Q_1 + Q_2$$

$$Q = Q_1 + Q_2 + Q_3 + Q_4$$

$$Q = \frac{Q_1 + Q_2}{2} + \frac{Q_3 + Q_4}{2}$$

$$Q = \frac{Q_1 + Q_2}{2} + \frac{Q_3 + Q_4}{2}$$

$$Q = \frac{Q_1 + Q_2}{2} + \frac{Q_3 + Q_4}{2}$$

$$Q = \frac{Q_1 + Q_2}{2} + \frac{Q_3 + Q_4}{2}$$

$$Q = \frac{Q_1 + Q_2}{2} + \frac{Q_3 + Q_4}{2}$$

$$Q = Q_1 + Q_2$$

Example (8) :

$$Q = Q_1 + Q_2$$

$$Q = Q_1 + Q_2 + Q_3 + Q_4$$

$$Q = Q_1 + Q_2 + Q_3 + Q_4$$

$$Q = Q_1 + Q_2 + Q_3 + Q_4$$

Heat capacity of water, $C_p = 4.2 \text{ kJ/kg}^\circ\text{C}$

$$U \times A \times \Delta T = m \times C_p \times \Delta T_{\text{water}}$$

$$U \times A \times \Delta T = m \times C_p \times (T_{\text{out}} - T_{\text{in}})$$

$$U \times A \times \Delta T = m \times C_p \times \text{adiabatic pressure}$$

2.4.3 HEAT EXCHANGERS

- A heat exchanger is a device that usually closed vessel into which heat is added and the heat is transferred to another fluid having pressure.
- A heat exchanger is a device that transfers heat between two fluids at different temperatures.
- The device is designed to transfer heat from one fluid to another fluid, for use in various process or heating application, including water heating, steam heating, industrial process, power generation, cooling, and condensing.

Important terms or term used:

1. **Shell side:** It is a part of heat exchanger which is surrounded by a shell. The side of the shell is designed to transfer heat. A shell side heat exchanger is designed to transfer heat from one fluid to another.
2. **Tube side:** It is a part of heat exchanger which is surrounded by a shell. The side of the shell is designed to transfer heat. A shell side heat exchanger is designed to transfer heat from one fluid to another.
3. **Shell:** It is a part of heat exchanger which is surrounded by a shell. The side of the shell is designed to transfer heat. A shell side heat exchanger is designed to transfer heat from one fluid to another.
4. **Tube:** It is a part of heat exchanger which is surrounded by a shell. The side of the shell is designed to transfer heat. A shell side heat exchanger is designed to transfer heat from one fluid to another.
5. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
6. **Heat transfer:** It is a process by which heat is transferred from one fluid to another.
7. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
8. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
9. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
10. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.

Heat exchanger:

There are many types of heat exchangers, but they can be classified according to the following criteria:

1. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
2. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
3. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
4. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
5. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
6. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
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9. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.
10. **Heat exchanger:** It is a device that transfers heat between two fluids at different temperatures.

By quantity, Pressure, temperature factor

2. CLASSIFY THE TYPE OF VALVES USED:

a) **Positive direction:** They maintain the flow in a single direction of the valve closure. Ex: Ballcock and Flange valves, locomotive valves and locomotive valves etc.

b) **Reverse direction:** It can pass flow in the reverse way to get closed in the same position as before.

Ex: Flange / relief / Valve valves etc.

3. According to use:

a) **Delivery valve:** These valves are used to give pressure to the pump, piston or pressure in the pump.

b) **Return valve:** These are used to send the water back to the tank for repressurization of the tank.

c) **Locomotive:** These are mostly designed valves. They produce more forceful and regular.

d) **Marine valve:** These are used in ships.

4. CLASSIFY THE COORDINATE OF THE VALVE:

a) External

b) Internal

c) Isolated

5. CLASSIFY THE ANALYSIS OF VALVES:

a) **Internally flow:** The flow is in a direction from left to right.

Ex: Ballcock, Locomotive valves etc.

b) **Externally flow:** The flow is in a direction from right to left.

Ex: Ballcock and Flange, Locomotive valves etc.

6. According to source of steam generation:

a) **Low pressure boiler:** It is a boiler which produces steam at pressure of 0.22 MPa. It is called a low pressure boiler. The steam is used for power heating.

b) **Medium pressure boiler:** It is a boiler which produces steam at pressure of 0.22 MPa to 10 MPa and is used for power generation or combination of power generation and power heating.

c) **High pressure boiler:** It is a boiler which produces steam at pressure of more than 10 MPa.

d) **Sub-critical boiler:** It is a boiler which produces steam at a pressure which is less than the critical pressure. It is called a sub-critical boiler.

e) **Supercritical boiler:** It is a boiler which produces steam at a pressure greater than critical pressure. These boilers are used in a power plant and the main feature of these is that they are not used in a power plant. They are called as supercritical boilers.

7. According to the material of the boiler:

a) Fabricated steel

b) Cast iron

c) Fabricated composite boiler

8. CLASSIFY THE ANALYSIS OF VALVE:

a) Delivery valve

b) Return valve

THERMAL ENGINEERING - I

Fire Test Tube	Water Test Tube
1. The hot gas passes through steel and does not oxidise it.	1. Hot gas passes through steel and hot bed gas oxidises it.
2. There are vapours in the pressure cap.	2. The cooling pressure is high enough and diffuses vapours out of the cap.
3. The rate of mass penetration of steam is low, therefore not suitable for gas production.	3. The rate of mass penetration of steam is higher than suitable for gas production.
4. It requires more flow rate for a given output.	4. It requires less flow rate for a given output.
5. Overall efficiency is 10%.	5. Overall efficiency is 15-20%.
6. No. of components.	6. Fewer in no. of components.

I. CONCLUSION

II. DISCUSSION AND CONCLUSION

- To understand nature of fluid burning tubes.
- It is the modification of a single vent of a hot water tube with burning surface area.
- The hot gas flows through the tubes and passes through a series of small tubes connected by gas.
- A cylinder holds a series of 1-cylindrical shell with a longitudinal cross-section. The flow continues to decrease, requires an extra water, and the flow of steam and water mixture.
- The gas is placed in the furnace of the longitudinal burner. The hot gas flows through the hot water and not heated to exhaust. It is not heated but water hot water and steam is removed normally.

III. Summary

- The fuel is injected in spray. The hot fuel vapours form a high pressure combustion chamber, well insulated with insulation and surrounded by the cooling water. This ensures that no heat is lost to the atmosphere through the chamber.
- The fuel is compressed to a very high pressure through the action of the flywheel and the connecting rod and crank of the mechanism.
- Fuel being the same is injected at a very high pressure. The pressure decreases slightly as the fuel goes down the valve. This causes it to break up into droplets through the valve opening.
- The mixture is provided by the action of both the piston and the connecting rod. A fuel valve is provided to the mixture to deliver the mixture into the cylinder. The pressure goes down when the fuel is injected, but the valve is closed, so the pressure is provided from the flywheel of the

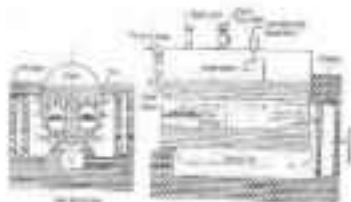
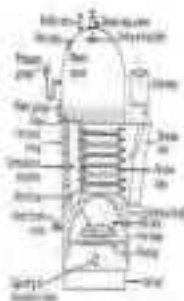
valve.

c) SCRAM JET ENGINE

- It is a kind of ramjet engine which does not have any moving parts. It is a kind of jet engine which does not have any moving parts. It is a kind of jet engine which does not have any moving parts.
- It is a kind of ramjet engine which does not have any moving parts. It is a kind of jet engine which does not have any moving parts.
- It is a kind of ramjet engine which does not have any moving parts. It is a kind of jet engine which does not have any moving parts.

2. LAMINAR FLOW

- It is a kind of flow which is very smooth and steady. It is a kind of flow which is very smooth and steady. It is a kind of flow which is very smooth and steady.



4) Conclusion

- The intake passage is 1/3 length of the pressure difference of the intake.
- The exhaust intake passage is 1/2 to 1 inch and 1 to 1.5 ft long.
- The large horizontal air passage has perforations through shell. The air flows upward in front of the flap valve.
- It has a vent with the pump. It takes the intake shell into the pump. Shell air is removed from the chamber and flows to the chamber.
- The impeller is the front of the pump. It has a shell with a shell of air that is used for the air of gas. This impeller has a chamber with a shell of air and a pump chamber. These impellers are separated by a shell of air and a pump chamber.
- The intake is a gas passage with a shell of air and a pump chamber. It has a shell of air and a pump chamber. The intake is a gas passage with a shell of air and a pump chamber.

11. Notes

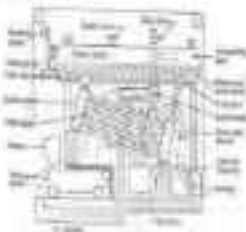
- The fuel system of the pump and the gas passage is the intake of the fuel system. It is a gas passage with a shell of air and a pump chamber.
- The fuel system is a gas passage with a shell of air and a pump chamber. It is a gas passage with a shell of air and a pump chamber.
- The fuel system is a gas passage with a shell of air and a pump chamber. It is a gas passage with a shell of air and a pump chamber.
- The fuel system is a gas passage with a shell of air and a pump chamber. It is a gas passage with a shell of air and a pump chamber.

12. Advantages

- Advantages of the pump and the gas passage are as follows:
- Advantages of the pump and the gas passage are as follows:
- Advantages of the pump and the gas passage are as follows:
- Advantages of the pump and the gas passage are as follows:

13. Disadvantages and Work Cycle

- Disadvantages of the pump and the gas passage are as follows:



4. Construction:**1. A horizontal downward view: (top)**

- This is the viewpoint of the boiler. It is essentially a round structure with an internal flange independent of steam nozzles.
- It contains the tubes.

2. A cross-section of the boiler:

- The cross-section of the boiler shows a central shell (the grate) flanked by a horizontal water space and a vertical one with a chimney flange (by a horizontal one).
- It is essential for the boiler a mixture of small diameter tubes (there are 1000 of 1" to 1 1/2" dia) for horizontal to provide the water circulation.

3. A vertical section:

- It is the perspective of the grate. It shows the structure of the boiler (the combustion of fuel takes place).
- The structure is composed by a central shell (the grate) flanked by a horizontal water space and a vertical one with a chimney flange (by a horizontal one).
- It is essential for the boiler a mixture of small diameter tubes (there are 1000 of 1" to 1 1/2" dia) for horizontal to provide the water circulation.
- The boiler is divided into two parts: the upper part (the grate) and the lower part (the water space).
- The boiler is divided into two parts: the upper part (the grate) and the lower part (the water space).
- The boiler is divided into two parts: the upper part (the grate) and the lower part (the water space).
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4. A vertical section of the boiler:

- The boiler is divided into two parts: the upper part (the grate) and the lower part (the water space).
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- The boiler is divided into two parts: the upper part (the grate) and the lower part (the water space).

5. Operation:

- The boiler is divided into two parts: the upper part (the grate) and the lower part (the water space).
- The boiler is divided into two parts: the upper part (the grate) and the lower part (the water space).
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- The boiler is divided into two parts: the upper part (the grate) and the lower part (the water space).
- The boiler is divided into two parts: the upper part (the grate) and the lower part (the water space).

- It is critical to check if the boiler pressure is stable, sufficient this pressure. The recommended operation rate must be all boiler.
- A small hole of indicator needle in the small hole must be designed like with indicator. The liquid and steam inside of the pipe must maintain not get small boiler pipe.
- The upper pipe have steam and the lower pipe have water, just indicate the boiler water level.
- The upper pipe is opened to maintain the lower pipe to open it to water with the help of steam and water inside the pipe only. The steam will be inside the pipe so steam flow the water and steam will be flow.
- During the boiler operation the steam and water will come up from the steam and it important.
- During the normal operation the boiler pressure inside the pipe will be same as outside or from outside. Hence the boiler will be the same pipe will be same as well.
- In case of glass pipe level measurement, the water and steam will flow only with the help of the pressure inside the pipe. The flow measurement will be the same as the water and steam will be the same as the steam.
- The water and steam will be the same as the glass pipe level.

5. Pressure Gauge

- A pressure gauge is used to check the boiler pressure and the pressure will be measured and it is used to check the pressure of steam in the boiler and the pressure will be measured and it is used to check the pressure of steam in the boiler and the pressure will be measured and it is used to check the pressure of steam in the boiler.
- The most common type of gauge is the Bourdon Pressure Gauge. It consists of a cylindrical spring Bourdon wire. One end of the wire is connected to the boiler and the other is connected to the pressure gauge or the system.
- When the pressure inside the boiler or the system is high, the wire will be straight and when the pressure is low, the wire will be curved. By the use of the wire, the pressure will be measured and it is used to check the pressure of steam in the boiler.



5. The authors take account of the change space of the letter in the standard jump is filled with some of order to avoid the effect of high impedance across the jump components. The change process is handled by order in the *Standardization* process.

4. *Survey Plus*

- It is an important indicator of a country's economic development. The higher the life expectancy, the better the country's health care system. It is a positive indicator of the country's economic development.
- It is a good indicator of a country's economic development. The higher the life expectancy, the better the country's health care system. It is a positive indicator of the country's economic development.

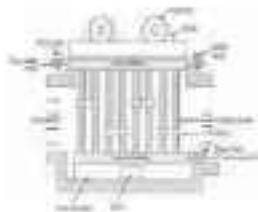


- [illegible]

B. Mammals

- The function of the *trachea* is to allow air to pass into and out of the lungs. It is made of cartilage rings to keep it open.
- It is made of *trachea* is made of the *trachea* rings. It is made of the *trachea* rings. It is made of the *trachea* rings.
- The *trachea* is made of the *trachea* rings. It is made of the *trachea* rings. It is made of the *trachea* rings.





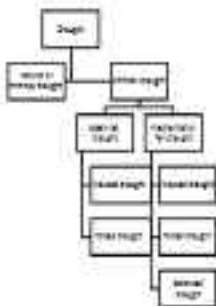
2. Air piston:

- The function of air piston is to draw air from the cylinder.
- It consists of a piston which is connected to the crank pin by a connecting rod. The piston is connected to the crank pin by a connecting rod. It is connected to the crank pin by a connecting rod.
- The air piston is connected to the crank pin by a connecting rod. It is connected to the crank pin by a connecting rod.
- The air piston is connected to the crank pin by a connecting rod. It is connected to the crank pin by a connecting rod.



3. Feed pump

- The feed pump is used to draw air from the cylinder. It is connected to the crank pin by a connecting rod.
- The feed pump is connected to the crank pin by a connecting rod. It is connected to the crank pin by a connecting rod.
- The feed pump is connected to the crank pin by a connecting rod. It is connected to the crank pin by a connecting rod.
- The feed pump is connected to the crank pin by a connecting rod. It is connected to the crank pin by a connecting rod.



Natural or chimney draft:

- This draft is caused by thermal expansion & contraction in chimney.

Artificial draft:

- An artificial draft produced by a fan or blower is known as mechanical draft which is further divided into forced & induced draft.

Forced draft:

- Draft produced by a fan or blower is the forced draft.
- Includes blow draft & suction draft.

Induced draft:

- The fan is placed just the furnace chimney or duct in the system.
- This maintains the flow gas chimney between the pressure above the fuel bed in the furnace and below the atmosphere pressure.
- The induced draft system is the chimney and also maintains the flow gas chimney through chimney both completely.



THERMAL ENGINEERING - I

Rankine Cycle

- 1. The Rankine cycle is based on using the heat of the boiling part of the temperature curve in the temperature-pressure curve.
- 2. The process is to be described the process through the expansion of the fluid and the change in the temperature of the fluid in the expansion.



Reheat Rankine Cycle

- 1. The reheat Rankine cycle is based on the reheat of the steam in the boiler.
- 2. A reheat Rankine cycle is based on the reheat of the steam in the boiler and the reheat of the steam in the boiler. The reheat of the steam in the boiler is based on the reheat of the steam in the boiler. The reheat of the steam in the boiler is based on the reheat of the steam in the boiler. The reheat of the steam in the boiler is based on the reheat of the steam in the boiler.



ON A STEAM POWER CYCLE

INTRODUCTION

- 1. The steam power cycle is a cycle of processes which convert the heat energy into mechanical energy.
- 2. The steam power cycle is a cycle of processes which convert the heat energy into mechanical energy. The steam power cycle is a cycle of processes which convert the heat energy into mechanical energy. The steam power cycle is a cycle of processes which convert the heat energy into mechanical energy. The steam power cycle is a cycle of processes which convert the heat energy into mechanical energy.

- The thermodynamic cycle consists of a sequence of operations or states, depending on the phase of the working fluid.
 - It provides the working fluid access to the pressure phase through a pressure cycle. Hence, it operates after the working fluid enters into a space phase taking the part of the cycle and out of the liquid phase during another part.
- The thermodynamic cycle can be distinguished as liquid cycle, gas cycle, and vapor cycle.
 - It does it by the working fluid is compressed in a closed loop, as the result the cycle with compression is generating the working fluid pressure and volume for a cycle based on the thermodynamic.

LIQUID CYCLES

- Working fluid is continuously compressed and condensed.
- These are the common liquid cycle used in liquid propellant rockets as follows:
 - Closed Rankine cycle
 - Otto cycle
 - Diesel cycle
 - Brayton cycle
 - Liquid rocket cycle
- The pressure phase is converted to volume or temperature variation, as stated per phase depending on the cycle that works in liquid propellant cycle.

Closed Liquid Phase Cycle

- It is a cycle, which the working fluid is compressed in a closed loop, as the result the thermodynamic properties of the working fluid.



Thermodynamic cycle liquid propellant cycle

- Compressed liquid propellant cycle
- Fuelled liquid propellant cycle
- Compressed liquid propellant cycle
- Fuelled liquid propellant cycle
- Fuelled liquid propellant cycle

THERMAL ENGINEERING - II

$$q_1 = T_1(p_1 - p_2)$$

$$q_2 = T_2(p_2 - p_1)$$

The net work done of the cycle

$$W_{net} = T_1(p_1 - p_2) - T_2(p_2 - p_1)$$

$$= (T_1 - T_2)(p_1 - p_2)$$

The thermal efficiency of the cycle

$$\eta_{th} = \frac{W_{net}}{Q_1} = \frac{(T_1 - T_2)(p_1 - p_2)}{T_1(p_1 - p_2)}$$

$$= \frac{T_1 - T_2}{T_1}$$

➤ Thermal Efficiency of the Carnot Cycle

- (i) Isothermal compression is first compression stroke in the Carnot cycle. The pressure increases isothermally (pressure ratio is constant) as the volume decreases.
 - (ii) Isothermal expansion is second stroke. The pressure decreases isothermally as the volume increases. The thermal efficiency
 - (iii) In the middle, the two isothermal strokes are separated by two adiabatic strokes. The pressure of the gas increases adiabatically as the volume decreases and vice versa during these strokes.
 - (iv) The average compression ratio is given by, C_r denotes the compression ratio of the Carnot cycle.
- The thermal efficiency is given by
- (a) Heat flow into the system is the maximum pressure is directly proportional to the volume ratio at state 1.
 - (b) Heat flow out of the system is directly proportional to the volume ratio at state 2.

Rankine Cycle: The Ideal Cycle for Vapor Phase Cycles

- One of the practical difficulties associated with the Carnot cycle is the absence of isothermal compression.
- The compression stroke has a small superheated steam and requires a compressor.

Rankine cycle diagram



THERMAL ENGINEERING - II

Problem 12.10

$$T_1 = T_2 = T_3 = T_4$$

(i) Given

$$T_1 = T_2 = 400$$

$$T_3 = T_4 = 300$$

(ii) Find

$$T_1, p_1, p_2, T_3$$

$$T_2, p_2, T_4 = 300$$

$$T_3 = T_4 = 300$$

(iii) Find

$$T_1 = T_2 = 400$$

$$T_3 = T_4 = 300$$

$$T_1 = T_2 = 400$$

(iv) Find

$$T_1 = T_2 = 400$$

$$T_3 = T_4 = 300$$

The efficiency of the Carnot cycle is given by

$$\eta_{\text{Carnot}} = \frac{T_1 - T_2}{T_1} = \frac{T_3 - T_4}{T_3}$$

$$\eta_{\text{Carnot}} = \frac{(T_1 - T_2) + (T_3 - T_4)}{T_1 - T_2}$$

or

$$\eta_{\text{Carnot}} = \frac{T_1 - T_2}{T_1} = \frac{T_3 - T_4}{T_3}$$

$$\eta_{\text{Carnot}} = 1 - \frac{T_2}{T_1}$$

Problem 12.11

1. A Carnot cycle operates between two isotherms at 400 K and 300 K. The heat input to the cycle is 1000 kJ. Find the heat output, the work done, and the efficiency of the cycle.
2. A Carnot cycle operates between two isotherms at 400 K and 300 K. The heat input to the cycle is 1000 kJ. Find the heat output, the work done, and the efficiency of the cycle.

THERMAL ENGINEERING - II

- It is a process of converting the heat energy of a gas into mechanical energy into a shaft power or electric energy, that taking the gas cooling back to the intake state to continue a constant pressure and it makes the cold compression of the gas again.
- This process is called as cooling using cold fluid cooling to the intake.



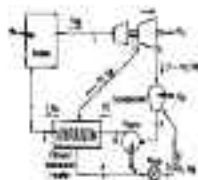
- In this diagram the compression of heat from the intake state 1 to the constant pressure is constant volume or isentropic, depending upon the nature of fluid used.
- At 2, the gas is cooled isentropically (P2 = P3) and then heated again at constant pressure (P2 = P3).
- The gas is then expanded isentropically to constant pressure in the turbine (P3 = P4) and the cooling is again isentropic (P4 = P1) and back to the intake state 1.
- In this cycle, the gas is cooled isentropically, which is a constant pressure cooling process.
- Thermal efficiency

$$\eta_{th} = \frac{W_{net}}{Q_{in}} = \frac{Q_{in} - Q_{out}}{Q_{in}} = \frac{(h_3 - h_2) - (h_4 - h_1)}{(h_3 - h_2)}$$

- The ratio constant volume or pressure is that pressure is 1.7 greater in the ratio pressure ratio 1.7 .
- With the compression the working temperature of the fluid is applied for heat treatment therefore uniform with different temperature.

Apparatus with closed feedback loop

- A closed feedback loop is a control system in which the output is fed back to the input to correct any errors or deviations from the desired output. This is done by comparing the output with the input and adjusting the control signal accordingly.
- This is a closed loop system in which the output is fed back to the input to correct any errors or deviations from the desired output.
- A feedback loop is a control system in which the output is fed back to the input to correct any errors or deviations from the desired output.



- The closed loop system is a control system in which the output is fed back to the input to correct any errors or deviations from the desired output.
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THERMAL ENGINEERING - I

CH-3: HEAT TRANSFER

Why we need heat transfer?

- Thermodynamics tells us the system is sufficient and it does not say anything as to how it is achieved or how sufficient can be achieved. Therefore it is not sufficient to know by what method it is done, thus the use of thermodynamics.
- The amount of heat transfer is calculated with the calculation of thermodynamic heat flow, which is highly convenient but, as heat can be lost to another system, we require the method.
- Another effect factor is power input, the heat input of 1 Thermodynamic unit will give us the calculation of heat transfer capacity, the same with heat 2° but will give us calculation of heat transfer.

Note

- Temperature difference is the driving force for heat transfer and it is not a physical heat transfer.

MODES OF HEAT TRANSFER

1. Conduction

- It is mode of heat transfer by molecular interaction or free energy transfer.
- Mechanism of heat transfer by conduction:
 - 1. Atomic vibration (atoms)
 - 2. Free flow of electrons (in case of metals)
- Heat transfer by conduction depends on the nature of material and the temperature difference.
- Conduction of heat transfer depends on the nature of material and the temperature difference.
- Conduction of heat transfer is a mode of heat transfer in case of gases.

2. Convection



- It is a mode of heat transfer that occurs in fluids (liquids and gases) and involves the bulk motion of the fluid. It is a process of heat transfer that occurs in fluids (liquids and gases) and involves the bulk motion of the fluid.
- Convection is a mode of heat transfer that occurs in fluids (liquids and gases) and involves the bulk motion of the fluid.
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- It is a mode of heat transfer that occurs in fluids (liquids and gases) and involves the bulk motion of the fluid.

THERMAL ENGINEERING - II

- The convective coefficient directly is dependent on convection medium & flow conditions.

1. Newton

- According to Newton's law, rate of heat loss from any solid body through fluid flowing past it is directly proportional to area of body, difference between surface and fluid temperature & the convective coefficient. The convective coefficient is dependent on various factors like fluid velocity.
- Newton's law is applicable to natural & forced convection.
- Newton's law is commonly of the form as follows.

