

SWAMI VIVEKANANDA SCHOOL OF

ENGINEERING & TECHNOLOGY

LECTURE NOTE

REFRIGERATION & AIR CONDITIONING

ER. ANIL KUMAR PANDA

Date: 09/18/2023 matation moder parties to some potent by their filling Refrigeration :-It is the process of producing and maintaing low temperature por a storage, space in compare to i atmospheric temperature la mainificant la frontino al anoma orta in the and an and a constance Refrigeration effect (RE, QE):-Million in Inmonthe My It is the amount of heat which is to be removed from storage space in order to produced and maintaing low temperature. Whit of refrigeration to taboard : 2. (i) "It lies the amount of heat is just to be removed from 1+000 of water at 0°c in order to ai convert printe alice of o'cin ay hours. Pripo as Rolative cop (ii) The heat treanspenate connexponding to this process is defined as ton of refrigeration (TR) = 1TR since the latent theat of ace is 335 KJ/Kg, therefore, one ton of refrigeration, 1TR = 907 X 335 Kg in 24 hr

 $\frac{907 \times 385}{24\times 60} = 211 \times 5/mein$

and the state Coefficient of perdonmance of Retnigeration system - noistannaking coefficient of performance (CO.P) is the nates of heat eatraited in the metric gerutore to the work done on the metric gereant. provide a station for the monk done It is also known as theoretical coefficient of penformance Mathematically, = (12, 79) for the saintanapinetast baueron is Théorétécal co.P. = A ponote airet bau bezubang présent co.P. = Autorio 2001 20018 airet priotripon . A : amount of heat extracted in refrigerator houseness about the Work done on the refnigerant. * The natio of actual CO.P to the theoretical C.O.P is hown as Relative Cop Mathomatically, Actual C.O.P Relative C.O.P = Actual C.O.P Theoretical C.O.P , ma ku-upartion to not ons. un Burgat

ALE = dot X 385 1 in State

Aus find the cop of medning on at soon system if the work done input is so K3/kg and refrigeration effect produced is 160KJ/Kg of refrigerant. Solu? ! Géven : Repaired as W= SOKJ/Kg gra = ·160 Kg/Kg We know that C. O.P of retrigeration system . C.D.P of (restrigozant's W (12/12/2- F29 160 KJ/Kg 88 Kg/Kg (Ans) E stopal, but losh to 2 Dat 2: 11/08/2023 (Evense compot eyde) Different type of refnigenation cycle: 1. I deal Refnigeraite in cycle 0:0, 0:01 a. Ice Ref. cycle 3. Dry Pee Ref. jucy ale 4. Evaporative Ref. cycle (Indean Ref. System) 5. Enpoind Ref. cycle

i malena aniloro per lan la Ma Ma Ma reitar On bris Icerila si tuqui mot fied hours the root of policy of hours 21) 1. 71, 02 Reject de pril Elois ind Reject de grand Elois odt : Ship Esepond to de sign (Clow temp) for 7.3.3 6 Expand Ref. cycle (Ideal Ret. Sycle:-(Reverse cornot cycle) 2306 30 11 : 2 WC routinepineteur la apple theory FRACT P 1=0 20 100 Trista printing TSC 2.1 20=0 2010 0:01 Trista printing TSC 2.1 31/10 10-02 2.1 (asteps aloyour Fait bringing . 2

Dt: 18/08/2023

COP 5 HICAT Parap: P P3 P2 1-1- (11355)--3-9(9) 2 < monta TEC STITY -4 V.P-eP Nolume > Ta-T, of reversed carnot cycle:-COP (C.O.P) R = Wingentleatil absorbed nois ifter EU 90 Work done (con) E = 9/A AVP (P-9/R. TIPAST) = (29/4 = 2) et 92-3 - 94-1 $\frac{T\left(S_{2}-S_{3}\right)}{\left(T_{2}-T_{1}\right)\left(S_{2}-S_{1}\right)} \\ \frac{T_{1}}{T_{2}-T_{1}} \\ \frac{T_{1}}{T_{2}-T_{1}} \\ \frac{T_{2}-T_{1}}{T_{2}-T_{1}} \\ \frac{T_{2}-T_{1}}{T_{2}-T_{1}} \\ \frac{T_{1}}{T_{2}-T_{1}} \\ \frac{T_{1}}{T_{1}} \\ \frac{T_{1}}{T_{1}}$

