Seat No. :

7164

December-2008

Refrigeration Engineering (EP-I)

(New Course)

Time : 3 Hours] **[Max. Marks : 100**

(10 : 30 A.M. to 1 : 30 P.M.)

Instructions : (1) Attempt **all** questions from both Sections.

(2) Use separate answer book for each section.

(3) Figures to the right indicate full marks.

(4) Assume suitable additional data if necessary.

(5) Use of refrigerant property tables, charts and calculator is permissible.

SECTION – I

1. (a) Write the numbers of refrigerants with the following chemical formula : **16**

(i) CH_4

(ii) CH_3F

(iii) C_3H_8

(iv) $C_2H_2Cl2F_2$ and name them.

(b) What are the new refrigerants ? Which refrigerants are required to be replaced and why ?

(c) What is the Global Warming Potential (GWP) ?

(d) What is insulation ? Mention the different types of insulations used in refrigeration system ?

OR

(a) What do you mean by volumetric efficiency of a reciprocating compressor ? Derive an expression for clearance volumetric efficiency of a reciprocating compressor.

(b) A deep freezer requires 7.0 kW (seven) cooling capacity at – 40 °C (R134a system)

Condensing temperature = 40 °C

Subcooling of refrigerant = 5 °C

Degree of superheat in evaporator = 5 °C

Temperature of refrigerant of the beginning of compressor = – 30 °C

Pressure drop at suction valve = 0.2 bar

Pressure drop of discharge valve = 0.3 bar

% clearance = 4.0%, $\eta = 1.121$

Calculate :

(1) Clearance and total volumetric efficiency

(2) Mass flow rate

(3) Volume displacement by the compressor m^3/min.

(4) COP of deep freezer. (Attach p-h diagram given in the question paper)

2. (a) Classify different types of condensers used in refrigeration plant and equipments. **16**

(b) With the help of neat sketch explain the construction and working of an evaporative condenser used in Ice plant.

(c) What is purging ? What is the importance of purging in refrigeration industry ?

OR

(a) Why artificial cooling is required in aeroplane ? Why air is used as a refrigerant in an aircraft cooling ?

(b) For an aircraft refrigeration system explain the following (i) Ram air and ram efficiency (ii) Evaporative cooling and its use.

(c) In an air refrigeration system working on reversed Brayton cycle, air enters into the compressor at a condition 1 bar and – 15 °C. The air is compressed in compressor upto 5.5 bar. Air enters the expander at 15 °C. Calculate (1) COP (2) The mass flow rate of the air into the compressor/min/ton of refrigeration (TOR). Assume that both compression and expansion process are adiabatic.

3. Write short notes (any **three**) : **18**

(a) Hot gas defrosting method.

(b) Flooded type evaporator.

(c) Automatic expansion valve.

(d) Thermoelectric Refrigeration.

(e) Leak detection methods in Refrigeration Systems.

SECTION – II

4. (a) Describe construction and working of a vortex tube. **16**

(b) Explain the method of obtaining clean and clear ice from an Ice plant.

(c) Explain merits and demerits of cascade refrigeration system.

OR

(a) The optimum intermediate pressure is not equal to the geometric mean of the evaporator pressure and the condenser pressure for compound vapour compression refrigeration system. Why ? **16**

(b) What is flash intercooler ? Explain with the neat sketch its working.

(c) Explain with schematic diagram and p-h diagram, the working of a multi evaporator system with multi expansion valves.

5. (a) Under what circumstances the steam jet refrigeration system is preferred over other systems. **16**

(b) With a neat sketch describe the working of a steam jet refrigeration system.

(c) State the applications, and limitations if any of steam jet refrigeration.

OR

(a) With a neat sketch describe the construction and working of Scroll Compressor. **16**

P.T.O.

(b) Which pairs of substances have been found practical for vapour absorption system. Out of them which are used in the vapour absorption refrigeration machines for air conditioning ? Why ?

(c) Explain the functions of the following :

(1) Drier-filter

(2) Sight glass

(3) Relay

(4) Overload protector

(5) Accumulator

6. Write short notes (any **three**) : **18**

(a) Walk in cooler.

(b) Manufacturing of Dry Ice.

(c) Deep freezers and Bottle coolers.