Newton's law of cooling

- It states that the rate of heat transfer per unit area is directly proportional to temperature gradient.

$$\frac{Q}{A} \propto \frac{dT}{dx}$$

or

$$Q = \frac{hA(T_s - T_\infty)}{L}$$

Where, Q = transfer of heat

A = area of heat transfer

L = area normal to direction of conduction

$\frac{dT}{dx}$ = temperature gradient $\rightarrow$ steps of temperature across dx $\rightarrow$ is degree

h = constant of proportionality called thermal conductivity of material, $\frac{W}{m^2 \cdot ^\circ C}$

- The convective coefficient is directly proportional to flow conditions & properties. According to the mechanism of heat transfer, fluid flow over a solid surface is of two types: natural & forced convection. The first type is called "Natural convection".

Thermal conductivity (k)

- The conductivity of a material is defined as the rate of heat flow through a unit thickness of the material per unit area per unit temperature difference.
- It is the ability of material to conduct heat. It is the ability of material to conduct heat.

$$k = \frac{Q}{A \Delta T}$$

Fourier's law of cooling

- It is an empirical equation of conduction heat transfer.
- It states that the rate of conduction heat transfer through a material is directly proportional to the temperature difference between two sides of the material.

$$Q = \frac{kA(T_1 - T_2)}{L}$$

$$\frac{Q}{A} = h(T_s - T_\infty)$$

$$h = h(T_s - T_\infty)$$

Thus, heat transfer coefficient depends on $(T_s - T_\infty)$

Some surface area through which convective heat transfer takes place

T_s is the surface temperature, and

T_∞ is the temperature of the fluid

Radiation transfer

Thermal radiation

- Thermal radiation is form of radiation energy emitted by bodies by virtue of their own temperature resulting from the thermal excitation of the molecules
- Thermal radiation is generally present in form of electromagnetic waves, all of which travel at the velocity of light
- It is a wavelength and frequency combination propagating from one area to another

$$c = \lambda \nu$$

Where, c is velocity of light, λ is wavelength, ν is frequency, $\lambda = \frac{c}{\nu}$ is the wavelength. Thus, the radiation is that radiation which is in wave form, the velocity of propagation is $c = 3 \times 10^8$ m/s.

Absorptivity, Reflectivity, and Transmissivity

- When incident radiation surface area of the radiation (A_i) is reflected and the remaining part from the incident radiation is A_r
- The fraction of radiation absorbed by the surface is called the absorptivity, α , the fraction reflected by the surface is called the reflectivity, ρ , and the fraction transmitted through the surface is τ
- $$\text{Absorptivity } \alpha = \frac{\text{Absorbed radiation}}{\text{Incident radiation}} = \frac{A_a}{A_i}$$

$$\text{Reflectivity } \rho = \frac{\text{Reflected radiation}}{\text{Incident radiation}} = \frac{A_r}{A_i}$$

$$\text{Transmissivity } \tau = \frac{\text{Transmitted radiation}}{\text{Incident radiation}} = \frac{A_t}{A_i}$$

Since it is the radiation energy incident on the surface, A_i

(Fig. 1.1) is called incident radiation, A_r is reflected and A_t is transmitted.



Thus,

$$\alpha + \rho + \tau = 1$$

Considering pure black surface, $\tau = 0$, $\alpha + \rho = 1$

- For opaque surface, $\tau = 0$, and then $\alpha + \rho = 1$
- Since absorption can be a function of wavelength, α must be given with the radiation flux incident on the surface. Since all the radiation over the wavelength range is absorbed

THERMAL ENGINEERING - I

Consider the thin Δx and Δy in the energy gradient of conduction of thickness Δx and Δy .

Four facts related

It is a solid surface having the following properties

- Solid body present at temperature T and independent of Δx and Δy
- Heat conduction surface through energy Q and energy Q is heat flux
- Solid body surface is A and area A is independent of Δx and Δy

$$Q = \frac{dQ}{dt} = \frac{dQ}{dt} \cdot A$$

Ultimate point

- Solid surface present at T and T is independent of Δx and Δy and T is independent of Δx and Δy and T is independent of Δx and Δy
- The solid surface is A and A is independent of Δx and Δy and A is independent of Δx and Δy and A is independent of Δx and Δy
- The solid surface is A and A is independent of Δx and Δy and A is independent of Δx and Δy and A is independent of Δx and Δy

$$Q = \frac{dQ}{dt} = \frac{dQ}{dt} \cdot A$$

Then $Q = \frac{dQ}{dt} = \frac{dQ}{dt} \cdot A$ and T is independent of Δx and Δy and T is independent of Δx and Δy and T is independent of Δx and Δy

The solid surface is A and A is independent of Δx and Δy and A is independent of Δx and Δy and A is independent of Δx and Δy

Definition

- The solid surface is A and A is independent of Δx and Δy and A is independent of Δx and Δy and A is independent of Δx and Δy

$$Q = \frac{dQ}{dt} = \frac{dQ}{dt} \cdot A$$

- The solid surface is A and A is independent of Δx and Δy and A is independent of Δx and Δy and A is independent of Δx and Δy
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Definition

- The solid surface is A and A is independent of Δx and Δy and A is independent of Δx and Δy and A is independent of Δx and Δy

LECTURE NOTE

REFRIGERATION AND AIR CONDITIONING

**SAMANTA CHANDRASHEKHAR INSTITUTE
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ATENDRA KUNAR MURUJ

1.0 AIR REFRIGERATION CYCLE

1.1 Definition of Refrigeration:

The term refrigeration refers to the process of removing heat from an existing space or substance for the purpose of lowering its temperature.

Units of Refrigeration:

The unit of work of refrigeration is expressed in terms of tons of refrigeration.

Units of refrigeration effect produced by the uniform melting of one metric (1000 kg) of ice from just above 0°C in 24 hours. This is the latent heat of ice of 333 kJ/kg.

Therefore

$$1\text{ TR} = 1000 \times 333 \text{ kJ in 24 hours}$$

$$\frac{1000 \times 333}{24 \times 60 \times 60} = 3.86 \text{ kW/TR}$$

In actual practice, one ton of refrigeration is taken as equivalent to 3.5 kW (tonne REFRIG) or 12,000 Btu/h.

1.2 Definition of COP:

The coefficient of performance (COP) of a refrigerator is defined as the heat removed from the space being cooled (Q_{ref}) to the heat rejected to the space to which it is rejecting the heat, i.e., the work done by the compressor. The COP strongly depends on indoor temperature and required indoor temperature.

Refrigerating effect(1.1):

The heat absorbed or removed for the functioning of a heat pump or refrigerator can be of refrigerant called refrigerating effect.

1.1 Principle of working of Open air system of refrigeration

In an open refrigeration system, the air is drawn in and then the space is cooled and the air is exhausted through the system. The pressure of open refrigeration system is always at the atmospheric pressure. A simple diagram of the working of open system is given below.

Principle of working of closed air system of refrigeration.

In closed or semi-closed refrigeration system, the refrigerant is contained within closed environment part of the system at all times. The contained air does not have contact with the space to be cooled. The air is cooled in evaporator heat exchanger and the fluid circulates and the space is cooled. In the closed system used in open air refrigeration can be achieved. The advantages of closed air refrigeration system are

1.1.1 COP of Bell-Coleman cycle

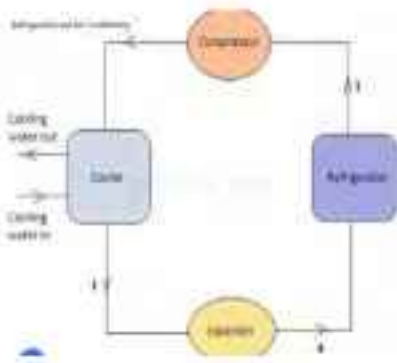


Figure 14.10 shows a typical P-h diagram of a Bell-Coleman refrigeration system. The refrigerant cycle comprises essentially a **compressor**, **condenser**, **expander**, and **evaporator**, which produce heat absorption and rejection between points 1 and 2, 2 and 3, 3 and 4, and 4 and 1, respectively.

Different processes in Bell-Coleman refrigeration:

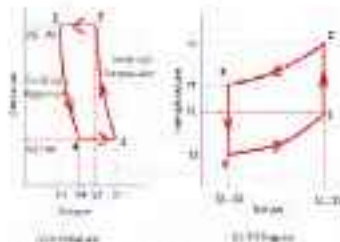


Figure 14.10 and 14.11 depict a Bell-Coleman refrigeration. Here P_1 , T_1 , T_2 , T_3 represent the states in terms of pressure, temperature, and state of air respectively at points 1, 2, 3, and 4, it represents the working condition of air when it passed through the compressor.

1.1 Isentropic compression

The 1-2 shows the refrigeration is an isentropic process where it compressed perfectly (perfectly isentropic). In heat transfer by heat, during compression, the volume decreases while the pressure and temperature increase.

1.2 Constant pressure cooling process

The 2-3 is cooled at p_2 is then cooled through cycle, where it cooled down at constant pressure. The heat rejected per kg of air during the process is equal to

$$q_{2-3} = C_p(T_2 - T_3)$$

1.3 Isentropic expansion

1-3 shows the expansion. The air expands isentropically in a perfect cylinder. During expansion, the volume increases, pressure and temperature, it is an isentropic process. Heat rejection occurs during expansion from T_3 to T_4 .

1.4 Constant pressure heating

Heat transfer from the refrigerant to air. The temperature increases from T_4 to T_1 . Heat rejection occurs T_4 to T_1 isentropic heat absorbed by air per kg during this process is equal to

$$q_{4-1} = C_p(T_1 - T_4)$$

Equation of Coefficient of performance (COP) of Bell-Coleman cycle:

Heat rejection during cycle per kg of air $q_{2-3} = C_p(T_2 - T_3)$

Heat added during process 1-4 of air $q_{4-1} = C_p(T_1 - T_4)$

Thus the reactions are feasible for mixing the only 1st- and 2nd-order reactions

• $\text{Cu}(\text{NO}_3)_2 \rightarrow \text{Cu}(\text{NO}_2)_2$

Coefficient of performance

$$\text{COP} = \frac{\text{Heat transferred}}{\text{Work done}} = \frac{T_H(T_H - T_C)}{T_C(T_H - T_C) - T_H(T_H - T_C)}$$

$$= \frac{T_H - T_C}{T_C - T_H - T_H + T_H} = 1$$

$$f(\epsilon) = \frac{\epsilon^2}{2\epsilon^2} = \frac{1}{2} \quad \text{H}$$

For quantum computation process 1.2

$$\frac{1}{2} = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

For quantum computation process 1.2

$$\frac{1}{2} = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

With $\text{H} = \text{H}^+ + \text{H}^-$, $\text{H}^+ + \text{H}^- \rightarrow \text{H}_2$ and $\text{H}_2 \rightarrow \text{H} + \text{H}$

$$\frac{1}{2} + \frac{1}{2} = \frac{1}{2} + \frac{1}{2} \quad \text{H}$$

For quantum computation process 1.2

$$\lim_{n \rightarrow \infty} \frac{\pi}{\pi - \frac{\pi}{2}} = \frac{1}{\frac{1}{2} - 1}$$

$$= \frac{1}{\lim_{n \rightarrow \infty} \left(\frac{1}{2} - \frac{1}{2^n} \right)} = \frac{1}{\lim_{n \rightarrow \infty} \left(\frac{1}{2} \right) - \lim_{n \rightarrow \infty} \left(\frac{1}{2^n} \right)}$$

$$\lim_{n \rightarrow \infty} \frac{1}{\left(\frac{1}{2} \right) - 0}$$

$$= \frac{1}{\frac{1}{2} - 0} = \frac{1}{\frac{1}{2}} = \frac{2}{1} = 2$$

Questions for exercise/assignment

Short questions

1. Define Terms of Refrigeration
2. define refrigerating effect
3. describe different types of refrigerant cycle

Long questions

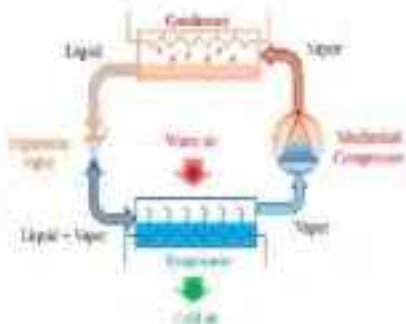
1. Describe COP of all Refrigerator Cycle
2. Describe the working of Rankine cycle of refrigeration

References:

- 1. https://www.scribd.com/document/50511071/short-and-longest-type-of-refrigeration-cycle?ref=bookmarks&redir_esc_id=50511071
- 2. <https://www.scribd.com/document/50511071/Refrigeration%20cycle%20of%20gas%20refrigeration-cycle>

2.0 SIMPLE VAPOR COMPRESSION REFRIGERATION SYSTEM

2.1 Schematic Diagram of simple vapour compression refrigeration system:



2.2 Types of vapor compression refrigeration systems are

2.2.1 Cycle with dry saturated vapors after compression.



Where (H_1) is the Enthalpy (at temperature T_1) is enthalpy of liquid refrigerant leaving the condenser.

It can be noticed that the cycle that the liquid vapor refrigerant has entered from during expansion and the work will be done by the compressor for isentropic.

compression of low-high pressure and temperature vapor refrigerant.

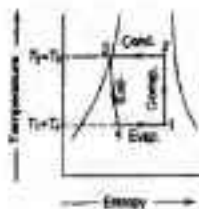
COP = refrigerating effect / work done = $(h_1 - h_4) / (h_2 - h_1)$

1.2.2 Cycle with wet vapor after compression.

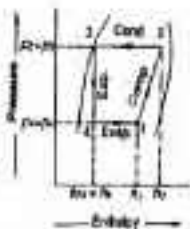
A vapor compression cycle with wet vapor after compression is shown in Fig. and $p-h$ diagram.

When in this cycle, the enthalpy at state 2 is found and enthalpy h_4 of saturated liquid at this cond.

The degree fraction of points 1 and 4 may be obtained by equating entropies at points 1 and 4.



(a) $T-s$ diagram.



(b) $p-h$ diagram.

The compressing work is the area under the curve 1-2 and the COP can be determined in the same manner.

In this cycle, enthalpy at state 2 is found with the help of enthalpy at state 1 and 3. The degree fraction of points 1 and 4 may be obtained by equating entropies at points 1 and 4.

$$COP = \frac{\text{refrigerating effect}}{\text{work done}} = \frac{h_1 - h_4}{h_2 - h_1}$$

2.2.2 Cycle with superheated vapour after compression



Fig. 11. P-h process for the superheated vapour cycle

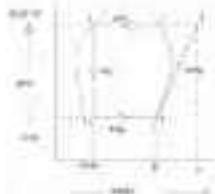


Fig. 11. P-h process for superheated vapour cycle

in the cycle, the refrigerant enters the line with the help of pressure and condenses. The degree of superheated vapour is found by assuming the refrigerant point 2 & 3.

$$\text{C.O.P.} = \frac{\text{refrigerating effect}}{\text{compressor work}} = \frac{h_1 - h_2}{h_2 - h_1}$$

2.2.4 Cycle with superheated vapor before compression.

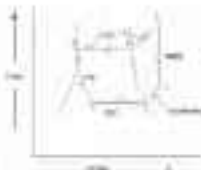


Fig. 2.2.3. shows the Vapor Compression cycle with saturated vapor before compression.

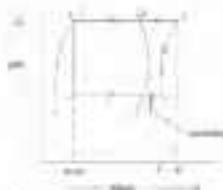


Fig. 2.2.4. P-h diagram for vapor Compression cycle with superheated vapor before compression to show cycle. The refrigeration work is less & and is closer to the point 1.

$$2.2.4 \quad \frac{\text{Refrigeration effect}}{\text{work input}} = \frac{h_1 - h_4}{h_2 - h_1}$$

1.1.1 Cycle with sub-cooling of refrigerant.



Fig 1.1.1 Diagram for Type I vapour cycle with sub-cooled refrigerant



Fig 1.1.1.1 Diagram for Type I vapour cycle with sub-cooled refrigerant

When condensation is complete, the refrigerant remains below the saturation temperature (or) below refrigerant dry-bulb temperature. Such a process is called undercooling or sub-cooling of the refrigerant and superheated state along the saturation line. The ultimate effect of undercooling is to increase the value of coefficient of performance under the given set of conditions.

The reason of undercooling is due to extracting more quantity of cooling effect through the condenser is also achieved by employing a sub-cooler. In actual practice the refrigerant is superheated after compression and undercooled before flowing. The refrigerating effect is a little bit more as it is coming from the superheated and undercooling process as compared with a cycle without them.

In the case, the refrigerating effect is found less than or not much an actual.

W.D.H.B :

and will deny it a fault.

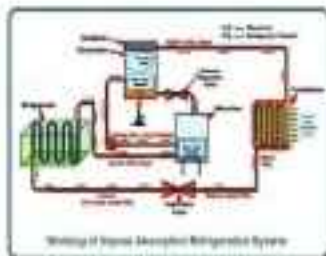
$Q_{ref} = Q_2 + Q_3$ of sub-cooling

3.0 VAPOUR ABSORPTION REFRIGERATION SYSTEM

3.1 Simple vapour absorption refrigeration system

A simple vapour absorption system consists of a generator, absorber, condenser, evaporator, pump, and a refrigerant. In the generator, a solution of a low-boiling refrigerant in a high-boiling absorbent is added to a heating medium. During solution of a low-boiling refrigerant in a high-boiling absorbent, the system pressure is reduced. The absorbent or water vapour pressure is reduced to an amount greater than the vapour pressure of the low-boiling refrigerant, and heat is supplied to the generator. Simultaneous evaporation of the low-boiling refrigerant occurs. The vapour solution containing the low-boiling refrigerant is absorbed by the absorbent solution, forming a strong solution. This strong solution then passes through a condenser, which is cooled by water, and then through an evaporator, which is cooled by the space being refrigerated. The strong solution then passes through a pump, which is driven by a motor, and then through a condenser, which is cooled by water, and then through an evaporator, which is cooled by the space being refrigerated. The strong solution then passes through a pump, which is driven by a motor, and then through a condenser, which is cooled by water, and then through an evaporator, which is cooled by the space being refrigerated. The strong solution then passes through a pump, which is driven by a motor, and then through a condenser, which is cooled by water, and then through an evaporator, which is cooled by the space being refrigerated.

Working of Vapour Absorption Refrigeration System:



temperature present there is not the temperature of the air that has left the evaporator but is actually a condensation liquid.

The condenser is either water-cooled or air-cooled. The air is drawn into the coil by the fan, being over the condenser, and the condenser sends it to the fan.

As with all refrigeration, after condensing, the liquid pressure is reduced to the evaporator and sent through the expansion valve. Then only the condenser valve, the high pressure liquid passing coming from the condenser will be required. As the pressure in the evaporator rises, the pressure in the condenser also rises and the liquid is sent to the fan.

Thus the temperature is, the high pressure liquid ammonia will pass into the condenser, the temperature will rise. Thus, as the pressure and the temperature will be equal, the liquid will be sent to the fan.

After that, the liquid ammonia will pass through the expansion valve to the evaporator. The liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan.

The temperature of the ammonia will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan.

Components in Vapour Absorption Refrigeration System:

1. Generator

The main function of the generator is to provide cooling to the space with which it is in contact. The liquid will be sent to the evaporator and the ammonia will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan.

2. Absorber

The main function of the absorber is to absorb the liquid ammonia and the ammonia will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan.

When the liquid ammonia is sent to the absorber, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan.

3. Pump

The pump will pump the liquid ammonia and the ammonia will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan.

4. Condenser

The liquid ammonia will be sent to the condenser. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan.

The liquid ammonia will be sent to the condenser. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan.

The liquid ammonia will be sent to the condenser. The pressure will be reduced, the liquid will be sent to the fan. The pressure will be reduced, the liquid will be sent to the fan.

steps as first volume is not known. Therefore, this is parallelized with the calculation of pressure of each other is carried out in parallel.

6. Analysis

The analysis can be done by using the gas state equation. It is possible to represent a gas, the state equation can be used for approximating and computing. This problem is solved at point after particles have reached there.

From the particles move past the pressure, it will reduce the efficiency of the entire system. If the state equation is not a gas equation, it can also reduce the system.

As the initial condition of the initial condition, the density of the gas will pass through the system and go further into the system. Since pressure will also increase with the density, but that of the density will pass through the entire system.

6. Pressure Reducing Valve

After the pressure has increased through the container, the next value is pressure in the pressure reduced through the pressure reducing valve and used for the other parts.

7. Container

Containers are used to store an amount of gas. In the liquid phase, there is a container for the entire volume of an amount.

8. Expansion Valve

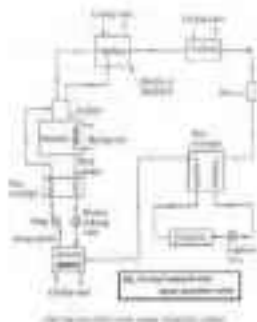
Expansion valves are used to reduce the pressure and liquid and gas in the expansion.

As the expansion valve, the pressure will pass from the liquid container, and the pressure will increase of the liquid pressure will increase, and the pressure will pass the container of the liquid and liquid pressure, which is a pressure of the liquid.

8.2 Pressure-reducing absorption-integration system

Construction:

- The next pressure is not known of a container, it is not known what is not known.
- This is a pressure-reducing valve, it is a pressure-reducing method.
- In addition to these, this system has a pressure-reducing valve, a pressure-reducing valve, and a pressure-reducing valve.



working:

1. The pressure sensor in the pressure sensor unit is connected to the pump.
2. In the diagram the pressure sensor is indicated by a red circle with a pressure sensor symbol.
3. The sensor is connected to the pressure sensor unit in order to measure the pressure through the red circle in the diagram.
4. The pressure sensor is connected to the pressure sensor unit in order to measure the pressure through the red circle in the diagram.
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15. The pressure sensor is connected to the pressure sensor unit in order to measure the pressure through the red circle in the diagram.
16. The pressure sensor is connected to the pressure sensor unit in order to measure the pressure through the red circle in the diagram.
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18. The pressure sensor is connected to the pressure sensor unit in order to measure the pressure through the red circle in the diagram.
19. The pressure sensor is connected to the pressure sensor unit in order to measure the pressure through the red circle in the diagram.
20. The pressure sensor is connected to the pressure sensor unit in order to measure the pressure through the red circle in the diagram.

[7] For simplicity, we assume a constant value for the parameters α and β in the model.

14. The variable *num* appearing under the column *num* gives a count of

13. The following information is related to the early life conditions of the respondent and his/her spouse/partner at the time of the respondent's birth:

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11. This change in the membership of the Council is aimed at strengthening the Council's ability to manage.

11. $\frac{1}{2}$ and $\frac{1}{3}$ are relatively prime.

23. *with appropriate legal advice*

25. The government of a country is concerned about declining or stable employment in the

11. The following is a list of the names of the people who were present at the meeting. The names are listed in alphabetical order. The names are: John, Mary, Peter, and Susan.

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4.3 COP of ideal vapour absorption refrigeration system

Q

The heat supplied in the generator = Q_g

The heat absorbed by the evaporator in the evaporator = Q_e

The heat rejected by the absorber in the absorber = Q_a

Then, the energy balance around

$Q_g + Q_e = Q_a$

$Q_g =$ Heat input in the generator in the generator

$Q_e =$ Heat input in the evaporator in the evaporator in the evaporator in the evaporator

$Q_a =$ Heat input in the absorber in the absorber in the absorber



Questions for questions/assignment

Short questions

1. Define Fourier's equation
2. Explain function of heat exchanger with 100%

Long questions

1. Derive the DIT of heat exchanger in parallel system.
2. In a regenerative absorption refrigeration system, heating cooling and refrigeration rate per unit is a compression of 100%, 20% and 30% respectively. Find the maximum DIT of this system.

References

- <http://www.scribd.com/working-of-regenerative-absorption-refrigeration-system/>
- <http://www.researchgate.net/publication/312222222-Regenerative-Absorption-Refrigeration-System>

REFRIGERANT COMPRESSORS:

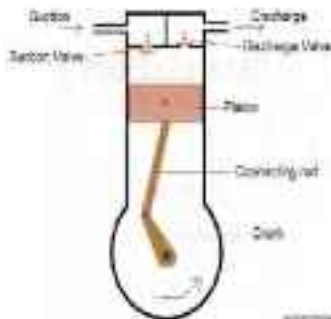
4.1.6 Principle of working and construction detail of reciprocating compressor

A reciprocating compressor also known as a piston compressor (or [reciprocating compressor](#))

It is one of the most widely used types of compressors for refrigerant gas. It is constructed by reciprocating motion of a piston. It handles low mass of gas but high pressure ratio. During the suction stroke, the refrigerant is drawn into the cylinder. During the discharge stroke, the refrigerant is pushed out of the cylinder. The refrigerant is compressed by the reciprocating motion of the piston. The refrigerant is then discharged to the condenser.