COP of Heat premp:- $(COP)_{P} = (COP)_{R} + 1$ $A = \frac{T_1 T_3}{T_2 - T_1} + 1.$ c- smult 1 T2_ $T_2 - T_1$ neversed connot cycle: . 5 COP of efficiency of a heat engine :-WR 9R NP (COP)E $= (T_2 + T_1)(J_2 - S_3)$ $T_2 \left(S_2 - S_3 \right)$ (Tg = T,) = 1 (2- T2) T (COP)p

COP of reversed carnot cycle may be emprove by 1. Accreasing the higher temperature (i.e. temp of ii) Incre hot body T2) ii) Increasing the lower temporature (i.e. temperature of cold body T, (iii) (cop) : (cop) : (cop)

<u>Ques</u>: A machine working on a carnot cycle operates between '305 K and 260 K. Determene the COP When it is operated as (i) ReFrégeration machine (") Heat pump (111) Heat Engine 10Given; 2de Tao= 013,05 Kille; Ja= 260 Karso A 100 A Sort sujecta si at soo Eask (i) Refrigeration machine statundor (i) to available (OP) & Finderado 260 Juinpor in 1000 1 1 10305-2601 060 9 Mars 225. 78

and many be the second copie and be singly by (iii) (iii), and the singly of (iii) (iii), and the singly of (iii) (iii), and the second of the

practice and the product of the product (is $\frac{305}{100} + \frac{305}{100} + \frac{305}{100}$

 $(iii) (cop)_{p} = \frac{1}{(cop)_{p}} = \frac{1}{6.78}$ EUL: A maching conting on a count cycle openates bet ween 18501 and 2601 . Ditematic the (0) <u>(0)</u> X1 is openated as (i) Retrigenalison machine = 0.142 gravy Jasif (") (III) Plat Cogine

Ques A carnot reforgerateion cycle absorbs heat at 270K rejects of at 270 300K (i) Calculate the coefficien of performance of refrigeration cycle (ii) If the cycle es absorberg 1130 KJ/men at \$ 270 K how may KJ of wook is required per second

(1) If the carnot heat pump operates between operates between the same temperature at the above referigeration cycle, what is the cop (1) How many KJ per men well the heat pump delever at sonk if theat absorbs 1130 KJ Per mit meniete at 270K 23.2 : 123 6 Solvetion : 21 M) DOYON 1.8 2 Geven; T, = 270K, T2 = 300K (i) C.O.P of refaigeration cycle (0.00) (11) $(COP)_R = \frac{T_i}{T_2 - T_i}$, q(9.0.0)= 270K (300-270)K $= \frac{30}{30} = 9 (Ans)$ (ii) if cycle is absorbing 1130 KJ/min at 270K Q, = 1130 Kt/min =. 1130 KJ 68 1000 = 18.83 KJ/sec

Westhrows that immi tool jours all in the stores will be $(C.D.P)_{R} = \frac{1}{W_{1}} \frac$ Allewin month with marin marin the head pund W, W, = 18.83) = 2.1 KJ/rec (Ang) -: 7, = 8 30K, 10 = 800K QO.P of heat pump Bump 100 400 (1 (iii) $(C.0:P)_{P} = \frac{T_{2-1}}{T_{2-1}T_{1}} = (900)$ X(0663-0008 300-270 (site) 800 30 NOEB to vival EN OSII privilizado (Anslopo FI (") 6, = 1130 Ka/min 1188 1 18,88 K3/500

(1), we know that $CoP_{ch}rf$ heat pump when $(Co.P)_{p} = 1 \frac{Q_{2}}{Q_{2}-Q_{1}}$ and $P_{ch}rf$ heat pump when $(Co.P)_{p} = 1 \frac{Q_{2}}{Q_{2}-Q_{1}}$ and $P_{ch}rf$ hope $(Co.P)_{p} = 1 \frac{Q_{2}}{Q_{2}-Q_{1}}$ and $P_{ch}rf$ hope $P_{$