(d) Starving and overfeeding of a Capillary Tube as expansion device.

(e) Compound gauge manifold.

R 134(a)

Temp, °C	Absolute Pressure, bar	Density, kg/m³ Liquid	Volume, m³/kg Vapour	Enthalpy, kJ/kg Liquid h_f	Enthalpy, kJ/kg Vapour h_g	Entropy, kJ/ (kg K) Liquid s_f	Entropy, kJ/ (kg K) Vapour s_g	Specific heat, c_p, kJ/(kg K) Liquid	Specific heat, c_p, kJ/(kg K) Vapour
20·00	5·7159	1225	0·03603	227·40	409·84	1·0960	1·7183	1·404	0·982
22·00	6·0777	1218	0·03388	230·21	410·89	1·1055	1·7176	1·412	0·994
24·00	6·4566	1210	0·03189	233·05	411·93	1·1149	1·7169	1·420	1·006
26·00	6·8531	1203	0·03003	235·90	412·95	1·1244	1·7162	1·429	1·018
28·00	7·2678	1195	0·02829	238·77	413·95	1·1338	1·7155	1·438	1·031
30·00	7·7008	1187	0·02667	241·65	414·94	1·1432	1·7149	1·447	1·044
32·00	8·1530	1179	0·02516	244·55	415·90	1·1527	1·7142	1·457	1·058
34·00	8·6250	1171	0·02374	247·47	416·85	1·1621	1·7135	1·467	1·073
36·00	9·1172	1163	0·02241	250·41	417·78	1·1715	1·7129	1·478	1·088
38·00	9·6301	1155	0·02116	253·37	418·69	1·1809	1·7122	1·489	1·104
40·00	10·165	1147	0·01999	256·35	419·58	1·1903	1·7115	1·500	1·120
42·00	10·721	1138	0·01890	259·35	420·44	1·1997	1·7108	1·513	1·138
44·00	11·300	1129	0·01786	262·38	421·28	1·2091	1·7101	1·525	1·156
46·00	11·901	1120	0·01689	265·42	422·09	1·2185	1·7094	1·539	1·175
48·00	12·527	1111	0·01598	268·49	422·88	1·2279	1·7086	1·553	1·196
50·00	13·177	1102	0·01511	271·59	423·63	1·2373	1·7078	1·569	1·218
52·00	13·852	1093	0·01430	274·71	424·35	1·2468	1·7070	1·585	1·241
54·00	14·553	1083	0·01353	277·86	425·03	1·2562	1·7061	1·602	1·266
56·00	15·280	1073	0·01280	281·04	425·68	1·2657	1·7051	1·621	1·293
58·00	16·033	1063	0·01212	284·25	426·29	1·2752	1·7041	1·641	1·322
60·00	16·815	1052	0·01146	287·49	426·86	1·2847	1·7031	1·663	1·354
62·00	17·625	1042	0·01085	290·77	427·37	1·2943	1·7019	1·686	1·388
64·00	18·464	1031	0·01026	294·08	427·84	1·3039	1·7007	1·712	1·426
66·00	19·334	1019	0·00970	297·44	428·25	1·3136	1·6993	1·740	1·468
68·00	20·234	1008	0·00917	300·84	428·61	1·3234	1·6979	1·772	1·515
70·00	21·165	996	0·00867	304·29	428·89	1·3332	1·6963	1·806	1·567
72·00	22·130	983	0·00818	307·79	429·10	1·3430	1·6945	1·846	1·626
74·00	23·127	970	0·00772	311·34	429·23	1·3530	1·6926	1·890	1·693
76·00	24·159	957	0·00728	314·96	429·27	1·3631	1·6905	1·941	1·770
78·00	25·227	942	0·00686	318·65	429·20	1·3733	1·6881	2·000	1·861
80·00	26·331	927	0·00646	322·41	429·02	1·3837	1·6855	2·069	1·967
85·00	29·259	886	0·00550	332·27	427·91	1·4105	1·6775	2·313	2·348
90·00	32·445	837	0·00461	343·01	425·48	1·4392	1·6663	2·766	3·064
95·00	35·916	772	0·00374	355·43	420·60	1·4720	1·6490	3·961	4·942
100·00	39·721	647	0·00265	374·02	407·08	1·5207	1·6093	–	–
101·03***	40·560	513	0·00195	389·79	389·79	1·5593	1·5593	∞	∞