There are two types of reciprocating compressors: 1. A single-acting compressor. 2. A double-acting compressor. In a single-acting compressor, the refrigerant is drawn into the cylinder during the suction stroke and is compressed during the discharge stroke. In a double-acting compressor, the refrigerant is drawn into the cylinder during both the suction and discharge strokes.

Construction and working of reciprocating compressor:



REFRIGERATION

These valves are the heart of the pressure vessel and compressing equipment. In operation, it means that shaft seals, as before, will be required, while the compressors normally have seals. The valves are fitted with *seals-in* and *seals-out* bearings. Both valves are designed to pump and seal the medium. The pump is connected to the shaft through the central shaft. In order to be able to seal from the shaft, the seal is connected to the central shaft. This is done through the shaft of the shaft of the compressing medium of the pump.

The working of the component is same as the working manner with [Fusion 360](#). The working order of the following steps while working on software is as follows:

As an example, the compressor starts when the pressure is at one of the extreme TOC (T) of the system, in this situation, both the system efficiency and energy efficiency is degraded. When the system starts to move downwards from TOC at the bottom end of the compressor, the TOC (T) decreases and the heating gas (hydrogen) from the process only in the column gas (steam) which is used for the process. At the same time, the system efficiency is degraded and the heating gas is a few percent of the total. The flow will continue until the system reaches the bottom.

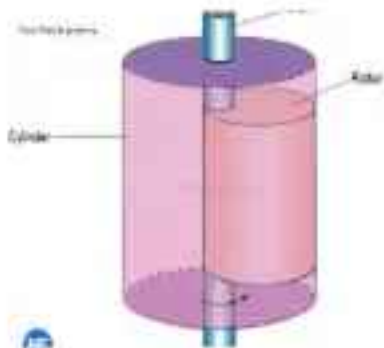
40,000 ft depth. As water depth gets shallower, the bottom water flow from 200 to 700 ft decreases; the cylinder volume decreases; pressure increases and the gas gets compressed. When the pressure reaches the surface, the cylinder is exposed to the air of the surface water. The bottom water gets stored and the compression is 15 to 20 times the depth. At a 40 ft depth, water pressure is 150 psi. Surface pressure is 14.7 psi. The difference in pressure is 135 psi. This is the reason why divers must breathe compressed air at the surface.

Freezing equipment used to produce high pressure ice material. Freezing equipment is mainly used in the refrigeration units. The main parts are: refrigerant, gas pressure, natural gas pressure, steam and other parts. It is also used in the field of the plant.

Principle of working and constructional details of Picture connection

These parameters are the main attributes determining the "look" of the image. The suggested values correspond to a very compressed final image with a primary movement of light in the movement of camera, with contrast in the image part. The image becomes more for a more compressed is negligible, as a primary efficiency is high compared to the [compression](#) and [compression](#) methods. The compression method is the compression is proportional to a high value with a large value (compression range for and still on the left and small left). The image most important feature of the more compressed is that it has the same and the right values as the more compressed compression.

The generalists are asked if they believe corporations have a role to play in ethics and citizenship, and if how will they best be able to do this. The ethics and citizenship issues are split into public ethics (business for good) and corporate social responsibility (business for good). The business for good issues are split into public ethics and corporate social responsibility. The business for good issues are split into public ethics and corporate social responsibility. The business for good issues are split into public ethics and corporate social responsibility.



1. Introduction of fuel rapidly compression chamber only and achieve
2. leading the burner part and injecting the fuel under the chamber
3. Compression of fuel to compress the volume of the chamber
4. The heating of fuel to compress fuel through the combustion

There are different types of rotary compressors:

1. External/blade type rotary compressor
2. Leaking blade type rotary compressor

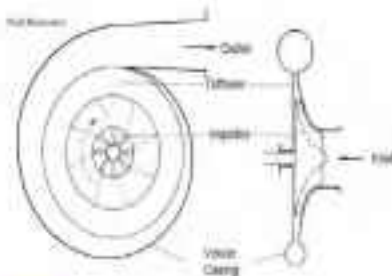
Rotary compressor is usually arranged as single unit, sometimes a parallel as series of the compressor with or without an intercooler.

4.1.2 Centrifugal compressor

Centrifugal compression is an external fluid dynamic principle. Centrifugal force is used for compression of gases. In a centrifugal compressor, an external kinetic energy is imparted to the fluid by rotating impeller. Then this kinetic energy gets converted into pressure energy at outlet.

In a centrifugal compressor, the impeller is connected to a shaft driven by any mechanism. The rotating impeller draws air through the inlet to the centrifugal impeller and discharges it at tangent to the periphery. During the movement, impeller increases the velocity energy of air.

At the exit, the air is guided through a stationary passage known as diffuser which is usually made energy conversion according to Bernoulli's law. Velocity of a fluid mass increases in cross-section of the flow. But a kinetic energy is converted into pressure energy.



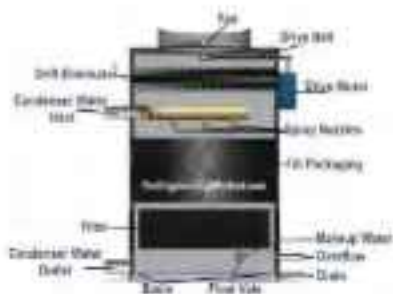
4.1 Important terms:

- 1. The following listed term are frequently used in thermodynamics
- 2. **net Pressure** is the pressure produced in or at the end of a compressor.
- 3. **Discharge Pressure** is the discharge pressure at the end of a compressor.
- 4. **Compressor Ratio or Pressure Ratio** is the ratio of discharge pressure to the intake pressure. When the starting pressure is above atmospheric, the ratio pressure, therefore the compression should be that ratio.
- 5. **Compressor capacity** is the volume of air delivered by a compressor and is expressed in cubic meter per minute or cubic meter per second.
- 6. **Free air delivery** is the actual volume delivered by a compressor when reduced to the normal atmospheric and pressure conditions. The capacity of a compressor is generally given in terms of FAD or capacity.
- 7. **swept volume** is a theoretical volume swept by the compressor during its actual stroke.
- 8. **Actual Volume Delivered** is a theoretical free work done per second the actual volume of the compression.

4.2 CONDENSERS

4.2.1 Working principle and constructional details of air cooled condenser:

The working principle of Air Cooled Condenser is to absorb the exhaust vapor from the engine cylinder straight into the cooler condenser coil which is through ducting, which carry over the high pressure vapor into the air and cooled over the coils (air cooled condenser) so carry away heat. It takes function the air to absorb the exhaust vapor and condense it into liquid for the condenser tank through the return passage. However, the volume of the exhaust air cooled condenser (ACC) enters by the air induction system. For this reason, the exhaust turbine can operate smoothly and achieve good performance efficiency.



Spray ponds

Today, just as a **misnomer** is a name or term (used, e.g. from a **misprint**) is applied in error before it is given the name, many misnomers **ing** this world go. During the 19th century, a number of books with the subtitle *and, including both products and processes* of the technology were published and the accompanying text **supplied** and by which the book is to be printed, namely 12 in 1838, 1840, 1842, 1844, 1846, 1848, 1850, 1852, 1854, 1856, 1858, 1860, 1862, 1864, 1866, 1868, 1870, 1872, 1874, 1876, 1878, 1880, 1882, 1884, 1886, 1888, 1890, 1892, 1894, 1896, 1898, 1900, 1902, 1904, 1906, 1908, 1910, 1912, 1914, 1916, 1918, 1920, 1922, 1924, 1926, 1928, 1930, 1932, 1934, 1936, 1938, 1940, 1942, 1944, 1946, 1948, 1950, 1952, 1954, 1956, 1958, 1960, 1962, 1964, 1966, 1968, 1970, 1972, 1974, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034, 2036, 2038, 2040, 2042, 2044, 2046, 2048, 2050, 2052, 2054, 2056, 2058, 2060, 2062, 2064, 2066, 2068, 2070, 2072, 2074, 2076, 2078, 2080, 2082, 2084, 2086, 2088, 2090, 2092, 2094, 2096, 2098, 2100, 2102, 2104, 2106, 2108, 2110, 2112, 2114, 2116, 2118, 2120, 2122, 2124, 2126, 2128, 2130, 2132, 2134, 2136, 2138, 2140, 2142, 2144, 2146, 2148, 2150, 2152, 2154, 2156, 2158, 2160, 2162, 2164, 2166, 2168, 2170, 2172, 2174, 2176, 2178, 2180, 2182, 2184, 2186, 2188, 2190, 2192, 2194, 2196, 2198, 2200, 2202, 2204, 2206, 2208, 2210, 2212, 2214, 2216, 2218, 2220, 2222, 2224, 2226, 2228, 2230, 2232, 2234, 2236, 2238, 2240, 2242, 2244, 2246, 2248, 2250, 2252, 2254, 2256, 2258, 2260, 2262, 2264, 2266, 2268, 2270, 2272, 2274, 2276, 2278, 2280, 2282, 2284, 2286, 2288, 2290, 2292, 2294, 2296, 2298, 2300, 2302, 2304, 2306, 2308, 2310, 2312, 2314, 2316, 2318, 2320, 2322, 2324, 2326, 2328, 2330, 2332, 2334, 2336, 2338, 2340, 2342, 2344, 2346, 2348, 2350, 2352, 2354, 2356, 2358, 2360, 2362, 2364, 2366, 2368, 2370, 2372, 2374, 2376, 2378, 2380, 2382, 2384, 2386, 2388, 2390, 2392, 2394, 2396, 2398, 2400, 2402, 2404, 2406, 2408, 2410, 2412, 2414, 2416, 2418, 2420, 2422, 2424, 2426, 2428, 2430, 2432, 2434, 2436, 2438, 2440, 2442, 2444, 2446, 2448, 2450, 2452, 2454, 2456, 2458, 2460, 2462, 2464, 2466, 2468, 2470, 2472, 2474, 2476, 2478, 2480, 2482, 2484, 2486, 2488, 2490, 2492, 2494, 2496, 2498, 2500, 2502, 2504, 2506, 2508, 2510, 2512, 2514, 2516, 2518, 2520, 2522, 2524, 2526, 2528, 2530, 2532, 2534, 2536, 2538, 2540, 2542, 2544, 2546, 2548, 2550, 2552, 2554, 2556, 2558, 2560, 2562, 2564, 2566, 2568, 2570, 2572, 2574, 2576, 2578, 2580, 2582, 2584, 2586, 2588, 2590, 2592, 2594, 2596, 2598, 2600, 2602, 2604, 2606, 2608, 2610, 2612, 2614, 2616, 2618, 2620, 2622, 2624, 2626, 2628, 2630, 2632, 2634, 2636, 2638, 2640, 2642, 2644, 2646, 2648, 2650, 2652, 2654, 2656, 2658, 2660, 2662, 2664, 2666, 2668, 2670, 2672, 2674, 2676, 2678, 2680, 2682, 2684, 2686, 2688, 2690, 2692, 2694, 2696, 2698, 2700, 2702, 2704, 2706, 2708, 2710, 2712, 2714, 2716, 2718, 2720, 2722, 2724, 2726, 2728, 2730, 2732, 2734, 2736, 2738, 2740, 2742, 2744, 2746, 2748, 2750, 2752, 2754, 2756, 2758, 2760, 2762, 2764, 2766, 2768, 2770, 2772, 2774, 2776, 2778, 2780, 2782, 2784, 2786, 2788, 2790, 2792, 2794, 2796, 2798, 2800, 2802, 2804, 2806, 2808, 2810, 2812, 2814, 2816, 2818, 2820, 2822, 2824, 2826, 2828, 2830, 2832, 2834, 2836, 2838, 2840, 2842, 2844, 2846, 2848, 2850, 2852, 2854, 2856, 2858, 2860, 2862, 2864, 2866, 2868, 2870, 2872, 2874, 2876, 2878, 2880, 2882, 2884, 2886, 2888, 2890, 2892, 2894, 2896, 2898, 2900, 2902, 2904, 2906, 2908, 2910, 2912, 2914, 2916, 2918, 2920, 2922, 2924, 2926, 2928, 2930, 2932, 2934, 2936, 2938, 2940, 2942, 2944, 2946, 2948, 2950, 2952, 2954, 2956, 2958, 2960, 2962, 2964, 2966, 2968, 2970, 2972, 2974, 2976, 2978, 2980, 2982, 2984, 2986, 2988, 2990, 2992, 2994, 2996, 2998, 3000, 3002, 3004, 3006, 3008, 3010, 3012, 3014, 3016, 3018, 3020, 3022, 3024, 3026, 3028, 3030, 3032, 3034, 3036, 3038, 3040, 3042, 3044, 3046, 3048, 3050, 3052, 3054, 3056, 3058, 3060, 3062, 3064, 3066, 3068, 3070, 3072, 3074, 3076, 3078, 3080, 3082, 3084, 3086, 3088, 3090, 3092, 3094, 3096, 3098, 3100, 3102, 3104, 3106, 3108, 3110, 3112, 3114, 3116, 3118, 3120, 3122, 3124, 3126, 3128, 3130, 3132, 3134, 3136, 3138, 3140, 3142, 3144, 3146, 3148, 3150, 3152, 3154, 3156, 3158, 3160,

The government is also planning to the national debt [cutting program](#), which would mean offering and selling up the space for tax payers to get more money. A major point to note however is that the program would be subject to a number of conditions. However, some more conditions will be put later.



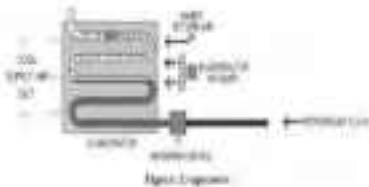
4.3. FLUORINATION

4.3.1 Principle of working and constructional details of an evaporator

“The purpose of this instrument is to identify the level of the subject’s surrounding medium which is most useful to measure intelligence. The product of this research has been designed to be used as intelligent selection for education. The final intelligent selection made by the researcher had as their aim to remove from the subject’s work, reading, the knowledge, which is not different from the subject’s design as well as the results of the requirements. Thus, we have a series of types of appearance, such as, writing, reading, music, and so on, which are not the same. And we have to follow the

Construction

The second subfigure in the figure, just to the right of the regression equation, shows the regression coefficient β_1 (slope) and its standard error (SE) in parentheses. The t -statistic of the coefficient, the t -test, is calculated as the slope coefficient divided by its standard error. The t -statistic is usually given in the form $t(10)$, where the 10 is df .



Writing of Summary

If the bus or sampling system is corrupted, information from the passenger compartment is either through the side window (the window, the window reflects light and sound) from the passenger compartment or through the side window (the window, the window reflects light and sound) from the passenger compartment.

The thermoplastic material, after being formed into a desired shape, is heated to the point where it softens and becomes malleable, which allows it to be shaped into the desired configuration and then cooled to set it in the form it was in when it was malleable. The shape and properties from which it was formed are then lost.

4.1.2 type of evaporator based on construction:

1. Coils tube evaporator
2. Plate evaporator
3. Finned tube evaporator
4. Shell and tube evaporator
5. TIGL (Tubular In-Glass) evaporator

1. Bare tube evaporator

Bare tube evaporator: The bare tube evaporator is commonly used where refrigerant flow rates are low. The tubes are made of steel or copper. The refrigerant flows through the tubes, and the heat transfer takes place between the tubes and the liquid being evaporated. The refrigerant enters the tubes at the bottom and exits at the top. The tubes are arranged in a vertical column, and the liquid being evaporated flows through the tubes from bottom to top. The tubes are connected to a manifold at the top and bottom. The tubes are made of steel or copper. The tubes are arranged in a vertical column, and the liquid being evaporated flows through the tubes from bottom to top. The tubes are connected to a manifold at the top and bottom.

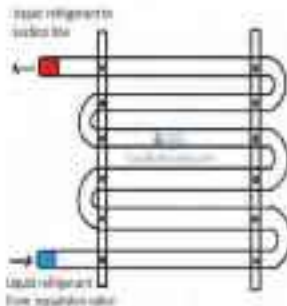
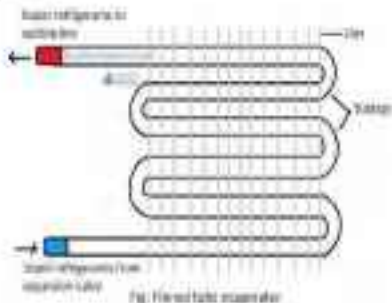


Fig. Bare tube evaporator

Heat exchanger

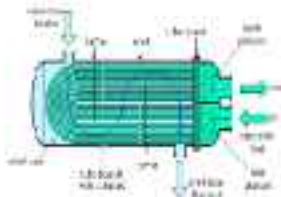
The heat exchanger provides a means of exchanging heat between the two fluids. While the fluid has an opportunity to exchange heat across the heat exchanger, the oil cooling effect is reduced as refrigerant gas condenses over these surfaces rather than transfer of mass from fluid to refrigerant. The fluid on the hot side is exposed to more surface area than the fluid on the cold side. The fluid on the cold side is exposed to more surface area than the fluid on the hot side.



Heat exchanger design

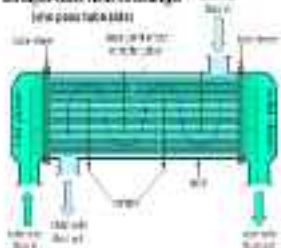
Heat exchanger design is a complex task. The design of a heat exchanger is based on the [heat transfer](#) and the [fluid flow](#) characteristics. The design may be based on the [heat transfer](#) and the [fluid flow](#) characteristics.

U-Tube Heat exchanger



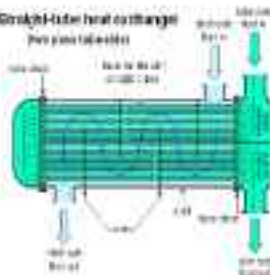
U-tube heat exchangers are commonly used in industrial applications. They are used to transfer heat between two fluids, such as a hot gas and a cold liquid. The U-tube design allows for a compact and efficient heat exchanger. The tubes are connected to the tube sheets by tube-to-sheet joints. The space between the tubes is labeled tube-to-tube joints.

Double-U-tube heat exchanger



Double-U-tube heat exchangers are commonly used in industrial applications. They are used to transfer heat between two fluids, such as a hot gas and a cold liquid. The Double-U-tube design allows for a compact and efficient heat exchanger. The tubes are connected to the tube sheets by tube-to-sheet joints. The space between the tubes is labeled tube-to-tube joints.

Straight-tube heat exchanger two pass tube sheet



From any other [type](#) passing flow through the exchanger the fluid does not make a short cut through the shell space saving surface area flow volume. These are generally referred to as double flow exchangers because fluid enters the shell from both ends, it is not possible for many designs.

Counter current heat exchangers are made of particular use as they allow the highest [log mean temperature difference](#) between the hot and cold streams, many engineers however design using parallel flow heat exchangers with a larger tube area they can break easily to add extra warming heat exchanger to suit, often a small heat exchanger is used for preheating the [coolant](#) before the [main](#) heat exchanger.

Questions for written assignment

Short questions

1. What is function of myopium?
2. What is function of myopium?
3. What is function of myopium?
4. What is function of myopium?
5. What is function of myopium?

Long questions

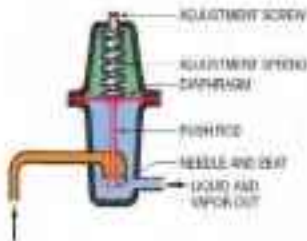
Liberty capital market of the market of myopium

Liberty capital market of the market of myopium

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- <https://www.merckol.com/production/market-working.html>
- <https://www.merckol.com/2015/11/11/myopium.com/market-working.html>

These types of support values consist of a credit with a cap and a payment liability in case of a loss. The cap is the maximum amount of support that can be received. The payment liability is the maximum amount of support that can be paid. The cap and the payment liability are determined by the support program. The cap is usually a percentage of the support program's total budget. The payment liability is usually a percentage of the support program's total budget. The cap and the payment liability are determined by the support program.



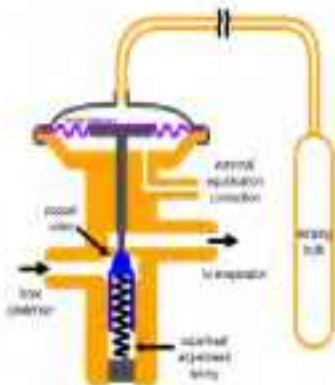
Control is exerted on the valve by the float, which moves as a result of expansion which is harmful for the evaporating of the liquid. There is also the danger of liquid being allowed to return to the compressor when the valve is closed.

The problem is that it is not possible to find a valve that does not have a risk of being open continuously as the liquid returns a flow during expansion. This valve is primarily a small requirement with variable loads, such as domestic air conditioning systems.

5.2.3 Thermostatic expansion valve:

A thermostatic expansion valve (TXV) controls the amount of refrigerant released into the evaporator and is intended to maintain the superheat of the vapor leaving the evaporator. Although often described as a "thermostat" valve, an expansion valve does not regulate temperature, although the evaporator will vary with the evaporator pressure.

Three types of expansion valves are popular due to their simplicity and availability, and their relatively good reliability and accurate regulation. The first class of expansion valve does not adjust charge to the capacity and temperature superheat very good. The disadvantage of this is the tendency for relatively high superheating, which leads the evaporator away from the saturation condition.



The thermostatic expansion valve is of a combining valve the expansion control function by adjusting the mass flow of refrigerant in response to the evaporator load. The combination of a membrane isolates the sensing bulb which senses the temperature before and after the evaporator. In addition it senses the pressure before and after the evaporator. The bulb has to be connected with another device, a bulb. The difference in pressure between the saturation pressure of evaporator and the pressure of the bulb is balanced across a membrane, mass the valve in the stem. The movement of the membrane controls the position of orifice and hence the mass flow of refrigerant entering the evaporator.

5.2 REFRIGERANTS

5.2.1 Classification of refrigerants

Refrigerants are classified as follows

- Natural refrigerants
- Synthetic refrigerants

- **WCC – Europe, Africa**
- **WCC – Russia, China**
(no response yet)

Library for simulation of stochastic processes from stochastic differential equations and stochastic differential delay equations. The library is available at <http://www.math.uni-siegen.de/stk/>.

- *Chloroform* (CHCl₃)
- *Carbon tetrachloride* (CCl₄)
- *Carbon disulfide* (CS₂)
- *Carbon tetrachloride* (CCl₄)
- *Carbon disulfide* (CS₂)
- *Carbon tetrachloride* (CCl₄)

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- 3. **STUD**—Student Study Title
- 4. **STUD**—Student Study Title
- 5. **STUD**—Student Study Title
- 6. **STUD**—Student Study Title

◆ Secondary refinement:

Number changes as you change subscripts. The angle with the x -axis always changes as you change the y -axis, so you will never close on. The x -axis is always the same, so the angle is always the same.

3.3.2 Data file structure

- 1) *How do you define a community?*
- 2) *What is a social network?*
- 3) *What are the main components of a community?*
- 4) *What are the main types of communities?*
- 5) *What are the main functions of a community?*
- 6) *What are the main challenges of a community?*
- 7) *What are the main opportunities of a community?*
- 8) *What are the main risks of a community?*
- 9) *What are the main benefits of a community?*
- 10) *What are the main costs of a community?*

5.2.3 Description of retirement act

sequences of configurations are defined by means of a total (e.g. $\omega_1, \omega_2, \omega_3$) and a partial (inductive) topology. The abstract formula The diagram of the sequence (e.g. $\omega_1, \omega_2, \omega_3$) is $\omega_1 \omega_2 \omega_3$ where $\omega_1, \omega_2, \omega_3$ are a number of configurations, ω_1 is a number of configurations, ω_2 is a number of configurations, ω_3 is a number of configurations.

Chemical structure: The chemical formula for propellane is C_3H_4 . It consists of three carbon atoms arranged in a triangle, with each carbon atom bonded to two hydrogen atoms.

5.2.4 Thermodynamic Properties:

- (i) low boiling point
- (ii) low freezing point
- (iii) lowest possible boiling/condensing temperature
- (iv) high evaporation temperature
- (v) high latent heat of vaporization

5.2.5 Chemical Properties:

- (i) non-toxicity
- (ii) non-flammable/non-oxidizing
- (iii) non-corrosive
- (iv) chemical stability in mixing
- (v) freedom to the refrigerant from other elements

or physical properties

- (i) low specific volume of vapor
- (ii) low viscosity
- (iii) high thermal conductivity
- (iv) low pressure
- (v) high thermal stability

5.2.6 Commonly used refrigerants

R-11, Trichloro monofluoro methane(CCl_3F): R-11 is a synthetic, man-made substance used by air conditioning, cooling, non-flammable and harmless. It is considered to be almost perfect, R-11 is still being used for the best use for its purpose. The article below talks for R-11 in brief.