GIEVED : 191 = - 5°C = 1-5 1 838K= 268 K 1808 = 18:10:0 = 11:300 = d2 2) 18Q2 = Q2 + 11300 $=) 10 a_2 - a_2 = 1130$ =) 9, A2 = 11, 3, DQ, 0, 1X 151 $= 2 = \frac{11300}{9} = 13956 \text{ KJ/min}$ We know that core of redugeration YC. a) = 1 & 1 P-P

Aves A cold storage is to be maintained at -5°C Nhile the surcrounding are at 85°C. The heat in rejects from the surroundings in to the cold storage is estimated to be ag KW. The actual cop of refrigeration plant is 1/2 . an ideal plant working between the same tem enature. Find the power required to draiped the plant Solution : 1000 - 1910 - 5 (190 - 5) 01 (2) Géren; TI=-5°C=-Sta73K= 268K Ta = 35°C = 35 + 273 K = 308 K 05191 = 29 KW KADO JA 10 01 $\frac{C.0P}{R} = \frac{1}{3}$. We Know that so.P (COPR Que) WK nim! 3 2831 2.11 We know that COP of refugeration C. afe= AR 29 410

Ques: A cold storage is to be maintained at -50 while the surrounding are at 35°C. The heat leakage from the swarounding in to the cold storcage is estimated to be 29 KW. The actu Cop of refrigeration plant is 1/3 of anot ide plant working between the same temperatur find the power required to drive the plant. Solution: Gléven; TI = -5°C = -57233K = 268K T2 = 85°C = 35 + 272K = 8084 Q1= 29KW

The actual retrigeration plant is $\frac{1}{3}$ of an ideal plant $\frac{1}{2}$ $\frac{1}{3}$ $\frac{$

We Know that ,

(C.0.p)Ideal = $\frac{T_1}{T_2 - T_1}$

268 308-268 268 = #. 6.7 (Aus)

Putting the value of (COP) in equil () we get alt le in (COP) it = in le <u>6.7 h</u>abie abie tonons acrossis ad at ai principa: 23.233 CAns Ans principal is to be 905 (2) (ii) Hard and the wind the format (iii) with (COP) A F WR with (iii) 1805 - 862 128 200 28 - 27WRHP (10) 29) (155 tulo N 225: 866 1 21 - 2) 21 - 29 KW WK = 29 KW 010 DI 0525 - 016 X 31 = 9 F&. 2330 ma taya 202 trazgis KW to Ans 100 (i) (That The action of X 828 858 K 1 305 - 25E) K (311-A) 228 21.2 Jan 150 (iii) harder power soquered WE KNOW That , (COP) = - 101

D1:19/08/2023

Ques: A riefnigeration system of operates on the révenue carnot ycle. The higher temperature of the refrigerant in the system is 35°C and the lowa temperature is -15°C. The capacity is to be 12 tonnes determine (1) COP (ii) Heat rejected from the system per hour (iii) Power requered Solution Geven; TH = 1 = 85°C = 85 + 273 = 300 The T1 = -15°C = -15 + 278 = 255 Q1 = 12TR = 12X210 = 2520 K (i) cop if of refuigeration system $(COP)_{R} = \frac{T_{1}}{T_{2}-T_{1}}$ = <u>308</u> = 258 K 258 50 S.16 (Ans)

(iii) 1000000 Power required We know that $(COP)_R = \frac{Q_i}{w_R}$

(iii) f(at) = g(at) + g(at)

he at march (att 188.34) in water at 2520 to 188.34 KJ/mine to att

3008.3 000 180498

Mass of die hand caced per minute Boog X 0.3+X E. 8006 180498 KJ/mr (Ans) claster icitario 429.5 KJ/Kg -95.56 kg/min

Dues: The capacity of a netnigerator is 200 TR when Working between -6° and 25° . Determine the mass of eice produced per day from water at 25° Also find the power required to drive the unit. Assume that the cycle operates on reversed carnot cycle and latent leat of ice 935 KJ/Kg.