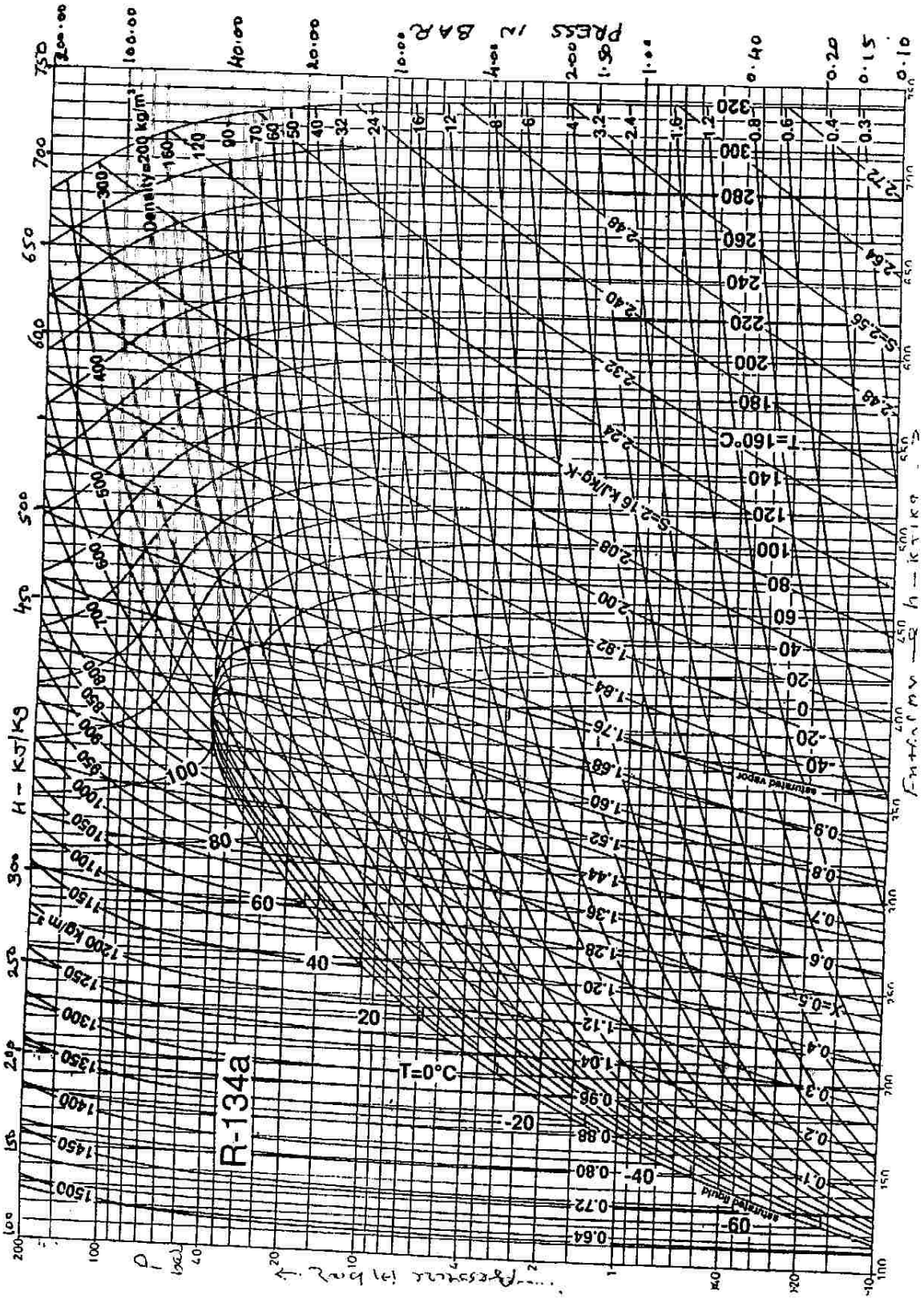
*** critical point

Table 13 Tetrafluoroethane– CH_2FCF_3 (Refrigerant 134 a): Properties of Saturated Liquid and Saturated Vapour