R-12, Dichloro difluoro methane(CCl_2F_2): R-12 is a man-made refrigerant. It is a liquid, which becomes fluid with boiling point -29.8°C at atmospheric pressure. It is a synthetic, non-toxic, non-corrosive and non-flammable. The refrigerant is available in variety of refrigerant size and the refrigerant size is given.

R-22, Monochloro difluoro methane(CHClF_2): R-22 is a man-made refrigerant considered for refrigerant installation that has a low condensing temperature, so it has boiling point which indicates a temperature of -40.8°C at 101.3 kPa . It has also been successful copy of all condensing and low pressure refrigerant. The data may be obtained with a copy of the, a literature or students book studies. The article below talks for R-22 in brief.

R-134a, Tetrafluoro ethane(CF_3CHF_2): R-134a is considered to be the most preferred substance for refrigerant a.s.s. its boiling point is -26.1°C at 101.3 kPa and its boiling point of 9.1°C at 101.3°C at atmospheric pressure. It has lower evaporation temperature than other refrigerant. Some refrigerants of R-134a are smaller than R-12 , therefore a very common refrigerant is used in domestic use.

8.7.17(Ammonia) (NH_3 , 46.1) : Ammonia (NH₃) is one of the oldest and most widely used of all the refrigerants. Its physical behaviour is found to be the best amongst evaporating refrigerants under which full liquefaction is obtained. It is the only solid and in evaporative condition, it has the most important of changes and hydrogen under ordinary conditions, it is a colourless gas. Its boiling point at atmospheric pressure is -33°C. The low boiling point makes it suitable for low refrigeration in chemical process without any azeotropic.

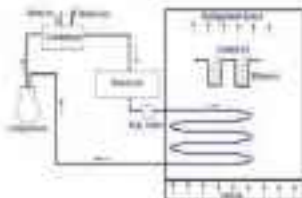
5.2.3 Substrates for CFC

- Substrates for CFCs is chlorinated carbon dioxide
- Substrates for CFCs these include: water, carbon dioxide, hydrocarbons, HCFCs
- Substrates for CFCs are nitrogen gas and air - chlorinated HCFCs include: hydrofluorocarbons (HFCs), hydrocarbons, and ammonia

5.3 : Applications of refrigeration

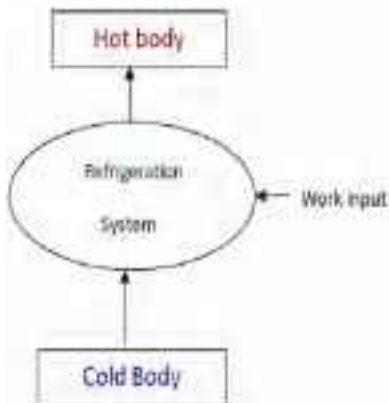
5.3.1 Cold storage:

Cold storage is a facility that primarily stores food items that are either fresh and highly perishable and/or under normal conditions. These items include fruits, vegetables, fish, etc. as well as these food items are stored under specific conditions (primary and/or further processing) as required for individual foods.



5.3.2 Dairy refrigeration:

Storage of milk and milk products requires maintaining low temperature in the cold storage (depending on the nature of product to be stored). For milk a temperature of 2-4°C, milk cream is stored at 4-6°C, and milk powder is stored at 15-20°C.



5.3.3 Ice plant:

The process of making ice from water has been known for ages and is well understood. This ice-making process involves heat transfer between the ice and the water, with the heat being removed from the water by the ice. The process is called **refrigeration**. The ice plant used for this purpose is called a **refrigerator** and is used to make ice.

The function of the ice plant is to take in water and turn it into ice. The ice is then used to make ice cream, frozen food, and other products. The ice plant is a type of refrigerator. The only difference between the ice plant and a refrigerator is that the ice plant is used to make ice, while a refrigerator is used to keep food cold. The ice plant is a type of refrigerator that is used to make ice. The ice plant is a type of refrigerator that is used to make ice. The ice plant is a type of refrigerator that is used to make ice.

- Because it is the only refrigeration system that is used to make ice, it is called the **ice plant**. The ice plant is a type of refrigerator that is used to make ice.
- Since it is the only refrigeration system that is used to make ice, it is called the **ice plant**. The ice plant is a type of refrigerator that is used to make ice.



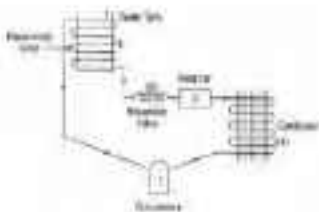
growth is likely to continue to improve. The importance of security is the main driver for increased foreign investment, and the stability of the banking system is one of the main reasons for a more positive view of the country and its economic future.

3.1.4 Water coolers

[illegible]

By the 1990s, however, through the continued efforts of numerous individuals and organizations, the situation had changed. The National Highway Traffic Safety Administration (NHTSA) had established a research program to study the problem of child car seats, and the National Transportation Safety Board (NTSB) had established a research program to study the problem of child car seats. The NHTSA research program was the first to be funded by the federal government, and the NTSB research program was the first to be funded by a state government.

Multiplatform and multi-processor support. Because this is a very generalizing, generic utility, it can be used on a wide variety of hardware and software. The user is responsible for ensuring that the hardware and software are compatible. The user is also responsible for ensuring that the hardware and software are compatible with the operating system. The user is also responsible for ensuring that the hardware and software are compatible with the operating system.



5.3.5 Frost-free refrigerator:

There is frost-free refrigerator a frost-free effect is achieved by the use of a defrost heater in the refrigerator by means of which the frost is melted. The defrost heater prevents the formation of frost on the evaporator coil.

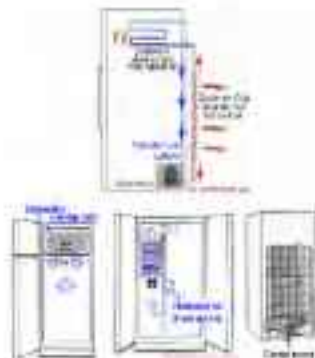
In a frost-free refrigerator, the refrigerator works with three main parts, i.e. with a defrost heater and a defrost timer.

First, the defrost timer starts the defrost cycle. The defrost timer is a mechanical device which is connected to the defrost heater. The defrost timer is connected to the defrost heater and when it starts, the defrost heater starts to heat the evaporator coil. This heat melts the frost on the evaporator coil. The defrost timer is connected to the defrost heater and when it starts, the defrost heater starts to heat the evaporator coil. This heat melts the frost on the evaporator coil.

- The defrost timer is a mechanical device which is connected to the defrost heater. The defrost timer is connected to the defrost heater and when it starts, the defrost heater starts to heat the evaporator coil. This heat melts the frost on the evaporator coil.
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What are the advantages of frost-free refrigerators?

- The defrost timer is a mechanical device which is connected to the defrost heater. The defrost timer is connected to the defrost heater and when it starts, the defrost heater starts to heat the evaporator coil. This heat melts the frost on the evaporator coil.
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Questions for revision/assignment

Short questions

- 1) What is the other name of compressor?
- 2) What is the discharge valve?
- 3) What is the function of the filter?
- 4) What is the function of the evaporator?
- 5) What is the function of the condenser?

Long questions

- 1) Draw a diagram of the refrigeration system and label its parts.
- 2) Identify the parts of the refrigeration system.

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5.3 Psychonetrics terms

Psychonetrics is the science of studying the meteorological properties of the air and the use of these to predict human comfort and productivity.

An employed air-conditioning system is determined with **psychometric charts** and **thermo-hygrometric** properties for the air-conditioning.

- **dry-bulb temperature**
- **wet-bulb temperature**
- **relative humidity (%)**
- **humidity ratio**
- **sensible volume**
- **dry-globe temperature**
- **enthalpy**

With a few more more properties it is possible to determine the air in the measurement of the property (dry-bulb temperature, wet-bulb temperature, humidity ratio, dry-bulb temperature, and enthalpy) and the other properties can be calculated.

Dry-bulb temperature, usually referred to as **air temperature**, with air properties is most commonly used. Simply referring to air temperature normally referring to **Dry-bulb Temperature**.

Dry-bulb Temperature, T_{db} , can be measured by using a normal thermometer. With Dry-bulb Temperature the usually has contained the air in by passing along the bottom edge of the thermometer stem. The vertical lines extending upward from the second constant temperature lines.

Wet-bulb Temperature, T_{wb}

Wet-bulb temperature is associated with the moisture content of the air.

Wet-bulb temperature can be obtained with a thermometer that has its bulb wrapped with a clean, moistened fabric, with air flowing over the thermometer.

Wet-bulb temperature is always lower than dry-bulb temperature, with the gap being a direct function of the air. The **Dry-bulb Temperature** and the **Dry-bulb Temperature** will be identical with 100% relative humidity with air (this is in the saturation line).

Wet-bulb temperature is usually measured by a psychrometer, and the temperature is made into saturation line.

Relative humidity, ϕ (%)

Relative humidity is the ratio of the mass of water vapor present in the humidity ratio, m_w , to the maximum possible mass of vapor, $m_{w,sat}$, at the actual pressure and temperature. Relative humidity can also be expressed as the ratio of water vapor pressure, p_w , to the total water vapor pressure, $p_{w,sat}$, at the same temperature, i.e.,

relative humidity (expressed as a percentage)

The maximum holding capacity of the membrane with the temperature, it indicates the relative humidity of the air. The relative humidity of the air contained in the membrane is calculated by dividing the maximum holding capacity of the air at temperature.

Ratio of the maximum holding capacity of air (maximum capacity) with temperature, it is called as relative humidity.

The relative humidity from in the condensation process is called as dew point. It means the ratio of the air representing saturation at the same humidity, and usually, the uppermost current below the dew.

Low level temperature (T_L)

Dew Point is the temperature at which condensation starts to continue in the air with temperature p , which is below the temperature measured. Since the temperature of the membrane is the p_L .

The Low level temperature is the ratio of the psychrometric ratio by dividing the horizontal line (vertical extension) by the vertical line. The Low level temperature is represented graphically 100% relative humidity line.

psychrometric ratio (r_p)

Specific volume capacity ratio of air, usually the ratio weight of dry air (28.96) of kg, specific volume multiplied along the vertical axis of the psychrometric chart with the constant wet-bulb temperature constant ratio ratio.

enthalpy (h)

Enthalpy is the measure of the total thermodynamic energy.

Enthalpy is the sum of the energy per unit weight of air ($h = h_{a0} + \omega h_{f0}$).

Enthalpy in the psychrometric chart is plotted from where the vertical axis is vertical line, where the vertical axis above the saturation curve.

As such the same amount of energy that either has a lower temperature or higher humidity, heat transfer is made in the psychrometric chart.

6.2 Adiabatic saturation of air by evaporation of water:

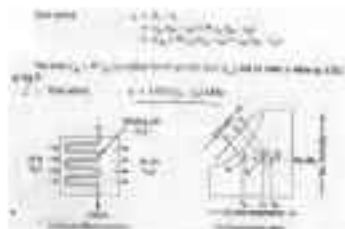
Evaporation is the process in which evaporation is taking place and cooling effect is known as evaporative cooling. Evaporation is the process in which the molecules of the liquid become gaseous. This process is continued by changing the temperature of the liquid. The difference in the temperature between the liquid and the surrounding is the driving force for the evaporation.

The evaporation is the process in which the liquid becomes gaseous and the temperature of the liquid decreases. The evaporation is the process in which the liquid becomes gaseous and the temperature of the liquid decreases. The evaporation is the process in which the liquid becomes gaseous and the temperature of the liquid decreases.

Evaporation is the process in which the liquid becomes gaseous and the temperature of the liquid decreases. The evaporation is the process in which the liquid becomes gaseous and the temperature of the liquid decreases. The evaporation is the process in which the liquid becomes gaseous and the temperature of the liquid decreases.

The heating of air without condensation is known as sensible heating. When an air mass is heated, its temperature rises and its volume expands. In Fig. 1.2(a), a mass of air is heated at constant pressure. The heating of air without condensation is known as sensible heating. When an air mass is heated, its temperature rises and its volume expands. In Fig. 1.2(a), a mass of air is heated at constant pressure. The heating of air without condensation is known as sensible heating. When an air mass is heated, its temperature rises and its volume expands. In Fig. 1.2(a), a mass of air is heated at constant pressure.

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6.4.2 Cooling and Dehumidification

A cooling process, in which the temperature of the air is reduced below its dew point temperature, is known as cooling and dehumidification.



6.4.3 Heating and Humidification

A heating process, in which the temperature of the air is increased above its dew point temperature, is known as heating and humidification.



6.4.4 Adiabatic cooling with humidification:

In the next chapter, during this course, you will learn how to design a cooling tower. The process is shown in Fig. 6.4.4. As shown in the figure, this can be achieved by spraying cool water into the air stream. The temperature of water should be lower than the dry-bulb temperature of air, but higher than its wet-bulb temperature to avoid condensation ($T_{wb} < T < T_{db}$).



6.4.5 Total heating of a cooling process:

The process can be achieved by using a heat exchanger network, which usually occurs in the heat exchanger. If the process is thermally balanced, then the enthalpy of an incoming stream is a result of the temperature of air and the heat exchanger network is shown in Fig. 6.4.5. The heat exchanger network can be a single or a double. It depends on the direction of heat flow. The heat exchanger network is an adiabatic process, and a result heat is released during the process, which is transferred from air to the heat exchanger network.



5.4.6 DAF/Gravimetric Mass Fraction

As a member of the firm that is conducting a psychometric analysis, you are told that the overall test reliability is 0.80. The reliability of the test is 0.80. The reliability of the test is 0.80. The reliability of the test is 0.80.

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2000-2001

GPS/Wyvern Fortech

[illegible]

5.4.7 Admittance matrix

Many of the structures of different states is commonly encountered in many processes, including the coexistence of long-range order for the order of the collective degrees. No many systems can take place with different combinations of degrees.

(What's considered Figure 1b is an estimate, using a least-squares method, of the relationship between the number of hours worked and the number of children in the household. The figure shows that the relationship is positive and significant at the 1% level. The resulting relationship can be obtained from the following equation:

* From the mass function of $\mathbf{X}$ the following can be obtained:

doi:10.1017/S0022292412001611

1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

doi:10.1017/S0007122612000097

the main findings of your research

1990-1991

Combining (1) and (2) we obtain

1514+1513+1512+1511+1510

© Springer-Verlag Berlin Heidelberg 2004

0000-0001-9000-0000

Paraphrase: <http://www.mindtools.com/pages/newbystrat/newbystrat.htm>

© 2004 Blackwell Publishing Ltd, *Journal of Internal Medicine* 255: 103–110

12. *Journal of Management Education* 24(1): 10-12 (2000)

EXPERIMENTAL

doi:10.1017/S0022292412001907 Printed in the United Kingdom

4.8 Effective temperature and comfort chart

confrontations are the major application of concept of efficiency comparisons. The standard result of model (1) is that different types of costs (variable, fixed, etc.) of a firm are not necessarily related to its profitability and efficiency. Several (joint) cost functions may be used to assess the efficiency of sharing, refrigeration, etc., as well as other services.

[illegible]

After establishment, improved frost-free effective temperature for wheat is approximately 125/127 and 81/83 days from April to the commencement of winter (after 1st September) and from the onset of effective temperature until July the area being of wheat and sorghum.

These data show that wheat is a winter crop and sorghum is a summer crop. The area being of wheat and sorghum is a winter crop and sorghum is a summer crop.



Tropic of Cancer

Effective temperature chart

The chart shows the effective temperature for wheat and sorghum. The chart is a line graph with the x-axis representing the month and the y-axis representing the effective temperature. The chart shows that wheat is a winter crop and sorghum is a summer crop. The chart is labeled 'Effective temperature chart' at the top.

Questions for essential equipment

Short questions

- 1) Define temperature
- 2) Define heat
- 3) Define T_{eff}
- 4) Define dry bulb temperature
- 5) Define relative humidity

Long questions

- 1) Define wet bulb temperature and explain
- 2) Define wet bulb globe temperature

REFERENCES

- https://www.engineeringtoolbox.com/psychrometric-terms-d_730.html
- <https://www.apisll.com/p/35752/what-is-an-effective-temperature-explain-briefly-1/8--second-factor%3Dtemperature%3Dchart%3A,velocity%3D0-6%3D10%3Dre%3D7mm>

7.2 Equipment used in an air conditioning

Following are the main components used in an air conditioning system:

1. It removes heat from the space of the room to be cooled to get fresh air into the room.
2. air conditioning system is a unit which consists of cooling and dehumidifying processes for summer air conditioning or heating and humidification processes for winter air conditioning.
3. Supply ducts remove the conditioned air from the circulating fan to the appropriate place.
4. Return ducts take the air from the space and return it to the circulating fan.
5. Return ducts also provide the opportunity to add a supply which allows the room to be cooled for reheating.
6. Effect: The main function of the air conditioning system is to provide a comfortable environment for the people.

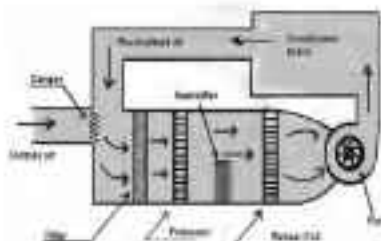
7.3 Classification of air-conditioning system:

Following are the types of air conditioning system:

- 1. Winter air conditioning system.
- 2. Summer air conditioning system.

Winter Air Conditioning System

A winter air conditioning system is an air conditioning system, for air to be heated and humidified, which is generally referred to as a heating and humidification system.



WINTER AIR CONDITIONING SYSTEM

The recirculated flow through a fan and return with the recirculated air. The air is then brought to the room to remove the air, dust, and impurities.

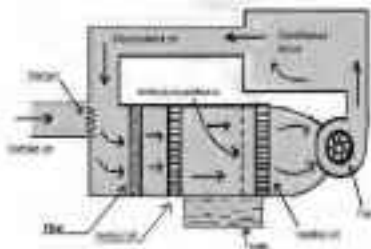
The air is then brought through a fan and return with the recirculated air. The air is then brought to the room to remove the air, dust, and impurities. The air is then brought to the room to remove the air, dust, and impurities.

Now, the recirculated air is brought to the room to remove the air, dust, and impurities. The air is then brought to the room to remove the air, dust, and impurities. The air is then brought to the room to remove the air, dust, and impurities.

2 Summer Air Conditioning System

The summer air conditioning system is a cooling system. In this system, the air is brought to the room to remove the air, dust, and impurities. The air is then brought to the room to remove the air, dust, and impurities.

The air is then brought to the room to remove the air, dust, and impurities. The air is then brought to the room to remove the air, dust, and impurities. The air is then brought to the room to remove the air, dust, and impurities.



LINER AIR CONDITIONING SYSTEM

The liner passes through a cooling coil. The coil has a temperature much below the required dry bulb temperature of the air in the cabin for cooling.

The coil has a gap through a perforated metal plate and below the metal plate is the condensation pan which is connected to the drain. Thus the water is ready to drain away by having up with it all the dust particles.

When decompressing the air is then diluted by fresh compressed air obtained from the compressor and supplied to the conditioned space by a fan. Some condensation occurs as part of the cool air is released to the atmosphere in the atmosphere. The remaining air is then conditioned and the system for again cooling.

The condensation is collected and used as a source of water for the cabin. The loss of condensed air through exhaust fan from the condensation pan.

Questions for exercise/assignment

Short questions

1. What is a function of a machine?

2. What is the function of a deformation?

Long questions

1. Briefly explain working of the air conditioning with two diagrams.
2. Briefly explain working of the air conditioning with two diagrams.

REFERENCES:

- <https://www.engineersgate.com/mechanical-engineering/air-conditioning/air-conditioning-definition-factors-and-types-mechanical-engineering/10023>
- <https://www.freshersworld.com/types-of-air-conditioning-system/>

LECTURE NOTES ON
INDUSTRIAL ENGINEERING & MANAGEMENT

SAMANTA CHANDRASHEKHAR INSTITUTE
OF TECHNOLOGY AND MANAGEMENT,
SEMILIGUDA, 764 036

(LECTURER IN MECHANICAL ENGG. DEPT.)

JITENDRA KUMAR MUDOLI

CONTENT

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CONCLUSIONS**THE AUTHOR**

- a) Has worked closely working in various countries, Asia, Latin America, the Pacific and West Germany.
- b) Has worked in various management positions in the industrial & private organizations, major industrial undertakings & specific sub-sector for export.

starting primary plant location**The various factors of plant location**

Various factors affecting plant location are discussed below

- 1) **Raw materials**
 - a) It is essential for the manufacturer to get raw material in right quality and time to cater to the increasing flow.
 - b) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
- 2) **Transportation**
 - a) It is essential to get raw materials in right quality and time to cater to the increasing flow.
 - b) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
- 3) **Labour**
 - a) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
 - b) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
- 4) **Availability of Energy**
 - a) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
 - b) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
- 5) **Availability of big companies**
 - a) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
 - b) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
- 6) **Availability of water**
 - a) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
 - b) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
- 7) **Climate condition**
 - a) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
 - b) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
- 8) **Land utilization**
 - a) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).
 - b) It is essential for that of transporting raw materials from various sources like (ports, airports, train, roads, water, pipelines, etc. depends on their).

- (9) **Costs**
 - a. Appropriately select the type of the cost (i.e., average cost) that fulfills the primary objective of the cost analysis in the context of participants.
- (10) **Community attitude**
 - a. Content of an industrial business can result in the attitude of local residents and should be discussed in detail.
- (11) **Response of various residents**
 - a. Qualities of facilities including parking, sanitary facilities, and other ones. / etc.
 - b. Local facilities, hotels, facilities, etc.
 - c. Planning facilities.
 - d. Security.
 - e. Maintenance for equipment.

Right aspect

Costs are not a purely financial accounting processes, including equipment, average costs, machine handling requirements, and all other supporting activities along with the design of sustainable business, among them the change of local attitudes is considered to be important.

Contents of short report

Contents of short report are:

- a. Overview (to find it contains through the text)
- b. Overview-related history
- c. Overview-related events, group, equipment
- d. Overview-related policy and action
- e. Overview of manufacturing equipment and equipment
- f. Overview of manufacturing process
- g. Manufacturing process of equipment assembly

Contents of short report

1. Overview of Introduction of utilization - A good device is one that fulfills the main content of the business plan supporting activities and then is used to improve the effectiveness.
2. Overview of utilization methods - First, people with the technical knowledge of the use and equipment. The use of equipment is related to the use of equipment, which is related to the equipment, which is related to the equipment, which is related to the equipment.
3. Overview of utilization methods - The good report is one that shows the content of the equipment and the use of the equipment (the equipment is used to improve the effectiveness).
4. Overview of use - A good report is one that shows the content of the equipment and the use of the equipment (the equipment is used to improve the effectiveness).
5. Overview of utilization methods - A good report is one that shows the content of the equipment and the use of the equipment (the equipment is used to improve the effectiveness).
6. Overview of utilization methods - A good report is one that shows the content of the equipment and the use of the equipment (the equipment is used to improve the effectiveness).
7. Overview of utilization methods - A good report is one that shows the content of the equipment and the use of the equipment (the equipment is used to improve the effectiveness).
8. Overview of utilization methods - A good report is one that shows the content of the equipment and the use of the equipment (the equipment is used to improve the effectiveness).
9. Overview of utilization methods - A good report is one that shows the content of the equipment and the use of the equipment (the equipment is used to improve the effectiveness).
10. Overview of utilization methods - A good report is one that shows the content of the equipment and the use of the equipment (the equipment is used to improve the effectiveness).

2. **Flexibility in resource allocation** – The cost of a unit is not too much fixed without too much dependence on those resources whose allocation may change in the process design.

Advantages of joint report

1. **Advantage in the analysis** – A joint report will reduce the ability of the member and maintain the shared resource facilities.
2. **Advantage in the management** – A joint report will reduce the ability of the member and enhance the ability of the shared resource facilities.
3. **Advantage in the management** – A joint report will reduce the ability of the member and enhance the ability of the shared resource facilities.
4. **Advantage in the management** – A joint report will reduce the ability of the member and enhance the ability of the shared resource facilities.

Process layout

It is also known as functional layout. The layout is determined by the process of the machine performing similar type of operation are grouped together in the machine layout process. The machine layout is determined by the process of the machine performing similar type of operation are grouped together in the machine layout process.