Solution: Given all CH SIRE = 200TR = 200X210 K The capacity of refrigerator = 200TR = 200X210 K was in an antage alt most bottoge = 242000 K $T_L = T_1 = -6^{\circ}C = -6+273K = 267K$ $T_H = T_2 = 25^{\circ}C = 25+273K = 308K$ Latent heat of ece = 235KJ/Kg

he at removed from ikg of water at 25°C to 0°C = mars X specifie heat X rissing temperature + late

Ξ	1000 X 4.187 (25-0) + 335
:	439.5 KJ/Kg-1-2-1

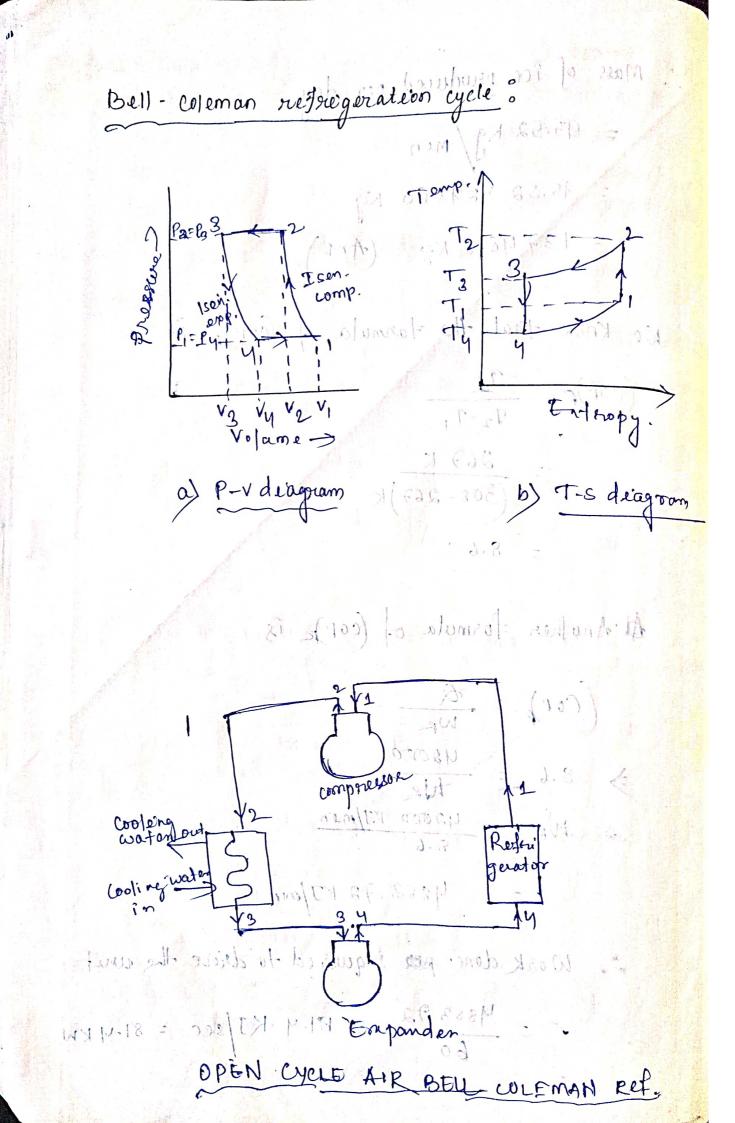
Mass of sice produced per menute entraction source = Heat 1 capacity (2014) Heat 1 riemoved 0.31 = 42000 KJ/min 439.5 KJ/Kg 93.56 Kg/min

Mass of the psubluced per day monor b) - 11201
= 95.52 Kg/Men
= 95.52 Kg/Men
= 137 48.8 Kg (Ans)
We Know that the tormula, of (CoP) e. 18
(COP) e. TA

$$T_2-T_1$$

 $= \frac{363 K}{T_2-T_1}$
 $= \frac{363 K}{(308-263)K}$ magnitude of
 $= 8.6$
Alt Another tormula of (CoP) is
 $(CoP) k$ $= \frac{2}{W_R}$
 $= 8.6$
 $\frac{(CoP) k}{W_R}$ $= \frac{4}{W_R}$ $= \frac{4}{W_R}$
 $= 8.6$
 $\frac{(CoP) k}{W_R}$ $= \frac{4}{W_R}$ $= \frac{1}{W_R}$ $= \frac{1}{W_R}$

OPEN CYCLE AIR BELL- COLIMAN RES.