Temp, °C	Absolute Pressure, bar	Density, kg/m³	Volume, m³/kg	Enthalpy, kJ/kg		Entropy, kJ/(kg K)		Specific heat, c_p, kJ/(kg K)	
		Liquid	Vapour	Liquid h_f	Vapour h_g	Liquid s_f	Vapour s_g	Liquid	Vapour
−103·30*	0·0039	1591	35·26	71·89	335·07	0·4143	1·9638	1·147	0·585
−100·00	0·0056	1582	25·04	75·71	337·00	0·4366	1·9456	1·168	0·592
−90·00	0·0153	1554	9·719	87·59	342·94	0·5032	1·8975	1·201	0·614
−80·00	0·0369	1526	4·250	99·65	349·03	0·5674	1·8585	1·211	0·637
−70·00	0·0801	1499	2·053	111·78	355·23	0·6286	1·8269	1·215	0·660
−60·00	0·1594	1471	1·077	123·96	361·51	0·6871	1·8016	1·220	0·685
−50·00	0·2948	1443	0·6056	136·21	367·83	0·7432	1·7812	1·229	0·712
−40·00	0·5122	1415	0·3609	148·57	374·16	0·7973	1·7649	1·243	0·740
−30·00	0·8436	1386	0·2260	161·10	380·45	0·8498	1·7519	1·260	0·771
−28·00	0·9268	1380	0·2068	163·62	381·70	0·8601	1·7497	1·264	0·778
−26·07**	1·0132	1374	0·1902	166·07	382·90	0·8701	1·7476	1·268	0·784
−26·00	1·0164	1374	0·1896	166·16	382·94	0·8704	1·7476	1·268	0·785
−24·00	1·1127	1368	0·1741	168·70	384·19	0·8806	1·7455	1·273	0·791
−22·00	1·2160	1362	0·1601	171·26	385·43	0·8908	1·7436	1·277	0·798
−20·00	1·3268	1356	0·1474	173·82	386·66	0·9009	1·7417	1·282	0·805
−18·00	1·4454	1350	0·1360	176·39	387·89	0·9110	1·7399	1·286	0·812
−16·00	1·5721	1344	0·1256	178·97	389·11	0·9211	1·7383	1·291	0·820
−14·00	1·7074	1338	0·1161	181·56	390·33	0·9311	1·7367	1·296	0·827
−12·00	1·8516	1332	0·1075	184·16	391·55	0·9410	1·7351	1·301	0·835
−10·00	2·0052	1326	0·09963	186·78	392·75	0·9509	1·7337	1·306	0·842
−8·00	2·1684	1319	0·09246	189·40	393·95	0·9608	1·7323	1·312	0·850
−6·00	2·3418	1313	0·08591	192·03	395·15	0·9707	1·7310	1·317	0·858
−4·00	2·5257	1307	0·07991	194·68	396·33	0·9805	1·7297	1·323	0·866
−2·00	2·7206	1300	0·07440	197·33	397·51	0·9903	1·7285	1·329	0·875
0·00	2·9269	1294	0·06935	200·00	398·68	1·0000	1·7274	1·335	0·883
2·00	3·1450	1287	0·06470	202·68	399·84	1·0097	1·7263	1·341	0·892
4·00	3·3755	1281	0·06042	205·37	401·00	1·0194	1·7252	1·347	0·901
6·00	3·6186	1274	0·05648	208·08	402·14	1·0291	1·7242	1·353	0·910
8·00	3·8749	1267	0·05284	210·80	403·27	1·0387	1·7233	1·360	0·920
10·00	4·1449	1260	0·04948	213·53	404·40	1·0483	1·7224	1·367	0·930
12·00	4·4289	1253	0·04636	216·27	405·51	1·0579	1·7215	1·374	0·939
14·00	4·7276	1246	0·04348	219·03	406·61	1·0674	1·7207	1·381	0·950
16·00	5·0143	1239	0·04081	221·80	407·70	1·0770	1·7199	1·388	0·960
18·00	5·3706	1232	0·03833	224·59	408·78	1·0865	1·7191	1·396	0·971

* triple point

** normal boiling point


R-134a
PRESS in BAR
H - KJ/KG
T=0°C
T=160°C
saturated vapor
saturated liquid
X=0.5
Density=200 kg/m³
1200 kg/m³