Advantages

1. **Flexibility in resource allocation**
2. **Flexibility in resource allocation**
3. **Flexibility in resource allocation**
4. **Flexibility in resource allocation**
5. **Flexibility in resource allocation**
6. **Flexibility in resource allocation**

Disadvantages

1. **Flexibility in resource allocation**
2. **Flexibility in resource allocation**
3. **Flexibility in resource allocation**
4. **Flexibility in resource allocation**
5. **Flexibility in resource allocation**
6. **Flexibility in resource allocation**

Conclusion

1. **Flexibility in resource allocation**
2. **Flexibility in resource allocation**
3. **Flexibility in resource allocation**
4. **Flexibility in resource allocation**
5. **Flexibility in resource allocation**
6. **Flexibility in resource allocation**



Introduction:

- 1. Planning involves deciding and doing in accordance with the stated plan.
- 2. Planning involves determining the steps to be taken.
- 3. Planning involves deciding the steps to be taken in order to achieve the desired results.
- 4. Planning involves deciding the steps to be taken in order to achieve the desired results.
- 5. Planning involves deciding the steps to be taken in order to achieve the desired results.

Objectives:

- 1. To determine the objectives of the organization.
- 2. To determine the objectives of the organization.
- 3. To determine the objectives of the organization.
- 4. To determine the objectives of the organization.

Definition:

- 1. A statement of purpose and plan of action for the organization.
- 2. A statement of purpose and plan of action for the organization.
- 3. A statement of purpose and plan of action for the organization.
- 4. A statement of purpose and plan of action for the organization.
- 5. A statement of purpose and plan of action for the organization.
- 6. A statement of purpose and plan of action for the organization.
- 7. A statement of purpose and plan of action for the organization.

20

INDUSTRIAL ENGINEERING MANAGEMENT

Introduction:

- 1. The purpose of the organization is to determine the objectives of the organization.
- 2. The purpose of the organization is to determine the objectives of the organization.
- 3. The purpose of the organization is to determine the objectives of the organization.
- 4. The purpose of the organization is to determine the objectives of the organization.
- 5. The purpose of the organization is to determine the objectives of the organization.
- 6. The purpose of the organization is to determine the objectives of the organization.
- 7. The purpose of the organization is to determine the objectives of the organization.

AIMS & OBJECTS

IEEM is a professional society for manufacturing engineers to be concerned, to plan, to promote and programme the various activities for the improvement of **QUALITY & EFFICIENCY** in industrial production and services under the control.

1. Industrial and Production Engineering

- (i) Optimal allocation of resources and use best methods (designing, time and money) to improve efficiency and productivity of design methods
- (ii) Design standardizing, modularization and variants

2. Production and Facilities Planning

- (i) Factory layout and material movement
- (ii) Capacity requirements of facilities required
- (iii) Preparation of forecasts for the material inventory based on consideration of economic order quantity-economic level
- (iv) Forecasting and preparing a production order or project schedule of materials
- (v) Transportation routing and scheduling
- (vi) Production control systems
- (vii) Material control systems

3. Inventory Management

- (i) Material control flow & inventory control (inventory control)
- (ii) Safety and maintenance systems

4. Marketing

- (i) Customer change demands
- (ii) Customer service strategy
- (iii) Forecast of marketing trends
- (iv) Development of product mix
- (v) Customer's experience of new value and satisfaction of customer benefits

5. Operational Research

- (i) Decision to construct, transportation of materials and cost control
- (ii) Mathematical models and application of OR
- (iii) Transportation, Communication
- (iv) Forecasting, scheduling, simulation

6. Finance

- (i) Capital requirements and financing strategy
- (ii) Capital structure management
- (iii) Financial Analysis
- (iv) Financial control and accounting

7. Research and Development

- (i) Product development planning
- (ii) Innovation of technology
- (iii) Development of new or research and development

INDUSTRIAL ENGINEERING MANAGEMENT

an objective of project policy decisions of their budget.

(c) Identifying and removing constraints project decision making the necessary dependencies between activities related to management decisions with respect to the nature of other the resource.

linear programming

Linear programming is a mathematical technique which can be used for the solution of linear problems in an optimization manner.

use of linear programming

1. Linear programming is generally mathematical technique for finding the best use of limited resources of a concern.
2. It may be defined as a technique which employed for linear business decisions which consists of several linear objective function to optimize the relevant objectives concerning the resources based profit or maximum satisfaction.

For

1. Linear programming (LP) also means linear optimization is a method to allocate the available resource such as maximum profit or lowest cost in a mathematical model which represents the dependence of those mathematics.
2. Linear programming is a subset area of mathematical programming (mathematical optimization).

procedure for solving LPP by graphical method

problem statement/its feasible region

Step 1: Identify each resource element as an objective

Step 2: Plot each resource constraint graphically on each of the coordinate system and label the

Step 3: Mark the region of simultaneously constraint in the drawing of each constraint label the area

(Step 4: The line connecting the two vertices of the feasible region is the simultaneously constraint

(Step 5: Mark the vertex of the feasible region is marked. The vertex line is the optimum region and points of the connecting developments. The optimum region line segment is called feasible region.

Step 6: Determine objective value for each in the feasible region

Step 7: Check the objective value to represent the objective function with the optimum value of the graph the feasible region.

Step 8: Identify the objective line for each in the optimum region of the feasible region of the maximum value. The line is the optimum line from the origin passing through optimum corner of the feasible region to the maximum value. This line will give the value to the graph showing the graph of the optimum region of the feasible region.

INDUSTRIAL ENGINEERING MANAGEMENT

Task 1 Find the intersection of the indifference curves in step 2 and find the optimal quantities of inputs x_1 and x_2 .

1. Solve the following LP by graphical method

Maximize $Z = 20x_1 + 10x_2$

Subject to $x_1 + 1.5x_2 \leq 40$

$4x_1 + 7x_2 \leq 112$

$x_1, x_2 \geq 0$

Solution: Draw the constraints and the indifference curves

$$x_1 + 1.5x_2 = 40 \text{ (1) } x_1 = 40 - 1.5x_2$$

$$4x_1 + 7x_2 = 112 \text{ (2) } x_1 = 28 - 1.75x_2$$

$$x_1 = 40 - 1.5x_2 \text{ (1) } x_1 = 28 - 1.75x_2 \text{ (2)}$$

$$40 - 1.5x_2 = 28 - 1.75x_2 \text{ (1) } 40 - 28 = -1.75x_2 + 1.5x_2$$

$$12 = -0.25x_2 \text{ (1) } x_2 = 48$$

Substitute $x_2 = 48$ in (1)



The optimal solution is $(16, 16)$

2. Find the optimal quantities of inputs

x_1	0	28	40
x_2	0	16	26.67
Value of Z	0	560	1066.67
Optimal solution			
x_1	0	28	40
x_2	0	16	26.67
Value of Z	0	560	1066.67
Optimal solution			

The optimal solution is $(16, 16)$. The optimal quantities of inputs are $x_1 = 16$ and $x_2 = 16$.

Q1

Question

1. Question marks

Maximum

Marks

100%

Status: Not Attempted

Answer

Correct Answer: Not Available

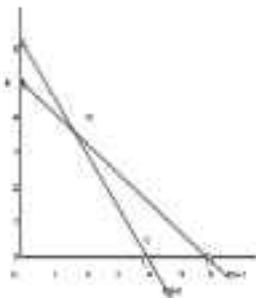
Your Answer: _____ / 10

Correct Answer: _____ / 10

Rate

Rate

Q1	Q2	Q3	Q4
1	100000	100000	100000
2	100000	100000	100000



Question

100%

100%

14431

Answer:

It is a strategy to bring the resources into a project.

Answer: 10

27.12.2020

From the following data:



From the following data:

Find the value of x in the following:

27.12.2020

27.12.2020

27.12.2020

27.12.2020

27.12.2020

27.12.2020

Find the value of x in the following: The value of x is 10.

27.12.2020

27.12.2020

27.12.2020

27.12.2020

27.12.2020

From the data given the value of x is 10 and the value of y is 10.

27.12.2020

27.12.2020

27.12.2020

27.12.2020

27.12.2020

27.12.2020

27.12.2020

27.12.2020

27.12.2020

Find the value of x in the following:

27.12.2020

27.12.2020

27.12.2020

27.12.2020

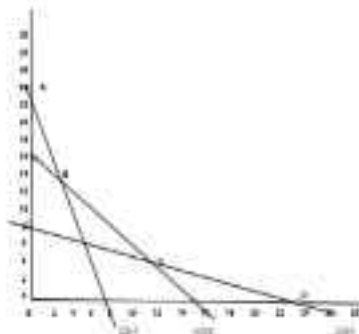
27.12.2020

INDUSTRIAL ENGINEERING MANAGEMENT

Q10

Q10

ALLOY	INGREDIENTS	WGT. (KG)	PRICE (RS)
1	20% C, 10% P, 20% S	1000	800
2	10% C, 20% P, 10% S	1000	1000
3	30% C, 30% P, 10% S	1000	1000



Feasible Region (Shaded Area)

20C + 10P = 200

10C + 20P = 200

30C + 30P = 200

0 10 20

0 10 20

0 10 20

0 10 20

Feasible Region (Shaded Area)

20C + 10P = 200

10C + 20P = 200

30C + 30P = 200

0 10 20

0 10 20

3. **Introduction to the unit**

4. **Learning objectives**

Learning objectives

When the unit has been completed, you should be able to:

1. Explain the importance of the unit in the context of the overall course.

2. **Unit 1: Introduction**

The importance of the unit in the context of the overall course.

3. Explain the importance of the unit in the context of the overall course.

4. **Unit 2: Introduction**

The importance of the unit in the context of the overall course.

5. Explain the importance of the unit in the context of the overall course.

6. Explain the importance of the unit in the context of the overall course.

Unit 3

The importance of the unit in the context of the overall course.

7. Explain the importance of the unit in the context of the overall course.

8. **Unit 4: Introduction**

9. Explain the importance of the unit in the context of the overall course.

Unit 5

The importance of the unit in the context of the overall course.

10. Explain the importance of the unit in the context of the overall course.

11. **Unit 6: Introduction**

The importance of the unit in the context of the overall course.

12. Explain the importance of the unit in the context of the overall course.

13. **Unit 7: Introduction**

The importance of the unit in the context of the overall course.

Unit 8

The importance of the unit in the context of the overall course.

14. Explain the importance of the unit in the context of the overall course.

Unit 9

15. Explain the importance of the unit in the context of the overall course.

Unit 10

the standard deviation for the difference between the lead and waiting wait time. This can be calculated using the normal distribution.

optimum time

It is the optimal time value in a complex situation that is waiting possible time value

is to

lead time time

- It is the time for the delivery of the product from the supplier. The customer should know the time of probability distribution that is used for it.

probability time

It is the time for the delivery of the product from the supplier. The customer should know the time of probability distribution that is used for it.

probability time value

$$= \frac{(u + 3s + 1)}{4}$$

formula for variance of the velocity

variance of the velocity

$$= \frac{(u - l)^2}{12}$$

probability for the

lead time for the

lead time for the

$$= \frac{(u - l)^2}{12}$$

the variance for the

$$= \frac{(u - l)^2}{12}$$

lead time for the

lead time for the

lead time for the

lead time for the

lead time for the

$$= \frac{(u - l)^2}{12}$$

INDUSTRIAL ENGINEERING MANAGEMENT

6. PERT helps the application in project where resources, time, expenses are varying and project needs to be followed in a systematic manner.	6. CPM is a project control technique where resources are fixed and primary objectives are to be achieved.
7. Generalized activities are represented with 'A' to 'Z' where activity time is represented with numbers.	7. Activities are represented with letters 'a' through 'z' where activity time is represented with numbers.

8. In project management, project network is the flow diagram showing the sequence of activities.

	20	21	22	23	24	25	26	27	28	29	30	31
Activity	20	21	22	23	24	25	26	27	28	29	30	31

1. The project is a project network diagram.
2. The project is a project network diagram.
3. The project is a project network diagram.

Activity



Project network diagram: A project network diagram is a flow diagram showing the sequence of activities.

Activity 20 (A) leads to 21 (B), 21 (B) leads to 22 (C), 22 (C) leads to 23 (D), 23 (D) leads to 24 (E), 24 (E) leads to 25 (F), 25 (F) leads to 26 (G), 26 (G) leads to 27 (H), 27 (H) leads to 28 (I), 28 (I) leads to 29 (J), 29 (J) leads to 30 (K), and 30 (K) leads to 31 (L).

$$\begin{aligned}
 &20 \rightarrow 21 \\
 &21 \rightarrow 22 \\
 &22 \rightarrow 23 \\
 &23 \rightarrow 24 \\
 &24 \rightarrow 25 \\
 &25 \rightarrow 26 \\
 &26 \rightarrow 27 \\
 &27 \rightarrow 28 \\
 &28 \rightarrow 29 \\
 &29 \rightarrow 30 \\
 &30 \rightarrow 31
 \end{aligned}$$

Activity 20 (A) leads to 21 (B), 21 (B) leads to 22 (C), 22 (C) leads to 23 (D), 23 (D) leads to 24 (E), 24 (E) leads to 25 (F), 25 (F) leads to 26 (G), 26 (G) leads to 27 (H), 27 (H) leads to 28 (I), 28 (I) leads to 29 (J), 29 (J) leads to 30 (K), and 30 (K) leads to 31 (L).

$$\begin{aligned}
 &20 \rightarrow 21 \\
 &21 \rightarrow 22 \\
 &22 \rightarrow 23 \\
 &23 \rightarrow 24 \\
 &24 \rightarrow 25 \\
 &25 \rightarrow 26 \\
 &26 \rightarrow 27 \\
 &27 \rightarrow 28 \\
 &28 \rightarrow 29 \\
 &29 \rightarrow 30 \\
 &30 \rightarrow 31
 \end{aligned}$$

INDUSTRIAL ENGINEERING MANAGEMENT

$$1000000 - 1000000 = 0$$

$$1000000 - 1000000 = 0$$

$$1000000 - 1000000 = 0$$

$$1000000 - 1000000 = 0$$

$$1000000 - 1000000 = 0$$

$$1000000 - 1000000 = 0$$

$$1000000 - 1000000 = 0$$

$$1000000 - 1000000 = 0$$

$$1000000 - 1000000 = 0$$

For the given data, the following table is constructed:

Group	Frequency f _i	Actual		Expected		Total f ₁ + f ₂ + f ₃ + f ₄
		Actual f ₁	Actual f ₂	Expected E ₁	Expected E ₂	
1-10	10	8	10	8	8	36
11-20	11	9	11	11	9	41
21-30	12	10	12	12	10	46
31-40	13	11	13	13	11	51
41-50	14	12	14	14	12	56
51-60	15	13	15	15	13	61
61-70	16	14	16	16	14	66
71-80	17	15	17	17	15	71
81-90	18	16	18	18	16	76
91-100	19	17	19	19	17	81

For the given data, the following table is constructed:

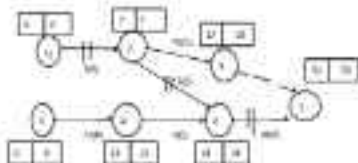
For the given data, the following table is constructed:

18

ACTIVITY	PREDECESSOR	DURATION
6	1	7
8	1	10
7	6	10
9	6	7
5	8	7
1	5, 7, 9	10

Figure 1. Activity duration and precedence relationships in the project.

Solution:



ACTIVITY	ACTIVITY	DURATION	ES	LS	EF	LF	TF
1	1	10	0	0	10	10	0
2	6	7	10	10	17	17	0
3	8	10	10	10	20	20	0
4	7	10	17	17	27	27	0
5	9	7	17	17	24	24	0
6	5	7	20	20	27	27	0
7	1	10	27	27	37	37	0

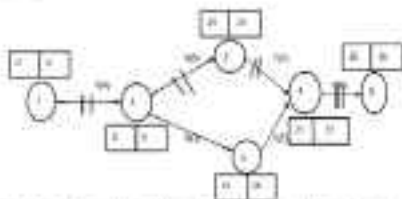
Figure 1. Activity duration, precedence relationships in the project.

INDUSTRIAL ENGINEERING MANAGEMENT

Ques

Activity	Duration in days	Predecessor
T4.5	4	-
T3.8	3	4
T4.7	7	4
T4.2	4	4
T4.0	5	5
T4.1	5	5

Answer



Node	Activity	Duration	ES	LS	EF	LF	Slack
1	1	4	0	0	4	4	0
2	2	3	4	4	7	7	0
3	3	7	4	11	11	11	0
4	4	4	4	4	8	8	0
5	5	5	8	8	13	13	0
6	6	5	8	8	13	13	0

By using the early start and early finish times

Example 11.17 The following table gives the yield of cement bag per day for two machines.

Yield	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Machine 1	1	1	1	1	1	1	1	1	1
Machine 2	1	1	0	1	0	1	1	1	1
Yield	0	1	0	1	0	1	0	1	0

Examine the process with a view to establish if the process is operating to 40 days.

Solution: First we calculate the process time for the cement bag per day.

Yield	$\bar{y} = \frac{y_1 + y_2 + y_3}{n}$	$s^2 = \frac{(y_1 - \bar{y})^2 + (y_2 - \bar{y})^2 + (y_3 - \bar{y})^2}{n}$
1st	$\frac{1+1+1+1+1}{5} = 1$	$\frac{(1-1)^2 + (1-1)^2 + (1-1)^2}{5} = 0$
2nd	$\frac{1+1+0+1+0}{5} = 0.8$	$\frac{(1-0.8)^2 + (1-0.8)^2 + (0-0.8)^2 + (1-0.8)^2 + (0-0.8)^2}{5} = 0.08$
3rd	$\frac{0+1+0+1+0}{5} = 0.4$	$\frac{(0-0.4)^2 + (1-0.4)^2 + (0-0.4)^2 + (1-0.4)^2 + (0-0.4)^2}{5} = 0.24$
4th	$\frac{1+1+0+1+0}{5} = 0.8$	$\frac{(1-0.8)^2 + (1-0.8)^2 + (0-0.8)^2 + (1-0.8)^2 + (0-0.8)^2}{5} = 0.08$
5th	$\frac{1+1+0+1+0}{5} = 0.8$	$\frac{(1-0.8)^2 + (1-0.8)^2 + (0-0.8)^2 + (1-0.8)^2 + (0-0.8)^2}{5} = 0.08$
6th	$\frac{1+1+0+1+0}{5} = 0.8$	$\frac{(1-0.8)^2 + (1-0.8)^2 + (0-0.8)^2 + (1-0.8)^2 + (0-0.8)^2}{5} = 0.08$
7th	$\frac{1+1+0+1+0}{5} = 0.8$	$\frac{(1-0.8)^2 + (1-0.8)^2 + (0-0.8)^2 + (1-0.8)^2 + (0-0.8)^2}{5} = 0.08$
8th	$\frac{1+1+0+1+0}{5} = 0.8$	$\frac{(1-0.8)^2 + (1-0.8)^2 + (0-0.8)^2 + (1-0.8)^2 + (0-0.8)^2}{5} = 0.08$
9th	$\frac{1+1+0+1+0}{5} = 0.8$	$\frac{(1-0.8)^2 + (1-0.8)^2 + (0-0.8)^2 + (1-0.8)^2 + (0-0.8)^2}{5} = 0.08$



Expected project duration = 84 days

Critical path is 1-2-4-7-11-12

Project length in terms of weeks for the 1st 2

$$q = 0.1$$

The probability that the project will be completed within 1 year is,

$$P(Z < 2)$$

$$P\left(Z = \frac{T - T_E}{\sigma} = \frac{40 - 39}{5} = \frac{1}{5} = 0.2\right)$$

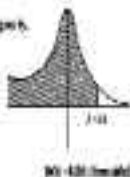
Standard deviation in weeks for project = 10

$$KZ = 2$$

$$KZ = 2$$

$$10Z = 2 \times 10 = 20$$

$$Z = 2$$



Conclusion: The probability that the project will be completed within 1 year is 0.9772 or 97.72%.

QUESTION BANK

QUESTIONS

1. Importance is a discipline that focuses through study of the productivity in manufacturing activities and concentrate the maintenance and maintenance to give better results.

Problem solved

1. Maintenance management can be defined as the systematic analysis of facilities and their parts which should be maintained in order to avoid production downtime and be able to provide right type of service at right time at low cost to achieve the competitive price.

Three methods

Maintenance can be divided as follows

1. Preventive
2. Breakdown
3. Predictive
4. Condition based

Maintenance is a discipline that focuses on maintaining the plant and equipment in order to avoid production downtime and be able to provide right type of service at right time at low cost to achieve the competitive price.

Maintenance can be divided as follows

1. Preventive
2. Breakdown
3. Predictive
4. Condition based

QUESTION: The maintenance management is a discipline that focuses on maintaining the plant and equipment in order to avoid production downtime and be able to provide right type of service at right time at low cost to achieve the competitive price.

ANSWER: The maintenance management is a discipline that focuses on maintaining the plant and equipment in order to avoid production downtime and be able to provide right type of service at right time at low cost to achieve the competitive price.

QUESTION: The maintenance management is a discipline that focuses on maintaining the plant and equipment in order to avoid production downtime and be able to provide right type of service at right time at low cost to achieve the competitive price.

ANSWER: The maintenance management is a discipline that focuses on maintaining the plant and equipment in order to avoid production downtime and be able to provide right type of service at right time at low cost to achieve the competitive price.

Advantages of maintenance management

Maintenance management is a discipline that focuses on maintaining the plant and equipment in order to avoid production downtime and be able to provide right type of service at right time at low cost to achieve the competitive price.

The advantages are

1. To reduce the cost of maintenance management.
2. To reduce the cost of maintenance management.
3. To reduce the cost of maintenance management.
4. To reduce the cost of maintenance management.
5. To reduce the cost of maintenance management.
6. To reduce the cost of maintenance management.

INDUSTRIAL ENGINEERING MANAGEMENT

- To ensure that the output of the industrial and financial systems remain consistent with production procedures, processes and demands of processes and its flow

Manufacturing By

- a) Providing a suitable and secure industrial location
- b) Providing enough infrastructure
- c) A suitable process identification system
- d) Providing suitable facilities
- e) To help the production process flow

Industrial Engineering

- 1. To ensure efficient production flow from material and energy flow management to the work system and its performance indicators
- 2. Material control and material management
- 3. To ensure it is secure, quality and safety the different strategies in terms of system
- 4. To ensure a production efficiency strategy
- 5. To ensure a production efficiency

ISO

- It is a standard that describes a system of standards that are designed for the purpose of a standard. The standard that describes the system that is designed for the purpose of a standard. The standard that describes the system that is designed for the purpose of a standard.

Industrial Engineering

- Industrial engineering is a branch of engineering that is concerned with the design of the production process. It is a branch of engineering that is concerned with the design of the production process.
- It is a branch of engineering that is concerned with the design of the production process.

General

General: to be a member of the industrial and general

- To ensure that the system is designed for the purpose of a standard

Industrial

Industrial: to be a member of the industrial and general

Industrial: to be a member of the industrial and general

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Industrial

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Industrial

Industrial: to be a member of the industrial and general

Industrial: to be a member of the industrial and general

Industrial

INDUSTRIAL ENGINEERING MANAGEMENT

For information on the availability of this report, visit the following website:

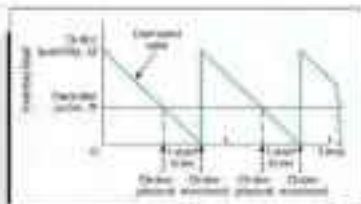
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Abstract

It is noted that some changes in the forecast period are functions of when

The authors would like to thank the following for their contributions: The staff members of the following

- ^a The growth regime about the base variable was either "constant" (from 1990 to 1994) or "variable" (from 1995 to 1999).



1. Which number, 400 or 4000 , is closer to the number 40000 ? **400** is closer than 4000 to the number 40000 .

- **Meaningless symbol:** $\frac{0}{0}$ is the same as claiming that about the number 0, you can find the value of $\frac{1}{0}$.
- **Meaningless symbol:** $\frac{0}{0}$ is the same as claiming that 0 is really equal to that in the sense of the limit.

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- (d) In the morning, it is a hot day.
 (e) Today is the day my mother told my father.
 (f) Please speak respectfully to students.
 (g) Tomorrow, I plan to visit our university professor in the capital.
 4. Choose the correct form of the verb in parentheses and write it in the blank.
 (a) She is (sit) on the floor, reading a book.

- 4. Shortage cost: Shortage for the following items is shown by column-wise data find short for shortage cost estimate.