1) Co.P. = Heat abs
Work done

$$= \frac{q_A}{q_P - q_A}$$

$$= \frac{(r_1 - r_y)}{(r_2 - r_y) - (r_P(r_1 - r_y))}$$

$$= \frac{(r_1 - r_y)}{(r_2 - r_y) - (r_1 - r_y)}$$

$$= \frac{(r_1 - r_y)}{(r_2 - r_y) - (r_1 - r_y)}$$

$$= \frac{(r_1 - r_y)}{(r_2 - r_y) - (r_y - r_y)}$$

$$= \frac{(r_1 - r_y)}{(r_2 - r_y) - (r_y - r_y)}$$

$$= \frac{(r_1 - r_y)}{(r_2 - r_y) - (r_y - r_y)}$$

$$= \frac{(r_y) - (r_y)}{(r_y - r_y) - (r_y - r_y)}$$

$$= \frac{(r_y) - (r_y)}{(r_y - r_y) - (r_y)}$$

ŝ

We =
$$\frac{n}{n-1} \left(\frac{P_2 V_2 - T_1 V_1}{P_1 - 1} \right) = \frac{n}{n-1} \left(\frac{RT_2 - RT_1}{RT_2 - RT_1} \right)$$

We = $\frac{n}{n-1} \left(\frac{P_2 V_2 - T_1 V_1}{P_1 - 1} \right) = \frac{n}{n-1} \left(\frac{RT_2 - RT_1}{P_1 - 1} \right)$
We = $\frac{n}{n-1} \left(\frac{P_3 V_3 - P_1 V_1}{P_1 - 1} \right) = \frac{n}{n-1} \left(\frac{RT_2 - RT_1}{P_1 - 1} \right)$
We = $\frac{n}{n-1} \left(\frac{P_3 V_3 - P_1 V_1}{P_1 - 1} \right) = \frac{n}{n-1} \times P \left(\frac{T_2 - T_1}{T_2 - T_1} \right)$
Wi = We & We = $\frac{m}{n-1} \left(\frac{RT_2 - RT_1}{RT_2 - RT_1} \right) = \frac{n}{n-1} \left(\frac{RT_3 - RT_1}{RT_2 - RT_1} \right)$
Wi = We & We = $\frac{m}{n-1} \left(\frac{RT_2 - RT_1}{RT_2 - RT_1} \right) = \frac{n}{n-1} \left(\frac{RT_3 R_1}{RT_2 - RT_1} \right)$
Wi = We & We = $\frac{m}{n-1} \left(\frac{RT_2 - RT_1}{RT_2 - RT_1} \right) = \frac{n}{n-1} \left(\frac{RT_3 R_1}{RT_2 - RT_1} \right)$
Wi = $\frac{(1 + \frac{RT_2}{R})}{\frac{RT_2 - RT_1}{RT_2 - RT_1}} = \frac{n}{n-1} \left(\frac{RT_3 R_1}{RT_2 - RT_1} \right)$
We = $\frac{RT_1 R_1}{RT_2 - RT_1} = \frac{n}{R} \left(\frac{RT_2 - RT_1}{RT_2 - RT_1} \right)$
We know k' done
Wi = $\frac{RT_1 R_1}{RT_2 - RT_1} = \frac{n}{R} \left(\frac{RT_2 - RT_1}{RT_2 - RT_1} \right)$
We know k' done
 $\frac{RT_1 R_1}{RT_2 - RT_1} = \frac{RT_1}{RT_2 - RT_1} = \frac{RT_1}{RT_2 - RT_1} = \frac{RT_1}{RT_1 - RT_1} = \frac{RT_1}{RT_2 - RT_1} = \frac{RT_1}{RT_1 - RT_1} = \frac{RT_1}{RT_1} = \frac{RT_1}{RT_1} = \frac{RT_1}{RT_1 - RT_1} = \frac{RT_1}{RT_1} = \frac{$