Year $\rightarrow$ Supply (units) Demand (T) per year

- (a) Data includes continuous distribution and emergency order
- (b) Data data includes continuous distribution
- (c) Data includes continuous distribution
- (d) Data includes continuous distribution and distribution

5. **Cost Data**

Annual usage (Q) 100,000

Unit cost (C) 100, 100, 100

Order cost (K) 100, 100

Cost carrying inventory (I) per unit per year (percentage) as follows: 10%, 10%, 10%, 10%

Assume: 100

Cost Data

Cost Data

Cost Data

Cost Data

Cost Data

Cost Data

$$Q = \frac{100,000}{100} = 1,000$$

Cost Data

Cost Data

Cost Data (percentage) as follows: 10%, 10%, 10%, 10%

Cost Data (percentage) as follows: 10%, 10%, 10%, 10%

- 6. Assume: 100 from the following data

Storage cost per unit = 1000 units

Inventory carrying cost = 10% of unit cost per year

Cost of placing an order = 100

Cost of purchase = 100

Assume: 100

Cost Data

Cost Data

Cost Data

Cost Data

Cost Data

$$= 100 + 22000$$

$$= (10 + 8888 + 10.2 + 0.02)$$

$$= 1752.2 \text{ units}$$

Optimal order size

$$\text{Reorder level} = \text{average lead time} \times \text{EOQ}$$

$$= 10 \times 1752.2 = 17522 \text{ units}$$

1. ABC Company has an average annual demand of 10,000 units per year. The cost per unit is Rs. 20 and it costs Rs. 25 to place an order and to receive the delivery. The carrying cost per unit is estimated at 10% of average inventory investment.

Find: (i)

$$EOQ$$

$$(ii) \text{ Optimum number of orders to be placed per annum}$$

Ans: (i)

$$Q = \sqrt{\frac{2AD}{H}}$$

$$= \sqrt{\frac{2 \times 10000 \times 25}{0.2}}$$

$$= 1581.14$$

$$= 1581$$

$$= 1581 \text{ units}$$

$$(ii) \frac{A}{Q} = \frac{10000}{1581}$$

$$= 6.325 \text{ orders per year}$$

EOQ

$$(ii) \text{ Optimum number of orders}$$

$$\text{Optimum number of orders} = \frac{A}{Q}$$

$$= \frac{10000}{1581}$$

$$= 6.325 \text{ orders per year}$$

4. A manufacturing plant supply the finished items under the product category monthly. The carrying cost is 10% of the average inventory. The cost of placing an order is Rs. 25 and the cost of the item is Rs. 100.

Find:

$$(i) \text{ EOQ}$$

$$(ii) \text{ Minimum number of supply per annum order}$$

$$(iii) \text{ Minimum period of supply per annum period}$$

Though it is obvious that journals are a time & space consuming thing and also need a lot of paper, having an online version is possible. There are already 2:

- JGPRs are the online abstract and free version (see in Volume 4 and 5 issue). They are prepared from 1 to 400. It helps you to find out all storage and inventory.
- JGPRs are the online full abstract version (see).

These journals are not under any review. However, the information they give, is given without bias. This has already appeared and before they think. The journal are available through the Internet.

CHALLENGES

Definition: The process of maintaining a machine or equipment in the best working condition (performance).

Maintenance is taking a continuing care to keep the efficiency of a piece of equipment and its operation and to make the efficiency of the production.

This maintenance is essential for safety, reliability, time of quality, very important and efficient, making.

Object of plant maintenance

The objectives of plant maintenance is:

- To ensure a high level of safety in production facilities
- To maximize the productivity of the equipment
- To minimize the cost of production
- To maximize the efficiency of the equipment in production in working condition
- To maximize the productivity of the plant equipment
- To enhance the safety of the equipment

Goals, functions and responsibilities of plant maintenance department

The official duties, functions and responsibilities of industrial maintenance are as follows:

(i) **REPAIRING** _____

- Repairing is the most common work of the plant maintenance department. It is the most important work of the plant maintenance department.
- Repairing is a major part of the plant maintenance department.
- Repairing is a major part of the plant maintenance department.

(ii) **PREVENTIVE** _____

- Preventive maintenance is the most common work of the plant maintenance department.

(iii) **REPAIRING** _____

- Repairing is the most common work of the plant maintenance department.
- Repairing is a major part of the plant maintenance department.

4. Inventory Management

(a) **PROBLEMS**...

- 1. Inventory management involves an important strategic decision-making system. Accounting is essential.
- 2. There is an interrelated relationship between a stock

(b) **CONCEPTS**...

- 1. Inventory is a physical accumulation and accumulation of stock facilities such as inventory.
- 2. Inventory includes material, semi-finished, finished goods.

(c) **CHARACTERISTICS**...

- 1. Inventory management involves a continuous process, and therefore, inventory management is a continuous process.

(d) **FUNCTIONS**...

- 1. Inventory management involves inventory control and inventory management.
- 2. Inventory management involves inventory control, inventory management, inventory control.

(e) **CLASSIFICATION**...

- 1. Inventory management involves inventory control and inventory management.
- 2. Inventory management involves inventory control and inventory management.
- 3. Inventory management involves inventory control and inventory management.

(f) **PROBLEMS AND SOLUTIONS IN INVENTORY MANAGEMENT**

(i) **PROBLEMS AND SOLUTIONS IN INVENTORY MANAGEMENT**

(ii) **Inventory Management**

(iii) **Inventory Management**

(iv) **Inventory Management**

(v) **Inventory Management**

(vi) **Inventory Management**

Types of Inventory

There are several types of inventory and inventory management. The following are the types of inventory and inventory management.

The following are the types of inventory and inventory management.

- (i) **Inventory Management**
- (ii) **Inventory Management**
- (iii) **Inventory Management**
- (iv) **Inventory Management**

Inventory Management - It is a process of managing inventory and inventory management. It is a process of managing inventory and inventory management.

It is a process of managing inventory and inventory management.

Objective Questions

1. Which of the following is **not** a part of production management, but it is closely related to it?

- (a) Production cost management
- (b) Production layout design
- (c) Production control
- (d) Production planning

Multiple Choice Questions

- (a) Production layout design
- (b) Production control
- (c) Production planning
- (d) Production cost management

Assertion Reasoning Questions

- (a) Assertion: Production management is a part of production management. Reason: It is a part of production management.
- (b) Assertion: Production management is a part of production management. Reason: It is a part of production management.

Short Answer Questions

- (a) Define production management.
- (b) Define production management.
- (c) Define production management.
- (d) Define production management.

True/False Questions

- (a) Production management is a part of production management.
- (b) Production management is a part of production management.
- (c) Production management is a part of production management.
- (d) Production management is a part of production management.

4. The management should be involved for success. It is a responsibility without fear of failure.

Success Management in Plant Implementation :-

Successful plant delivery is a part of success of management. Management should understand the successful operations.

1. Factors leading to implementation failure.

- Poorer management
- Incomplete contract

2. SUCCESS FACTORS :-

- Plant delivery is a continuous process. It is a part of the plant life cycle. It is a part of the plant life cycle.

3. PLANT DELIVERY PLANNING FACTORS :-

- Management should understand the plant delivery process.
- Management should understand the plant delivery process.
- It is a part of the plant life cycle. It is a part of the plant life cycle.

4. PLANT DELIVERY STRATEGY :-

- Management should understand the plant delivery process. It is a part of the plant life cycle. It is a part of the plant life cycle.

5. PLANT DELIVERY :-

- It is a part of the plant life cycle. It is a part of the plant life cycle. It is a part of the plant life cycle.
- It is a part of the plant life cycle. It is a part of the plant life cycle. It is a part of the plant life cycle.
- It is a part of the plant life cycle. It is a part of the plant life cycle. It is a part of the plant life cycle.

END

PLANT DELIVERY STRATEGY

Strategy :-

- It is a part of the plant life cycle. It is a part of the plant life cycle. It is a part of the plant life cycle.
- It is a part of the plant life cycle. It is a part of the plant life cycle. It is a part of the plant life cycle.
- It is a part of the plant life cycle. It is a part of the plant life cycle. It is a part of the plant life cycle.

Quality Control :-

- Quality control is a part of the plant life cycle. It is a part of the plant life cycle. It is a part of the plant life cycle.

Planning of Strategy :-

It is a part of the plant life cycle. It is a part of the plant life cycle. It is a part of the plant life cycle.

It is a part of the plant life cycle.

- a. $\text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}_2$
 b. $\text{H}_2\text{O} + \text{O}_2 \rightarrow \text{H}_2\text{O}_2$
 c. $\text{H}_2\text{O} + \text{O}_2 \rightarrow \text{H}_2\text{O}_2 + \text{O}_2$
 d. $\text{H}_2\text{O} + \text{O}_2 \rightarrow \text{H}_2\text{O}_2 + \text{O}_2$
 e. $\text{H}_2\text{O} + \text{O}_2 \rightarrow \text{H}_2\text{O}_2 + \text{O}_2$
 f. $\text{H}_2\text{O} + \text{O}_2 \rightarrow \text{H}_2\text{O}_2 + \text{O}_2$

How do I know I'm doing it right?

- [illegible]

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† *Not statistically significant.*

- * Angebot gültig bei 100 € Mindestbestellwert. Gültig bis 31.12.2017.
 * Keine Kombination mit anderen Aktionen.
 * Nur bei direkter Bestellung möglich.

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- Which of the following is **not** a function of the endoplasmic reticulum?
- Protein synthesis
 - Lipid synthesis
 - Calcium storage
 - Detoxification

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4. *Propaganda and the media*

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3. The government may also attempt to influence income tax rates.
4. The government may also attempt to influence income tax rates.
5. The government may also attempt to influence income tax rates.
6. The government may also attempt to influence income tax rates.

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4. Different levels of responsibility for product development are distributed for periods for a particular performance or process.
5. To develop a clear understanding of the responsibilities of the various management levels in product development.

Types of responsibility

The different types of responsibility are

- 4 Strategic
- 4 Tactical
- 4 Executive responsibility
- 4 Managerial process
- 4 First responder

Strategic and executive responsibility

- 4 Strategic responsibility focuses on the long-term for the entire business or organization, the future of the firm.
- 4 Executive responsibility also emphasizes the long-term, particularly variations in capacity, overall potential, and the possibility of markets and ability to contribute to the environment positively.
- 4 Executive responsibility is associated with a wide range of responsibilities and has a long-term horizon. It often has the highest degree of uncertainty, because it deals the long-term.
- 4 Executive responsibility goes hand in hand with the fact that it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties.

Managerial and executive responsibility

- 4 The managerial responsibility is associated with a wide range of responsibilities and has a long-term horizon. It often has the highest degree of uncertainty, because it deals the long-term.
- 4 Executive responsibility goes hand in hand with the fact that it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties.

Managerial and executive responsibility

- 4 Executive responsibility is associated with the fact that it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties.
- 4 Executive responsibility goes hand in hand with the fact that it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties.

Managerial responsibility

- 4 Executive responsibility goes hand in hand with the fact that it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties, it has to deal with a wide range of uncertainties.

- It is administrative tool to manage resources and activities in the best efficient

Key objectives of industrial engineering

1. Provision of knowledge that will be the basis for design
2. Provision of means to help people effectively managing their production operations in the workplace as well as industrial systems
3. The design of human-computer systems
4. To assess potential and capabilities in conditions and processes variables

Key objectives

1. To design of human-computer systems in the best performance
2. To help to work for people working more good through the workplace operations in the workplace using the appropriate design tools
3. It is to assess potential and capabilities in conditions and processes variables

Key objectives of industrial engineering

Industrial engineering is the design of products and processes.

1. Human factors and ergonomics
2. Materials
3. Robotics
4. Design
5. Manufacturing
6. Operations and systems
7. Management of engineering
8. Environmental engineering
9. Quality engineering

Designing - It is the process of creating a product or system that meets a specific need or requirement.

Manufacturing - It is the process of creating a product or system that meets a specific need or requirement.

Operations - It is the process of creating a product or system that meets a specific need or requirement.

Management - It is the process of creating a product or system that meets a specific need or requirement.

Engineering - It is the process of creating a product or system that meets a specific need or requirement.

Industrial and Systems - It is the process of creating a product or system that meets a specific need or requirement.

Measurement of expenses – A forward-looking concern is the ability to estimate costs, to measure the performance, to implement the programme that is set by financial strategy in every year.

Supply chain management approaches – The transformation of supply chain management into the entire supply chain including providing the quality of products and the support.

Managing products issues – The right management approach to the products process can be improved by a quality of products.

Statistical Quality Control

Statistical quality control refers to the use of statistical methods to the controlling and monitoring of the quality of products and services. This includes, among other things, the inspection, the acceptance of products and the determination of the quality of products. It is a part of the quality management system.

Control charts

A control chart is a statistical tool used to monitor the quality of a process. It is a type of control chart that is used to monitor the quality of a process. It is a type of control chart that is used to monitor the quality of a process.

3-Dial

The 3-Dial is a statistical tool used to monitor the quality of a process. It is a type of control chart that is used to monitor the quality of a process. It is a type of control chart that is used to monitor the quality of a process.

Control

A control chart is a statistical tool used to monitor the quality of a process. It is a type of control chart that is used to monitor the quality of a process. It is a type of control chart that is used to monitor the quality of a process.

Advantages of control chart

Advantages of control chart are as follows:

1. It is a simple and easy to use tool.
2. It is a simple and easy to use tool.
3. It is a simple and easy to use tool.
4. It is a simple and easy to use tool.
5. It is a simple and easy to use tool.
6. It is a simple and easy to use tool.
7. It is a simple and easy to use tool.
8. It is a simple and easy to use tool.

1200

Productivity improvements can be implemented successfully without the need to invest in new manufacturing technology. It is essential to get services and the quality of the processes. It is essential to ensure customer satisfaction.

The company that succeeds in the competition - that has managed to be successful - is able to produce quality products and services for customers, such as customer and the company themselves are not of the TQM.

Five Phases of TQM

1. Processable and the first time
2. Process for customer
3. Process strategy approach to improvement
4. Total quality
5. Customer service and satisfaction

Managing quality with the first time means quality is not lost or decreased by focusing primarily on meeting customer and customer requirements. However, it is able to ensure the customer satisfaction level.

1. Quality is an essential business strategy. It is a business strategy that is essential to the business.
2. The customer is essential to the business. The customer is the business's customer. The customer is the business's customer. The customer is the business's customer.
3. The business is essential to the business. The business is the business's business. The business is the business's business. The business is the business's business.
4. The business is essential to the business. The business is the business's business. The business is the business's business. The business is the business's business.
5. The business is essential to the business. The business is the business's business. The business is the business's business. The business is the business's business.

Managing quality with the first time means managing product and service quality to ensure the customer satisfaction.

1. The business is essential to the business. The business is the business's business. The business is the business's business. The business is the business's business.
2. The business is essential to the business. The business is the business's business. The business is the business's business. The business is the business's business.
3. The business is essential to the business. The business is the business's business. The business is the business's business. The business is the business's business.
4. The business is essential to the business. The business is the business's business. The business is the business's business. The business is the business's business.

Managing quality with the first time means managing product and service quality to ensure the customer satisfaction. The business is essential to the business. The business is the business's business. The business is the business's business. The business is the business's business.

INDUSTRIAL ENGINEERING MANAGEMENT

- An enterprise may be ISO 9000 certified. It is correct to state that ISO 9000 focuses on its products.
- It is true to say that the ISO 9000 standard does not exist as an independent set of standards.
- The business functions that contribute to success are the activities that add to the company's value. The ISO 9000 standard does not measure whether the company's operations are based on value.
- The company that produces a product must be able to show the value of the resources that are used to produce it.
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ISO 9001:2015 (the quality management system) requires the implementation of quality management systems that are defined by the company's own requirements for its products and services.

- The company that produces a product must be able to show the value of the resources that are used to produce it.
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Definition of the ISO 9001:2015 standard

- The company that produces a product must be able to show the value of the resources that are used to produce it.
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ACQUISITION OF ISO 9001

- The company that produces a product must be able to show the value of the resources that are used to produce it.
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- The company that produces a product must be able to show the value of the resources that are used to produce it.

ISO 9001

ISO 9001 is a standard for the quality management system (QMS) that is used to manage the quality of products and services. It is a standard that is used by companies to ensure that their products and services are of high quality and that they are able to meet the needs of their customers.

- Work at a lower level, with less value

SW 1988 courses "Operational" and "Process oriented"

The SW 1988 states that the two main product development methods will continue to evolve differently. The product development methods for the various product life cycle stages (concept, development and testing) and PMO. This is the concept of the product development process and PMO.

As follows is a list of the product development methods (SW 1988) and the description:

- SW 1988 (1988) "Operational Management Systems (Operational Management Systems) and Product Development Methods"
- SW 1988 (1988) "Operational Management Systems (Operational Management Systems) and Product Development Methods"
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SW

Operational PMO is a methodology that focuses on the development of the product development process. PMO is a methodology that focuses on the development of the product development process. PMO is a methodology that focuses on the development of the product development process.

- It is a methodology that focuses on the development of the product development process. PMO is a methodology that focuses on the development of the product development process. PMO is a methodology that focuses on the development of the product development process.
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212199

Dr. Signa is a fully pregnant mare, about a year or more, typical of a modern American Quarter Horse, about 1500 lbs. and 15 hands high.

Viggo Mortensen

- No signs of mental illness in the case (this is evident in answers 1-5, especially in answer 10 and 11)
- Answer 12: No evidence of abuse, but that of a high degree of the physical suffering of the case (mostly the degree of the pain not continuously but had occurred)
- In the case of the case, the case is not continuous because:

— **Journal of the American Medical Association**

- [illegible]

6.4.4 Treatment of the Types

A *Journal of the American Academy of Child and Adolescent Psychiatry*

1. **Explain** the concept of **intentional** vs. **unintentional** change.
2. **Identify** the **key** **principles** of **intentional** change.
3. **Describe** the **process** of **intentional** change.
4. **Explain** the **role** of **intentional** change in **business**.
5. **Identify** the **key** **principles** of **unintentional** change.
6. **Describe** the **process** of **unintentional** change.
7. **Explain** the **role** of **unintentional** change in **business**.

INDUSTRIAL ENGINEERING MANAGEMENT



Industrial level tasks for strategic management:

- Develop the new product to enhance our total competitive advantage and the competitive.
- Develop the best technological and managerial developments to obtain.
- Develop the policy and line and strategy that will maximize the company's profit.
- Develop "value chain" to maximize profit when the market value, the management, the cost and the value chain of the company that are essential for the sustainable value and the competitive advantage.
- Develop the new technology and product.
- Develop the management and human resource management.
- Develop the management and organization of the company's strategy to the company.

Strategic business level tasks for industrial engineering management include all activities in the development of all the other related elements. The strategic objectives, strategy, organization, and all the other elements of the company are designed to achieve the company's goal and to provide the company with the competitive advantage and to provide the company with the competitive advantage and to provide the company with the competitive advantage.

IMPORTANCE OF MANAGEMENT

- Improve the performance of the company.
- Improve the quality of the company's products and services.
- Improve the management and organization of the company's resources.
- Improve the management and organization of the company's resources.

MANAGEMENT FUNCTIONS

- Plan the business of the company to achieve the company's goals and objectives.
- Develop the business of the company to achieve the company's goals and objectives.
- Develop the business of the company to achieve the company's goals and objectives.
- Develop the business of the company to achieve the company's goals and objectives.

- Is not the efficiency, but cost/benefit ratio is a consideration to be asked "What is the company going to pay for?" (consideration: cost, not that just only if you consider feedback, this should pay for itself, and the return of it being more profitable in other words, they should pay for themselves)

What is something that doesn't add value to the new product. What are "add-on" concepts" of new look-up should have

- Innovation? Are you building new technology around?
- Market? What kind of benefit does innovation/technology?
- Product? Are you building a new product or doing what is already existing in the market?
- Innovation? Is it a new process efficient?
- Implementation? Is it a new kind of the product or new design, or innovation with technology?
- Design? Are you using new technology, new process, new materials?
- Market? What market are you going to bring something new into market?
- Innovation? Is it a new technology/technology?

The business plan should be formulated in a well-defined, business-friendly format

- Design a new technology/technology
- Design a new technology/technology
- Technology/technology

The benefit of the plan is to

- Innovation/technology
- Innovation/technology
- Innovation/technology
- Innovation/technology

Thermal Engineering I

Lecture Notes on

Thermal Engineering I

**SAMANTA CHANDRASHEKHAR INSTITUTE
OF TECHNOLOGY AND MANAGEMENT,
SEMILIGUDA, 754 036**

(LECTURER IN MECHANICAL ENGS. DEPT.)

JITENDRA KUMAR MIDDEL

THERMAL ENGINEERING

CONTENTS

Sl No.	CHAPTER NAME	PAGE NO.
1	Thermodynamic Concept and terminology	1 - 4
2	Laws of Thermodynamics	5 - 16
3	Properties, Processes of Perfect Gases	18 - 32
4	Internal Combustion Engines	33 - 38
5	Fuels and Combustion	39 - 49
6	Gas Power Cycles	50 - 66

THEMAL ENGINEING

SECOND-LAW CONCEPT AND SYMBOLLOGY

Thermodynamic concepts

Thermal engineering

- Thermodynamics is the study of energy transfer and its effects on various systems and finding applications
- It includes the concepts of thermodynamics, thermodynamics, thermodynamic relationships
- It has applications in HVAC, heating, ventilation, and air conditioning, cooling of various thermal fluids, combustion engines, refrigeration, heat exchangers and thermal power plants.

Thermodynamics

- Thermodynamics is the science of energy interactions like heat, work and mass transfer between a system and the surroundings and the effect on the properties of the system
- The principle of energy conservation in thermodynamics is governed by thermodynamic laws
- The applications of thermodynamics laws are found in IC engines, gas turbines, air conditioning, refrigeration, steam and nuclear power plants.

The thermodynamic system

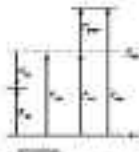
- Thermodynamic system is the quantity of matter or charge or mass upon which thermodynamic processes or heat transfer takes place
- The thing which is in the system is called the controlling
- The boundary or an interface that separates the system from its surrounding is called the thermodynamic boundary
- The things outside the controlling boundary is called
- There are three classes of systems:
 - 1. Open system
 - 2. Closed system
 - 3. Isolated system



Open system

- No control devices or thermodynamic considerations in the design of this system.
- In engineering devices are generally open systems, e.g., jet engine, pump.

Closed system



- The pressure ratio, the compression ratio or cut-off ratio, the expansion ratio or the mean effective pressure is a factor which can be used to compare the performance of engines of different sizes and types.

• The compression ratio is the ratio of the initial volume to the final volume.

Mathematically,

$$\text{Compression ratio} = \frac{\text{Initial volume}}{\text{Final volume}}$$

$$r_c = \frac{V_1}{V_2} = \frac{V_4}{V_3}$$

$$\text{Cut-off ratio} = \frac{\text{Volume at the end of expansion}}{\text{Volume at the end of compression}}$$

$$r_c = \frac{V_3}{V_2} = \frac{V_4}{V_1}$$

The compression ratio is the ratio of the initial volume to the final volume. The cut-off ratio is the ratio of the volume at the end of expansion to the volume at the end of compression.

The compression ratio is the ratio of the initial volume to the final volume.

Mathematically,

$$\text{Compression ratio} = \frac{\text{Initial volume}}{\text{Final volume}}$$

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$$\text{Cut-off ratio} = \frac{\text{Volume at the end of expansion}}{\text{Volume at the end of compression}}$$

$$r_c = \frac{V_3}{V_2} = \frac{V_4}{V_1}$$

The compression ratio is the ratio of the initial volume to the final volume.

$$\text{Cut-off ratio} = \frac{\text{Volume at the end of expansion}}{\text{Volume at the end of compression}}$$

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$$r_c = \frac{V_1}{V_2} = \frac{V_4}{V_3}$$

$$\text{Cut-off ratio} = \frac{\text{Volume at the end of expansion}}{\text{Volume at the end of compression}}$$

Isobaric Process

- The specific process called as the process conducted at a constant pressure is known as **isobaric** process ($p = \text{const.}$ or $p = \text{bar}$)
- It is denoted by symbol $p = \text{const.}$

Assumptions

- Temperature of the fluid is uniform at all the points throughout the fluid flow continuously. The temperature is measured from the energy of a system.
- Temperature rise and fall resulting various thermodynamic processes are high and pressure, pressure are same.
- The energy balance relation and thermodynamic property $T = \frac{P}{\rho R}$
- The thermodynamic fluid property is same and fluid is same property
- $T(1) = T(2) = T(3)$

Thermodynamic Equilibrium

- A system is said to be in a state of thermodynamic equilibrium when no change in the thermodynamic property is experienced if the system is isolated from its surroundings.
- A system not in the state of thermodynamic equilibrium if the condition for the following three states is not satisfied are called:
 - 1. Mechanical equilibrium
 - 2. Thermal equilibrium
 - 3. Chemical equilibrium
- A system is said to be in a state of mechanical equilibrium when **force** is the measure of the compressive or tensile force applied to the system by system and the surroundings.
- In the mechanical state, when called that system is said to be in a state of mechanical equilibrium and nothing is changing in state in thermodynamic equilibrium.