* Substatuting The value of R in equation (V) 2. 10x 13 Bearing apric 1 V : A ASTRAND AND ROL MORALDON N: Y is called up and poly (int) apply pipe and motorally $\frac{n}{n-1} \times R\left(\left(T_{2}-T_{1}\right)-\left(T_{2}-T_{4}\right)\right)$ $cp(T_1-T_1) - (r_1 - r_1))$ $\frac{n}{n-1}\chi(\gamma-1)c_{V}\left[(T_{2}-T_{1})-(T_{3}-T_{4})\right]$ Date: 34 05 100 8029 $\gamma(\tau_1-\tau_{\gamma})$ x_{2} x_{2 divers a boar ! Its (ipiligi) and a montante 1 10 for - - - (VII) en alos atqua-batas telte mitropinique holt han fonde de la sub- $x \left[\frac{r}{r} \left(\frac{n-1}{r} \right) \left(\frac{y}{r-1} \right) \right] x \left(\frac{y}{r} \right)$ Solut: Given; P. R. - 1 Hours Note:

(4) In this case the value of T2 and Ty are to be Nobtained from the following relations $2P \frac{T_{a}}{T_{1}} = \left(\frac{P_{2}}{P_{1}}\right) \frac{n-1}{n}$ on $\frac{T_{3}}{T_{4}} = \left(\frac{P_{3}}{P_{4}}\right) \frac{n-1}{n}$

To sullar value of R sin equintiers (V) or exponsion n=> 2. For Isentropée compression may be written a -therefore, the equation (Vii) $T\left(\frac{2}{11}T_{\mathbf{y}} \circ \Gamma\right) - \left(\frac{1}{1}T_{\mathbf{y}} \circ \Gamma\right) \left[\frac{1}{1}T_{\mathbf{y}} \circ \Gamma\right] = \left(\frac{1}{1}T_{\mathbf{y}} \circ \Gamma\right)$ $co.P = \int \left((T_2 - T_3) - (T_1 - T_4) \right)$ Date: 24/05/2023 $\left(\begin{array}{c} \Gamma \\ \Gamma \end{array} \right)$ Ques: In a refrigeration plant working on Bell-coleman cycle, air is compressed to 5th from 1 bar. Its initial temperature is 100 after compression the air is cooled repto 20°C in a cooler before rempanding that to a pressure of one bar. tetermine the themitical cop of the plant and Net refrigeration ef Take Cp = 1:005 KJ/KgK, X CV = 0.718 KJ/KgK Solun: Given; P=P4= 1-ban, 24 of 210 pl' produce of 10 and 14 200 2011 at 14 200 200 10 produce of 10 and 14 200 2011 at 16 14 200 200 10 10 10 10 10 10 10 10 233Ki =1028/3K $\frac{T_{3}}{G} = 20^{\circ}C = 120 + 233 = 1293 K$

$$(r = 0.718 \text{ kg}) \log (x)$$
We know that $r = \frac{c_{P}}{c_{V}} = \frac{1.005}{0.718} = 1.9$
(i) The theoretical cop of the plant
$$Cop = \frac{T_{V}}{T_{3}-T_{V}}$$
We know that $r = 0.4$ esentsupple process
$$\left(\frac{P_{3}}{P_{V}}\right)^{\frac{N-1}{2}} = \frac{T_{3}}{T_{3}} = 0.1 = 0.1$$

$$\left(\frac{P_{3}}{P_{V}}\right)^{\frac{N-1}{2}} = \frac{293}{(5)^{0.956}} = 1.85 \text{ K}^{\frac{N}{2}}$$

$$\left(\frac{Cop_{M_{3}}}{P_{M}}\right)^{\frac{N}{2}} = \frac{293}{(5)^{0.956}} = 1.85 \text{ K}^{\frac{N}{2}}$$

$$\left(\frac{Cop_{M_{3}}}{P_{M}}\right)^{\frac{N}{2}} = \frac{1.85}{(1000} \text{ M}^{\frac{N}{2}} = 0.133 \text{ Ans}$$

$$\left(\frac{P_{3}}{P_{M}}\right)^{\frac{N}{2}} = 0.133 \text{ Ans}$$

$$\left(\frac{P_{3}}{P_{M}}\right)^{\frac{N}{2}} = 0.138 \text{ M}^{\frac{N}{2}} = 1.85 \text{ K}^{\frac{N}{2}}$$