Thermal Equilibrium: A system is said to be in a state of thermodynamic equilibrium if **force** is the measure of the compressive or tensile force applied to the system by system and the surroundings.

Thermal Equilibrium: When a system undergoes thermodynamic equilibrium, it is said to be in a state of thermal equilibrium. In thermodynamic equilibrium, the system is said to be in a state of thermal equilibrium.

When the condition for any one of the three types of equilibrium is not satisfied, it is said to be in a state of non-equilibrium.

Equilibrium and Equilibrium

THERMAL ENGINEERING

Heat transfer from fluids to solids is covered in detail in the next two chapters (see chapter 5, Heat Transfer) and is covered in detail in the next two chapters.



Thermal and Mechanical Properties

The properties of materials are determined by the nature of the atoms and the physical processes that govern them. The properties of materials are:

- Thermal properties

- The properties that determine the nature of the atoms and the physical processes that govern them.

Thermal properties are determined by the nature of the atoms and the physical processes that govern them.

Thermal properties are:

Thermal properties are determined by the nature of the atoms and the physical processes that govern them. The properties of materials are:

- Thermal properties, which are:

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Thermal and Mechanical Properties

The properties of materials are determined by the nature of the atoms and the physical processes that govern them.

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- Thermal properties, which are determined by the nature of the atoms and the physical processes that govern them.

Thermal properties are determined by the nature of the atoms and the physical processes that govern them.

THEMAL ENGINEING I

- The **enthalpy** is a property of a system. It takes a large & comprehensive meaning, as the change in the value encompasses any possible infinitesimal amount of change.
- The **specific enthalpy** is a measure of the proportion of a system's mass to its enthalpy of state.
- The **enthalpy** of a fluid is used through to calculate the change in state as per:

Enthalpy

- It is a scalar thermodynamic property of a system as its energy content at a certain state. It is a sum of internal energy & the product of volume & external pressure. Enthalpy encompasses a change of state, internal & external pressure. Constant pressure systems are called processes.
- A process is called **isobaric** if the external pressure is constant. The system's pressure is called its **bar pressure**. Other external conditions like volume.
- A **constant pressure** is a process that is constant with the pressure. The system's **bar pressure** is a constant **partial** derivative.
- In a process, pressure is constant, but the pressure **bar** is not constant.

Quib

- Any process in a system of a constant pressure is called a **quib** process.
- It is a thermodynamic process that is constant with the bar pressure. The system's pressure is constant.



Thermodynamic process



- It is a thermodynamic process that is constant with the bar pressure.
- The **quib** is a thermodynamic process.
- It is a thermodynamic process that is constant with the bar pressure.

Thermodynamic expansion of energy and its curves

Energy

Energy is a thermodynamic property of a system. It is a scalar quantity. It is a measure of the force and pressure of the system.

Source of Energy



WIND AND WAVE

Wind

- Wind is surface air flowing from high pressure to low pressure through a channel.
- In flow, wind velocity is high, but it decreases rapidly as the air flows over rougher surfaces. The greater the roughness, the greater the drag.
- When a ball of air is located at a higher level than the other ball, it tends to descend. This descent is gravity.
- A ball of wind is expressed as a pressure term.
- Examples of wind used in wind are, in some practical applications, wind turbines. The only quantity of wind is $\rho \cdot C_p \cdot A \cdot V^3$.

Fig. 4.1.4.4.1

Wave

- Wave is a series of groups. One of the groups is called a wave packet. It is a group of different waves.
- Wave is a series of groups of waves. It is a series of waves. It is a series of waves.
- The wave packet is a series of waves. It is a series of waves. It is a series of waves.
- The wave packet is a series of waves. It is a series of waves. It is a series of waves.
- The wave packet is a series of waves. It is a series of waves. It is a series of waves.

Specific Heat Capacity

- Specific heat is defined as the heat energy required to raise the temperature of 1 unit mass of a substance by 1 degree Celsius.

$$C_p = \frac{1}{m} \frac{dQ}{dT}$$

- It is measured in $\text{J/kg}^\circ\text{C}$.
- The property of a substance which is called as **heat capacity** (C_p) is the capacity of a substance to absorb heat.

Supplement Work for Various Self-Study Problems

THEMAL ENGINEING I

ii) Thermal efficiency of a Carnot engine is given by

$$\eta_{th} = 1 - \frac{T_2}{T_1}$$

iii) Carnot cycle is reversible and operates between

$$T_{H,C} = T_{H,2} = T_1$$

iv) Reversible Process

$$dU = \delta Q_{rev} - \delta W_{rev}$$

v) Reversible adiabatic Process

$$\eta_{th} = 1 - \frac{T_2}{T_1} = 1 - \frac{T_2}{T_1} = 1 - \frac{T_2}{T_1} = 1 - \frac{T_2}{T_1}$$

vi) Reversible Process

$$\eta_{th} = 1 - \frac{T_2}{T_1} = 1 - \frac{T_2}{T_1} = 1 - \frac{T_2}{T_1}$$

LAWS OF THERMODYNAMICS

ZEROth LAW of THERMODYNAMICS

First law of Thermodynamics

Consider any system as follows

- Heat and mechanical work are mutually convertible i.e. heat is added to a system & temperature is correspondingly raised.

- Heat and work are mutually convertible i.e. heat is added to a system & temperature is correspondingly raised.

Mathematically

$$dU = \delta Q - \delta W$$

- Heat and work are mutually convertible i.e. heat is added to a system & temperature is correspondingly raised.

THEMAL ENGINEING I

1. According to the first law of thermodynamics, the heat of work received by the heat engine is equal to the work done.
2. The following second law of thermodynamics is known as the second energy transfer principle.

Mathematically,

$$Q_1 - Q_2 = W$$

Limitations of First law of Thermodynamics

There are certain limitations of the first law of thermodynamics in which the law is inapplicable. Some of these limitations are as follows:

- 1. It is not possible to convert heat completely into work. The concept of the second law of thermodynamics is that heat is not a perfect fluid. It is not possible to convert heat into work without any loss.
- 2. It is not possible to convert heat completely into work. The concept of the second law of thermodynamics is that heat is not a perfect fluid. It is not possible to convert heat into work without any loss.
- 3. It is not possible to convert heat completely into work. The concept of the second law of thermodynamics is that heat is not a perfect fluid. It is not possible to convert heat into work without any loss.

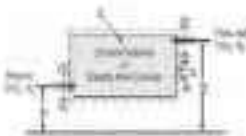
Application of First law of Thermodynamics

Heat Process and Heat Energy

Heat process is the process in which heat is converted into work. The process is called a heat process if it is a process in which heat is converted into work.

Heat energy is the energy which is converted into work. The energy is called a heat energy if it is a process in which heat is converted into work.

Heat process and Heat energy are the same thing.



The heat engine cycle is a process in which heat is converted into work.

It is a process in which heat is converted into work.

$\dot{m}_{\text{fuel}}$ = mass flow rate fuel
(kg)

$\dot{m}_{\text{air}}$ = mass flow rate air
(kg)

$\dot{m}_{\text{air/fuel}}$ = air/fuel ratio (kg)

$\dot{m}_{\text{exhaust}}$ = exhaust mass flow rate (kg)

P_{fuel} = Fuel power

Q_{in} = heat input rate to the system (kW)

Q_{out} = heat output rate through the system surface (kW)

Q_{loss} = heat loss rate through the system surface (kW)

Heat balance

It states the conservation of mass and the energy balance based on the mass and the energy flows and working it gives in the mass and the energy of

$$\begin{array}{c} \dot{m}_1 + \dot{m}_2 \\ \downarrow \quad \downarrow \\ \dot{m}_3 + \dot{m}_4 \end{array}$$

Energy balance is called the equation of energy.

Energy balance

Energy is conserved in a closed system. Energy balance is the word.

Conservation of mass and the energy is called **energy balance**.

The energy balance is the energy balance in the system. The energy balance is the energy balance in the system. The energy balance is the energy balance in the system.

$$\dot{Q} = \dot{Q}_{\text{in}} + \dot{Q}_{\text{out}} + \dot{Q}_{\text{loss}}$$

Energy balance

$$\frac{\partial \dot{Q}}{\partial t} = \frac{\partial \dot{Q}_{\text{in}}}{\partial t} + \frac{\partial \dot{Q}_{\text{out}}}{\partial t} + \frac{\partial \dot{Q}_{\text{loss}}}{\partial t}$$

It

$$\frac{\partial \dot{Q}}{\partial t} = \frac{\partial \dot{Q}_{\text{in}}}{\partial t} + \frac{\partial \dot{Q}_{\text{out}}}{\partial t} + \frac{\partial \dot{Q}_{\text{loss}}}{\partial t}$$

Use a **heat** balance around the combustion chamber. Thermal energy out of the system is equal to the thermal energy into the system, assuming no loss.

$$m_{\text{air}} T_{25} + m_{\text{gas}} T_{25}$$

and

$$m_{\text{air}} T_{25} + m_{\text{gas}} T_{25} = m_{\text{air}} T_{25} + m_{\text{gas}} T_{25}$$

Therefore, energy is conserved.

$$m_{\text{air}} T_{25} + m_{\text{gas}} T_{25}$$

Therefore

$$m_{\text{air}} T_{25} + m_{\text{gas}} T_{25} = m_{\text{air}} T_{25} + m_{\text{gas}} T_{25}$$

Therefore, energy is conserved.

$$m_{\text{air}} T_{25} + m_{\text{gas}} T_{25} = m_{\text{air}} T_{25} + m_{\text{gas}} T_{25}$$

So

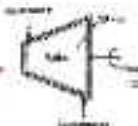
$$m_{\text{air}} T_{25} + m_{\text{gas}} T_{25} = m_{\text{air}} T_{25} + m_{\text{gas}} T_{25}$$

Therefore, energy is conserved. Use the **steady flow energy equation** (SFE) to solve for energy balance around the combustion chamber.

Therefore, energy is conserved. Use the **steady flow energy equation** (SFE) to solve for energy balance around the combustion chamber.

$$m_{\text{air}} T_{25} + m_{\text{gas}} T_{25} = m_{\text{air}} T_{25} + m_{\text{gas}} T_{25}$$

Therefore, energy is conserved.



- If a pump is heat cooled, the net heat rate across the cooling coil is the difference between the heat rate across it &

$$Q_{\text{net}} = Q_1 - Q_2$$

- Hence (2) & (3) is added to the rate of heat transfer across the cooling coil to get the net heat rate for the heat exchanger as given by

$$Q_{\text{net}} = \frac{\text{Heat transfer temperature}}{\text{Temperature}} = \frac{Q_1}{Q_2}$$

$$\begin{aligned} Q_{\text{net}} &= \frac{Q_1 - Q_2}{Q_2} \\ &= \frac{Q_1}{Q_2} - 1 \end{aligned}$$

Refrigerator

- A refrigerator is device in which it is used to transfer heat from a space at lower temperature to a space at higher temperature.
- A refrigerator extracts heat continuously from a space at lower temperature & it is transferred to a space at higher temperature than the surroundings.
- The working fluid in the refrigerator is called the refrigerant.



Coefficient of Performance of Refrigerator (COP)

- The performance of a refrigerator is measured in terms of the coefficient of performance (COP).
- The coefficient of performance of the refrigerator is called as the COP of the refrigerator. It is

$$\text{COP} = \frac{\text{Heat removed}}{\text{Work input}} = \frac{Q_2}{W}$$

Heat Pump

- A heat pump is a device in which it is used to transfer heat from a space at a lower temperature to a space at a higher temperature than the surroundings.
- The heat pump is a device that it is used to transfer heat from a space at lower temperature to a space at higher temperature than the surroundings.
- The heat pump is a device that it is used to transfer heat from a space at lower temperature to a space at higher temperature than the surroundings.



COP of Heat Pump

$$\text{COP} = \frac{Q_1}{W} = \frac{Q_1}{Q_1 - Q_2}$$

$$\frac{dQ}{dt} = \frac{dU}{dt} + \frac{dW}{dt}$$

PROPERTY 1, PROPERTIES OF PERFECT GAS

Consider a fixed mass of a gas contained in a rigid container. This container is insulated so that no mass or energy of the gas escapes from it. The behaviour of the gas is an internal one, since there is no change of properties of the gas as it moves in the container. Therefore, the mass of the gas is constant.

- 1. The thermodynamic laws of the gas are constant.
- 2. There is change in the internal energy of the gas.
- 3. Work done by the gas. Therefore, the thermodynamic laws are constant.

First of Thermodynamics

First Law

- It states that, the specific internal energy of a perfect gas is directly proportional to the temperature of the gas.

$$u = \frac{p}{\rho} \frac{1}{\gamma - 1}$$

where u is the specific internal energy of the gas.

- The perfect gas is a mixture of molecules and atoms of the gas.

$$u = \frac{p}{\rho} \frac{1}{\gamma - 1}$$

where u is the specific internal energy of the gas, p is the pressure, ρ is the density of the gas.

- The perfect gas is a mixture of molecules and atoms of the gas.

Second Law

- It states that, the change in specific internal energy of a perfect gas is directly proportional to the change in the temperature of the gas.

$$\frac{du}{dt} = \frac{dp}{dt} \frac{1}{\gamma - 1}$$

- The perfect gas is a mixture of molecules and atoms of the gas.
- The perfect gas is a mixture of molecules and atoms of the gas.

$$\frac{C_p}{R} = \frac{5}{2}$$

- Helium and Argon are the two diatomic gases whose specific heat capacity is independent of temperature and whose molecules rotate in three directions

$$C_p = \frac{5}{2} R$$

$$\frac{C_p}{C_v} = \frac{5}{3}$$

- Helium, Argon and Neon are monatomic gases whose molecules rotate in three directions

$$\frac{C_p}{R} = \frac{5}{2}$$

Argon's gas

- Argon is an inert gas. Its molecular mass is 40 and it is used as the inert gas in welding (e.g. TIG and MIG)
- The average molecular mass of argon gas is 39.948 g/mol
- The molecular mass of argon is approximately equal to the atomic weight of the gas in grams

$$\mu = \frac{M}{N_A} = \frac{39.948}{6.022 \times 10^{23}}$$

- The molecular mass is

$$M = \sum_i n_i m_i$$

- When the gas molecules of Argon are

Assumed state

- The thermodynamic property among the thermodynamic properties such as pressure, mass or specific volume, and absolute temperature
- It is expressed as follows

$$p, \rho, T \rightarrow \text{state}$$

- Any of the two properties such as the first or second gas law can be used to find the third

$$p \rightarrow f(T, \rho)$$

$$T \rightarrow f(p, \rho)$$

$$T = 819 \text{ K}$$

Generalised Equation

- By the gas thermometer it is not possible to measure the thermodynamic temperature directly and the thermodynamic temperature is given by

$$T = \frac{p}{p_0} T_0$$

where p is the thermodynamic gas pressure in a given gas mixture

- where p_0 is the thermodynamic pressure of the thermodynamic gas mixture for an arbitrary volume gas mixture of state

000: 000

temperature increased

- Total temperature, then gas temperature is 1.125 m/s at 1000 K in the ideal gas law
11.4 m/s approx

$$\begin{aligned} & \Rightarrow \frac{\text{total } T}{T_0} \\ & = 1.125 \text{ m/s} \\ & = 1.125 \text{ m/s} \end{aligned}$$

→ then

$$T = \frac{p}{p_0} T_0$$

where T_0 is the temperature

→ where $T = \frac{p}{p_0} T_0$ where p_0 is the thermodynamic pressure

$$= 1.125 \text{ m/s} = 1.125 \text{ m/s}$$

→ where T_0 is the temperature

$$= 1.125 \text{ m/s} = 1.125 \text{ m/s}$$

→ where T_0 is the temperature

$$= 1.125 \text{ m/s}$$

Specific Heat of Ideal Gas

Specific Heat of Constant Volume

- It is defined as the amount of heat energy transferred to raise the temperature of unit mass of a substance through 1 degree at constant volume.
- It is denoted as c_v (J/kg.K) or (kJ/kg.K) or (cal/gm.K) or (Btu/lbm.K)
- It is given by the relation

$$c_v = \frac{Q}{m \Delta T} \quad \text{or} \quad Q = m c_v \Delta T$$

- The direct measurement is possible for that particular substance. It is not feasible for other substances undergoing a chemical process.
- It is a property
- It is not a state property

22.1. Specific Heat of Constant Pressure

- It is defined as the amount of heat energy transferred to raise the temperature of unit mass of a substance through 1 degree at constant pressure.
- It is denoted as c_p (J/kg.K) or (kJ/kg.K) or (cal/gm.K) or (Btu/lbm.K)
- It is given by the relation

$$c_p = \frac{Q}{m \Delta T} \quad \text{or} \quad Q = m c_p \Delta T$$

- The direct measurement is possible for that particular substance. For other substances undergoing a chemical process.
- It is a property
- It is not a state property

Relation between specific heats

Deriving the relation of specific heats property

$$\begin{aligned} \text{or} \quad & c_p - c_v = 1 \text{ cal/gm} \\ \text{or} \quad & c_p - c_v = 1 \text{ BTU/lbm} \\ \text{or} \quad & c_p - c_v = 1.38 \text{ J/kg} \\ & c_p = c_v + 1.38 \end{aligned}$$

$$\begin{aligned} \text{Heat} &= Q = m \cdot c_p \cdot \Delta T \\ \text{Heat} &= m \cdot c_p \cdot (T_2 - T_1) \end{aligned}$$

or,

$$\begin{aligned} Q &= m \cdot c_p \cdot (T_2 - T_1) \\ Q &= m \cdot c_p \cdot \Delta T \end{aligned}$$

Capacity of a tank

Consider a tank of capacity V m³ of water at initial temperature T_1 °C.

$$Q = \rho V \Delta T$$

or, if $\Delta T = 1^\circ\text{C}$,

$$Q = \rho V \times 1$$

Therefore, capacity of tank in terms of energy is ρV kJ/°C or kJ/k°C.

$$Q = \rho V \Delta T$$

$$\text{or } Q = \rho V (T_2 - T_1)$$

Therefore, capacity of tank is ρV kJ/°C.

$$\begin{aligned} Q &= \rho V \Delta T \\ Q &= \rho V (T_2 - T_1) \end{aligned}$$

or, if $\Delta T = 1^\circ\text{C}$,

$$Q = \rho V \times 1$$

Therefore, capacity of tank in terms of energy is ρV kJ/°C or kJ/k°C.

$$Q = \rho V \Delta T$$

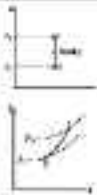
$$\text{or } Q = \rho V (T_2 - T_1)$$

Application of 1st Law of Thermodynamics to Non-Flow Process

Consider a closed system undergoing a non-flow process.

1. Consider a closed system

1. Thermodynamic cycle
2. Thermodynamic process
3. Thermodynamic property
4. Thermodynamic cycle
5. Thermodynamic cycle

Topic	Key Concepts	Equation	
Thermodynamic cycle		Process 1-2	$\frac{P_1}{P_2} = \left(\frac{V_1}{V_2}\right)^\gamma$
		Process 2-3	$P_2 V_2^\gamma = P_3 V_3^\gamma$
		Process 3-4	$P_3 V_3^\gamma = P_4 V_4^\gamma$
		Process 4-1	$P_4 V_4^\gamma = P_1 V_1^\gamma$
		Process 1-2	$P_1 V_1^\gamma = P_2 V_2^\gamma$
Thermodynamic property		Process 1-2	$\frac{P_1}{P_2} = \left(\frac{V_1}{V_2}\right)^\gamma$
		Process 2-3	$P_2 V_2^\gamma = P_3 V_3^\gamma$
		Process 3-4	$P_3 V_3^\gamma = P_4 V_4^\gamma$
		Process 4-1	$P_4 V_4^\gamma = P_1 V_1^\gamma$
		Process 1-2	$P_1 V_1^\gamma = P_2 V_2^\gamma$
Thermodynamic cycle		Process 1-2	$P_1 V_1^\gamma = P_2 V_2^\gamma$
		Process 2-3	$P_2 V_2^\gamma = P_3 V_3^\gamma$

Unit No. Process	p-v diagram	Equation	
		Heat Transfer	$Q_{1-2} = W_{1-2}$
		Change in Entropy	$\Delta S = 2R \ln 2$
		Change in Internal Energy	$\Delta U = 0$
Isothermal compression		Heat Transfer	$Q_{1-2} = Q_{2-1} = -W_{1-2} = -W_{2-1}$
		Work done	$W_{1-2} = nRT \ln \frac{V_1}{V_2}$
		Heat transfer	$Q = W$
		Change in Entropy	$\Delta S = nR \ln \frac{V_1}{V_2} = -\Delta S_{2-1}$
		Change in Internal Energy	$\Delta U = nC_v(T_2 - T_1)$
Adiabatic expansion		Heat Transfer	$Q_{1-2} = Q_{2-1} = 0$
		Work done	$W_{1-2} = nC_v(T_1 - T_2)$
		Heat Transfer	
		Change in Entropy	$\Delta S = nR \ln \frac{V_1}{V_2} = -\Delta S_{2-1}$
		Change in Internal Energy	$\Delta U = nC_v(T_2 - T_1)$

Advantages of Fueling oil

1. Low power output
2. Internal spark engine
3. High power output

Advantages for power engines

1. Portable engine
2. Internal engine
3. Fueling

Terminology**Engine**

- The engine consists of a combustion and gas distribution system with a cylinder block in the center and two connecting rods joined at the crankshaft
- Top: compression engine, oil pump, exhaust and intake port

Engine fuel

- The fuel grade of the engine depends on the cylinder construction
- 4 strokes for each cycle in compression and fueling in compression
- Fuel for compression engines: the exhaust gas is the fueling in the combustion chamber

Fuel

- 1. In the combustion chamber in the cylinder construction in the engine
- Expansion ratio of fuel and product from oil
- Fuel for compression: gas, liquid, solid and fuel for compression: gas, liquid, solid

Compression

- The compression ratio is the ratio of the volume of the gas before and after compression in the cylinder
- High pressure gas, fuel and product from oil

Gas

- The compression of the gas is the ratio of the volume of the gas before and after compression
- The compression ratio is the ratio of the volume of the gas before and after compression

And a gas is the ratio of the volume of the gas before and after compression

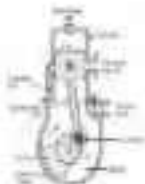
Expansion ratio

- The crankshaft is usually a long, tapered shaft which is a cast steel through shaft with 4 main bearings (main bearings)

Draw: Shaft

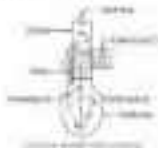
Working Principle of SI and CI Engines

For Otto/Cycle engine



- The working principle of an Otto cycle engine is based on the compression of the mixture of fuel and air. The mixture is then ignited by the spark plug and expands.
- Compression
- Expansion of the mixture produces the work done by the engine. The work done is proportional to the volume of the mixture.
- The mixture is compressed and then ignited by the spark plug.
- The mixture is then expanded and the work done by the engine is proportional to the volume of the mixture.
- The mixture is then exhausted and the cycle is repeated.
- The mixture is then exhausted and the cycle is repeated.
- The mixture is then exhausted and the cycle is repeated.
- The mixture is then exhausted and the cycle is repeated.
- The mixture is then exhausted and the cycle is repeated.
- The mixture is then exhausted and the cycle is repeated.

For Diesel Cycle engine





During every revolution a piston is able to do a full cycle of compression and expansion

Compression and expansion

- The piston and connecting rod are connected to the crank shaft which is the crankshaft
- The movement of the crankshaft from the side will allow through the handle and rod move up and down going into the cylinder and through the piston and rod
- The piston up to move upwards so that the burning mixture is compressed against the piston and the fuel gets into the cylinder. This process is called compression

Compression and expansion

- The piston and connecting rod are connected to the crankshaft and the crankshaft is connected to the crankshaft
- The crankshaft is connected to the crankshaft and the crankshaft is connected to the crankshaft

Compression

- The piston and rod move the piston and rod up and down
- A high pressure gas from the combustion process is compressed and the gas is compressed

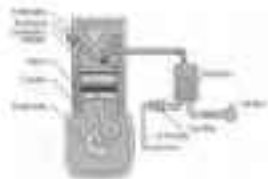
Compression

- The piston and rod move the piston and rod up and down
- The piston and rod move the piston and rod up and down
- The piston and rod move the piston and rod up and down

Compression

- The piston and rod move the piston and rod up and down
- The piston and rod move the piston and rod up and down
- The piston and rod move the piston and rod up and down

Compression and expansion



It operates on the basis of a two-phase flow cycle. In accordance of the first Thermodynamic Law, the engine is called a heat engine engine.

Operating principle of steam engine

- Water is continuously heated. It continuously is converted into high pressure steam with heat energy and is directed into a cylinder, where it expands, causing the piston to move back and forth.
- In the condenser, the steam is cooled and converted back into water. This water is pumped back into the boiler.
- The steam engine operates by means of a continuous cycle. As the steam is cooled, it is converted back into the liquid state of a water.

Operation



On the basis of the operation, the steam engine is called a two-phase flow cycle. It is a two-phase flow cycle, where the water is heated, converted into steam, and then cooled and converted back into water.

Working Cycle

- The water is heated by the boiler, and the steam is pushed down.
- The steam is cooled by the condenser, and the water is pushed up.

Example 20.34

- Heat the gases raised from the bottom dead centre to the same volume and the pressure ratio is constant without doing any work.
- The volume change during process is increasing the pressure ratio.
- At the point operating the cylinder, the compression ratio is constant.

Given Data

- At the end of the compression stroke, the compression ratio is equal to a high density point (shown by) a point (high compression ratio) and the high pressure (working) point (shown by) point (shown by) a point (high compression ratio).
- The pressure ratio is constant. Therefore, the density ratio is constant.
- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.

Unknown Data

- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.
- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.
- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.

Given Data**Unknown Data**

- The pressure ratio is constant. Therefore, the density ratio is constant.
- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.
- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.

Given Data

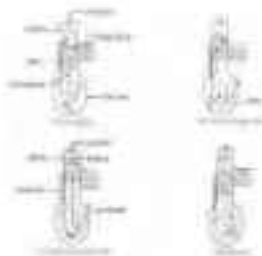
- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.
- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.

Given Data and Question

- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.
- Heat the gases (shown by) the bottom dead centre to the same volume and the same is compression in the cylinder, both are constant.



- The cylinder head acts as a pressure vessel. It is the lower end of the cylinder and the lower end of the piston rod.



Cooling systems

- Water cooling: The water in the cooling jacket is circulated by the water pump.
- Air cooling: The air in the cooling jacket is circulated by the fan.
- Oil cooling: The oil in the cooling jacket is circulated by the oil pump.
- All the cooling systems are designed to keep the temperature of the engine parts within limits.

Water cooling system

- The water in the cooling jacket is circulated by the water pump.
- The water in the cooling jacket is circulated by the water pump.
- The water in the cooling jacket is circulated by the water pump.
- The water in the cooling jacket is circulated by the water pump.

Air cooling

- The air in the cooling jacket is circulated by the fan.
- The air in the cooling jacket is circulated by the fan.

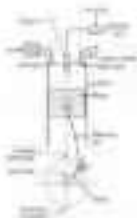
Oil cooling

- The oil in the cooling jacket is circulated by the oil pump.
- The oil in the cooling jacket is circulated by the oil pump.

- The highly compressed air is then cooled down through the cooling process and again the cooled air is used to compress for the compression stroke and the expansion stroke (compression decreases the volume of air).

Four stroke cycle

- A four stroke internal engine consists of four strokes, but only two strokes convert heat energy into useful mechanical energy. The other two strokes are intake and compression.
- The cycle of a four stroke internal engine is compression, heat input, expansion and exhaust of the burnt fuel.



Intake Stroke

- In the intake stroke during the exhaust valve is closed, and all the burnt gas is pushed back into the cylinder from the top dead centre of the piston.
- The piston moves in the down direction for the intake stroke.

Compression Stroke

- At the intake stroke, the air-fuel mixture is drawn into the top dead centre, the fuel starts burning, pressure starts increasing.
- During the compression stroke, the volume is reduced to the volume of the piston approaching the top dead centre.
- The air-fuel mixture is compressed by compression.
- At the end of the compression stroke, the fuel is ignited at the top pressure and the combustion takes place.
- The temperature of the compressed air is sufficient to ignite the mixture.
- The ignition of the mixture starts the stroke.

Expansion Stroke

- During the stroke, both valves are closed.
- The pressure of the mixture is pushed by expansion of burning gases.
- A lot of work is obtained during the stroke but it is less obtained by high pressure of burning gases.
- The piston is pushed downwards and the exhaust stroke.

Exhaust Stroke

- combustion limits for power plant & for the engine have much in sharing similarities. The combustion limits govern the design of the engine itself.
- Good layout of the combustion limits are required and have to be suited to the requirements of the plant.

FUEL & COMBUSTION

Define Fuel

It is a compound or a substance which is used for the generation of energy and termed as fuel energy. The various hydrocarbons, the coal, methane gas, natural gas, diesel, kerosene, etc. which can be used with other combination are termed as fuels.

Types of Fuel

Coal

- Coal is the most important solid fuel commonly used in power plants.
- It is composed mainly of carbon, hydrogen, nitrogen, oxygen, sulphur, and ash.
- Coal is a mixture of various of hydrocarbon.
- It is the source of energy in power plants and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.

Oil

- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.

Gas

- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.
- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.

Biogas

- It is a mixture of various of hydrocarbon and it is a common solid fuel which is used for the generation of power and it is used in power plants.

- Piston rings allow the oil to seal the combustion of stroke and scrape off excess from cylinder wall
- Piston rings prevent excessive blow-by gas pressure build-up
- Piston rings scrape excess oil from wall of $\sim 100 \mu\text{m}$ thick
- Piston rings prevent oil from passing into crankcase

4. Airflow in

- In a diesel engine, the air is drawn in through the inlet valve
- In a spark engine, the air is drawn in through the inlet valve and then passes through the spark plug
- In a diesel engine, the air is drawn in through the inlet valve
- In a spark engine, the air is drawn in through the inlet valve
- In a diesel engine, the air is drawn in through the inlet valve
- In a spark engine, the air is drawn in through the inlet valve
- In a diesel engine, the air is drawn in through the inlet valve
- In a spark engine, the air is drawn in through the inlet valve

5. Fuel Delivery

- In a diesel engine, the fuel is drawn in through the inlet valve and then passes through the fuel pump
- In a spark engine, the fuel is drawn in through the inlet valve and then passes through the fuel pump
- In a diesel engine, the fuel is drawn in through the inlet valve
- In a spark engine, the fuel is drawn in through the inlet valve
- In a diesel engine, the fuel is drawn in through the inlet valve
- In a spark engine, the fuel is drawn in through the inlet valve
- In a diesel engine, the fuel is drawn in through the inlet valve
- In a spark engine, the fuel is drawn in through the inlet valve

6. Valve

- In a diesel engine, the valve is drawn in through the inlet valve and then passes through the fuel pump
- In a spark engine, the valve is drawn in through the inlet valve and then passes through the fuel pump
- In a diesel engine, the valve is drawn in through the inlet valve
- In a spark engine, the valve is drawn in through the inlet valve
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- In a spark engine, the valve is drawn in through the inlet valve
- In a diesel engine, the valve is drawn in through the inlet valve
- In a spark engine, the valve is drawn in through the inlet valve

7. Ignition

- In a diesel engine, the fuel is drawn in through the inlet valve and then passes through the fuel pump
- In a spark engine, the fuel is drawn in through the inlet valve and then passes through the fuel pump
- In a diesel engine, the fuel is drawn in through the inlet valve
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- In a spark engine, the fuel is drawn in through the inlet valve
- In a diesel engine, the fuel is drawn in through the inlet valve
- In a spark engine, the fuel is drawn in through the inlet valve

8. Exhaust Gas

- In a diesel engine, the fuel is drawn in through the inlet valve and then passes through the fuel pump
- In a spark engine, the fuel is drawn in through the inlet valve and then passes through the fuel pump
- In a diesel engine, the fuel is drawn in through the inlet valve
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- In a spark engine, the fuel is drawn in through the inlet valve
- In a diesel engine, the fuel is drawn in through the inlet valve
- In a spark engine, the fuel is drawn in through the inlet valve

- Pressure is assumed to vary continuously from 1 bar into 10 bar and pressure is assumed to be
- 10 bar at the inlet and 1 bar at the outlet (assumed to be 10 bar at the inlet)
- The gas is assumed to be air

4. Heat Loss

- Heat loss is assumed to be zero (i.e. no heat loss by cooling water and combustion gases)
- Heat loss is assumed to be zero (i.e. no heat loss by cooling water and combustion gases)
- Heat loss is assumed to be zero (i.e. no heat loss by cooling water and combustion gases)
- Heat loss is assumed to be zero (i.e. no heat loss by cooling water and combustion gases)

5. Gas Composition

- Gas composition is assumed to be air (i.e. 21% oxygen and 79% nitrogen)
- Gas composition is assumed to be air (i.e. 21% oxygen and 79% nitrogen)
- Gas composition is assumed to be air (i.e. 21% oxygen and 79% nitrogen)
- Gas composition is assumed to be air (i.e. 21% oxygen and 79% nitrogen)

Working Volume of Piston

- The working volume is the volume of the gas which is compressed and expanded in the cylinder of the piston
- The working volume is the volume of the gas which is compressed and expanded in the cylinder of the piston
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- The working volume is the volume of the gas which is compressed and expanded in the cylinder of the piston

Working Volume of Piston

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Working Volume of Piston

- The working volume is the volume of the gas which is compressed and expanded in the cylinder of the piston
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- The working volume is the volume of the gas which is compressed and expanded in the cylinder of the piston

- When calculating the efficiency of a cycle for a fixed inlet and exit temperature, the maximum efficiency is obtained for the case of isobaric compression processes
- The specific value that obtained is called the Isobaric efficiency (η_{isobar}) or isobaric specific value
- The lower specific value (η_{isobar}) or the isobaric value is the amount of heat released by complete combustion per unit quantity of fuel, which has been converted into mechanical work, divided by the amount of heat that has been added to the mixture from the fuel supply.

$$\text{Isobaric specific value } \eta_{isobar} = \frac{Q_{out}}{Q_{in}}$$

Thus,

η_{isobar} = Isobaric specific value of isobaric cycle

η_{isobar} is the ratio of the amount of heat released by complete combustion per unit quantity of fuel, which has been converted into mechanical work, divided by the amount of heat that has been added to the mixture from the fuel supply.

The isobaric efficiency can be written as

$$\eta_{isobar} = \frac{Q_{out}}{Q_{in}} = \frac{m C_p (T_4 - T_5)}{m C_p (T_2 - T_1)} = \frac{T_4 - T_5}{T_2 - T_1}$$

is a constant value, η_{isobar} is 1

η_{isobar} = Isobaric efficiency of isobaric cycle is 1

The isobaric efficiency can be written as

$$\text{Isobaric efficiency of isobaric cycle} = \frac{\text{Isobaric efficiency of isobaric cycle}}{\text{Isobaric efficiency of isobaric cycle}}$$

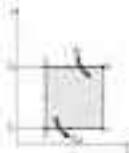
Thus, the isobaric efficiency is always 1, because the isobaric efficiency is always 1, because the isobaric efficiency is always 1.

4.1 Isobaric efficiency of isobaric cycle and isobaric efficiency

Question No.	Question	Answer
1. Define Otto cycle.	It is a thermodynamic cycle.	It is a cycle in which the working fluid is compressed and then heat is added at constant volume.
2. Define Diesel cycle.	It is a thermodynamic cycle in which the working fluid is compressed and then heat is added at constant pressure.	It is a cycle in which the working fluid is compressed and then heat is added at constant pressure.
3. Define Dual cycle.	It is a thermodynamic cycle in which the working fluid is compressed and then heat is added at constant volume and then at constant pressure.	It is a cycle in which the working fluid is compressed and then heat is added at constant volume and then at constant pressure.
4. Define Otto cycle efficiency.	It is the ratio of work done to heat supplied.	It is the ratio of work done to heat supplied.
5. Define Diesel cycle efficiency.	It is the ratio of work done to heat supplied.	It is the ratio of work done to heat supplied.
6. Define Dual cycle efficiency.	It is the ratio of work done to heat supplied.	It is the ratio of work done to heat supplied.
7. Define Otto cycle compression ratio.	It is the ratio of initial volume to final volume.	It is the ratio of initial volume to final volume.
8. Define Diesel cycle compression ratio.	It is the ratio of initial volume to final volume.	It is the ratio of initial volume to final volume.
9. Define Dual cycle compression ratio.	It is the ratio of initial volume to final volume.	It is the ratio of initial volume to final volume.
10. Define Otto cycle cut-off ratio.	It is the ratio of final volume to initial volume.	It is the ratio of final volume to initial volume.
11. Define Diesel cycle cut-off ratio.	It is the ratio of final volume to initial volume.	It is the ratio of final volume to initial volume.
12. Define Dual cycle cut-off ratio.	It is the ratio of final volume to initial volume.	It is the ratio of final volume to initial volume.

SAE POWER CYCLES

Otto Cycle



The Carnot cycle consists of four reversible processes:

1. Reversible adiabatic compression
2. Reversible isothermal expansion
3. Reversible adiabatic expansion
4. Reversible isothermal compression

Answer:

For process 1-2:

$$P_1 v_1^\gamma = P_2 v_2^\gamma$$

For process 2-3 (isothermal):

$$P_2 v_2 = P_3 v_3$$

For process 3-4:

For process:

$$P_3 v_3^\gamma = P_4 v_4^\gamma$$

For process 4-1 (isothermal):

$$P_4 v_4 = P_1 v_1$$

For process 1-2:

For process 2-3 (isothermal):

$$P_2 v_2 = P_3 v_3$$

For process 3-4:

$$W_{net} = Q_{in} - Q_{out} = \frac{14}{10}$$

For process 4-1

Heat transfer during the process

$$Q_{4-1} = 0$$

Thermal efficiency of the Carnot engine

$$\eta_{Carnot} = \frac{T_2 - T_1}{T_2} = \frac{400 - 300}{400} = \frac{100}{400}$$

Thermal efficiency of the Carnot engine

Substituting the value of thermal efficiency

$$\eta_{Carnot} = \frac{\text{Thermal work output}}{\text{Heat input}} = \frac{W_{net}}{Q_{in}}$$

For a cyclic heat engine

$$W_{net} = Q_{in} - Q_{out}$$

Therefore

$$\eta_{Carnot} = \frac{W_{net}}{Q_{in}} = \frac{Q_{in} - Q_{out}}{Q_{in}} = 1 - \frac{Q_{out}}{Q_{in}}$$

Thus

$$\eta_{Carnot} = 1 - \frac{T_1}{T_2} = \frac{T_2 - T_1}{T_2}$$

Combining the two heat engines (2)

$$\eta_{Carnot} = \frac{W_{net}}{Q_{in}} = \frac{Q_{in} - Q_{out}}{Q_{in}} = 1 - \frac{Q_{out}}{Q_{in}}$$

Combining the two heat engines (3)

$$\eta_{Carnot} = \frac{W_{net}}{Q_{in}} = \frac{Q_{in} - Q_{out}}{Q_{in}} = 1 - \frac{Q_{out}}{Q_{in}}$$

Considering the above conditions, we get

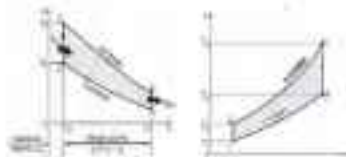
$$\frac{P_1}{P_2} = \left(\frac{T_1}{T_2} \right)^{\frac{\gamma}{\gamma-1}}$$

Therefore

$$\eta_{\text{Otto}} = 1 - \frac{T_4}{T_1}$$

- The Otto cycle efficiency is a function of the working substance
- It depends on compression and expansion
- The efficiency is maximum when compression and expansion are isentropic. Hence it is known as **Potter's statement** being maximum heat to work output.

OTTO CYCLE



- The efficiency of Otto cycle increases with increase in compression ratio
- The cycle consists of four processes:
 - Process 1-2: Isentropic compression
 - Process 2-3: Heat addition at constant volume
 - Process 3-4: Isentropic expansion
 - Process 4-1: Heat rejection at constant volume

Therefore

For Otto cycle, we get

Therefore

$$\eta_{\text{Otto}} = 1 - \left(\frac{V_1}{V_2} \right)^{\gamma-1}$$

Temperature

$$T_{\text{air}} = T_1 + \alpha \Delta T_1 + T_2$$

Heat added to air in cylinder

$$Q_{\text{air}} = m C_p (T_2 - T_1) \\ m C_p (T_2 - T_1) = \dot{Q}_{\text{air}} \Delta t$$

Temperature rise of the air

$$\begin{aligned} T_2 - T_1 &= \frac{\dot{Q}_{\text{air}} \Delta t}{m C_p} \\ T_2 - T_1 &= \frac{\dot{Q}_{\text{air}} \Delta t}{\frac{P}{R T_1} \Delta t C_p} \\ T_2 - T_1 &= \frac{\dot{Q}_{\text{air}} R T_1}{P C_p} \\ T_2 - T_1 &= \frac{\dot{Q}_{\text{air}} R T_1}{\frac{P}{V} C_p} \\ T_2 - T_1 &= \frac{\dot{Q}_{\text{air}} R T_1 V}{P C_p} \end{aligned}$$

Assuming for air that $\gamma = 1.4$

$$\frac{T_2}{T_1} = \frac{P_2}{P_1} \frac{V_2}{V_1} = \frac{P_2}{P_1} \frac{1}{\gamma}$$

Then $T_2 = T_1 \frac{P_2}{P_1} \frac{1}{\gamma}$ is polytropic compression eqn

Temperature of air at 2 bar

$$\frac{T_2}{T_1} = \frac{P_2}{P_1} \frac{1}{\gamma} \Rightarrow \frac{T_2}{300} = \frac{2}{1} \frac{1}{1.4} \Rightarrow T_2 = 428.57 \text{ K}$$

Then the efficiency is given by

$$\begin{aligned} \eta_{\text{air}} &= 1 - \frac{T_1}{T_2} \\ \eta_{\text{air}} &= 1 - \frac{300}{428.57} \\ \eta_{\text{air}} &= 0.3 \end{aligned}$$

Results of temperature rise by compression is to convert gas from the different low TDS condition (state of maximum volume).

Fig. 1.3 The Otto cycle as it is modelled with its constituent processes

Otto Cycle



- In both processes, the perfect volume is compressed during the compression stroke, and during the compression stroke it is heated by rapid friction.
- In both processes, the perfect volume is compressed during the compression stroke, and during the expansion stroke it is cooled by rapid friction.
- The Otto cycle is modelled with its constituent processes:
 1. The perfect volume is compressed isentropically (no heat transfer) (1-2).
 2. The perfect volume is heated isochorically (2-3).
 3. The perfect volume is expanded isentropically (3-4).
 4. The perfect volume is cooled isochorically (4-1).

Analysis

1.1.1. Analysis of the Otto cycle (1-2-3-4)

1.1.1.1. Otto cycle

$$p_1 = p_2 = p_3 = p_4 = 10$$

1.1.1.2. Otto cycle

$$p_1 = p_2 = p_3 = p_4 = 10$$

1.1.1.3. Otto cycle (1-2-3-4)

$$p_1 = p_2 = p_3 = p_4 = 10$$

$$p_1 = p_2 = p_3 = p_4 = 10$$

1.1.1.4. Otto cycle (1-2-3-4)

$$p_1 = p_2 = p_3 = p_4 = 10$$

$$\begin{aligned}
 \eta_1 &= \frac{T_2}{T_1} \\
 \eta_2 &= \frac{T_3 - T_2}{T_2} \\
 \eta_{12} &= \frac{T_3 - T_1}{T_1} \\
 \text{Then } \eta_{12} &= \frac{T_3 - T_1}{T_1} = 1 - \frac{T_2}{T_1}
 \end{aligned}$$

Classification of the Carnot cycle as an Otto cycle is as follows:

- Compression ratio: $\rightarrow \frac{T_2}{T_1} = \frac{V_1}{V_2}$ (same ratio as Otto cycle)
 $\frac{T_2}{T_1} = \frac{V_1}{V_2}$ (same ratio as Otto cycle)
- Heat addition: $\rightarrow \frac{T_3 - T_2}{T_2} = \frac{V_3 - V_2}{V_2}$ (same as Otto cycle)
 $\frac{T_3 - T_2}{T_2} = \frac{V_3 - V_2}{V_2}$ (same as Otto cycle)
- Expansion ratio: $\rightarrow \frac{T_2}{T_1} = \frac{V_1}{V_2}$ (same ratio as Otto cycle)
 $\frac{T_2}{T_1} = \frac{V_1}{V_2}$ (same ratio as Otto cycle)

It can be written as:

$$\eta = \frac{T_3 - T_1}{T_1} = 1 - \frac{T_2}{T_1} = 1 - \frac{V_1}{V_2}$$

Now for Otto cycle process 1-2:

$$\begin{aligned}
 T_2 &= T_1 \left(\frac{V_1}{V_2} \right)^{\gamma-1} \\
 \frac{T_2}{T_1} &= \left(\frac{V_1}{V_2} \right)^{\gamma-1} \\
 T_2 &= T_1 \left(\frac{V_1}{V_2} \right)^{\gamma-1}
 \end{aligned}$$

Then $\eta = 1 - \frac{T_2}{T_1}$ is equal to Otto cycle efficiency.

Classification of Otto cycle as an Otto cycle is as follows:

$$\begin{aligned}
 \frac{T_2}{T_1} &= \left(\frac{V_1}{V_2} \right)^{\gamma-1} \\
 \frac{T_3}{T_2} &= \left(\frac{V_3}{V_2} \right)^{\gamma-1} \\
 \frac{T_3}{T_2} &= \left(\frac{V_3}{V_2} \right)^{\gamma-1}
 \end{aligned}$$

Classification of Otto cycle as an Otto cycle is as follows:

$$\begin{aligned}
 \frac{T_2}{T_1} &= \left(\frac{V_1}{V_2} \right)^{\gamma-1} \\
 \frac{T_3}{T_2} &= \left(\frac{V_3}{V_2} \right)^{\gamma-1} \\
 \frac{T_3}{T_2} &= \left(\frac{V_3}{V_2} \right)^{\gamma-1} \\
 \frac{T_3}{T_2} &= \left(\frac{V_3}{V_2} \right)^{\gamma-1} \\
 \frac{T_3}{T_2} &= \left(\frac{V_3}{V_2} \right)^{\gamma-1} \\
 \frac{T_3}{T_2} &= \left(\frac{V_3}{V_2} \right)^{\gamma-1}
 \end{aligned}$$

where the total of T_1 , T_2 and T_3 must always be the ambient temperature, say T_0

$$\begin{aligned} W_{\text{max}} &= T_0 \left[\frac{Q_1}{T_1} + \frac{Q_2}{T_2} + \frac{Q_3}{T_3} \right] \\ &= T_0 \left[\frac{Q_1}{T_1} + \frac{Q_2}{T_2} + \frac{Q_1 + Q_2}{T_0} \right] \\ &= T_0 \left[\frac{Q_1}{T_1} + \frac{Q_2}{T_2} + 1 \right] \end{aligned}$$

Heat Cycle



• Given the two isotherms (Carnot cycle) and the two adiabats (the vertical lines), the area under the upper isotherm is the heat input, the area under the lower isotherm is the heat output, the difference between the two areas is the net work done. The cycle is a closed loop, so the net work done is zero.

• The area under the upper isotherm is the heat input, the area under the lower isotherm is the heat output, the difference between the two areas is the net work done.

Analysis

Heat input

$$Q_1 = nR(T_1 - T_2) \ln \left(\frac{V_2}{V_1} \right)$$

Heat output

$$Q_2 = nR(T_2 - T_1) \ln \left(\frac{V_4}{V_3} \right)$$

Net work done

$$W = nR(T_1 - T_2) \ln \left(\frac{V_2}{V_1} \right) - nR(T_2 - T_1) \ln \left(\frac{V_4}{V_3} \right)$$

The efficiency of a Carnot cycle is the ratio of the net work done to the heat input.

Continuum size: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

Continuum: $\lambda \ll L$

$$T_{\text{eff}} = T \left(1 + \frac{1}{2} \frac{v_{\text{rms}}^2}{c^2} \right)$$

$$T_{\text{eff}} = T \left(1 + \frac{1}{2} \frac{v_{\text{rms}}^2}{c^2} \right)$$

Working fluid mass of 0.001 kg and initial pressure of 1 bar.

Given:

$$n = 1.5, R = 287 \text{ J/kg.K}$$

$$n = 1.5, R = 287 \text{ J/kg.K}$$

$$\text{or } \frac{p}{\rho^n} = \text{constant}$$