$$\left(\frac{P_{3}}{P_{M}}\right)^{\frac{N}{2}} = 0.138 \text{ M}^{\frac{N}{2}} = 1.85 \text{ K}^{\frac{N}{2}}$$

$$\left(\frac{P_{3}}{P_{M}}\right)^{\frac{N}{2}} = 0.138 \text{ M}^{\frac{N}{2}} = 0.138 \text{ M}^{\frac{N}{2}} = 1.93 \text{ Ans}$$

$$\left(\frac{P_{3}}{P_{M}}\right)^{\frac{N}{2}} = 0.138 \text{ M}^{\frac{N}{2}} = 0.138 \text{ M}^{\frac{N}{$$

Ques A refrigerator working on Bell-coleman a operates between pressure limet of 1.05 bant and 8.5 born Aer is drawn from the cold chamber and one compressed and then it is could to soic be entoring the expansion cycender. The enpansion, entereng the unparision of priz = constant. compnessedon follows the law of priz = constant. Determined the theorietocal copi of the system. $P_1 = P_y = 1.05$ barr = $\left(\frac{1}{\sqrt{1}}\right)$ géven data 80/w? $P_2 = P_3 = 8.5 \text{ ban}$ $T_1 = 10^\circ \text{C} = 10^\circ \text{F}_2 + 3 \text{K} = 283 \text{K}^\circ$ T3 = 80°C = 80 + 273 K = 303 K PV-3:22C1 ? 000 ? pr 6 n - 1.9 and the end of company respectively. Sence, the compression & expansion follows the low pr's=c, thereforce $\frac{T_{a}}{T_{1}} = \left(\frac{P_{2}}{P_{P1}}\right) - e_{5}^{2} e_{5}^{2} \left(\frac{8.5}{201.05}\right) = 1.62$. Tail= TIX 1.62 = 283 × 1.62 = 458.5K

Similarly,

$$\frac{T_3}{T_4} = \left(\frac{P_3}{P_4}\right)^{n-1} = \left(\frac{9 \cdot 5}{1 \cdot 5}\right)^{1/3} = 1 \cdot 52$$

$$\frac{T_4}{T_5} = \left(\frac{P_3}{P_4}\right)^{n-1} = \left(\frac{9 \cdot 5}{1 \cdot 52}\right)^{1/3} = 1 \cdot 52$$

$$\frac{T_4}{1 \cdot 52} = \frac{T_2}{1 \cdot 52} + \frac{303}{1 \cdot 52} = 1 \cdot 32 \times 100$$
We know that theoretheral coefficient of performance

$$\left(-0 \cdot 9 = \frac{(T_1 - T_4)^{-1}}{n-1} \times \frac{(T_4 - 1)}{T} \times \frac{(T_4 - 1)}{1 \cdot 4} = \left(\frac{1}{1 \cdot 5}\right)^{-1} + \frac{(T_4 - T_4)^{-1}}{1 \cdot 5} + \frac{(T_4 - T_4)^{-1}}{1 \cdot 5}\right)^{-1}$$
has all to $\frac{1}{1 \cdot 5} = \frac{(T_2 - T_4)^{-1}}{n-1} \times \frac{(T_4 - 1)}{1 \cdot 4} = \left(\frac{1}{1 \cdot 5}\right)^{-1} + \frac{(T_4 - T_4)^{-1}}{1 \cdot 5}\right)^{-1}$
has all to $\frac{1}{1 \cdot 5} = \frac{(T_2 - T_4)^{-1}}{(T_1 - T_4)^{-1}} = \frac{(T_3 - T_4)^{-1}}{(T_4 - T_4)^{-1}} = \frac{(T_4 - T_4)^{-1}}{(T_4 - T_4)^{-1}} = \frac{(T_4 \times 1)^{-1}}{(T_4 \times 1)^{-1}} = \frac{(T_4 \times 1)^{-1}}{(T_$

per proficer & Solu Given data; $P_{1} = P_{3} = 4 - ban$ $P_{2} = P_{3} = 5 - ban$ T1 = -5°C' = -5 + 273 = 268 K T3, F, 15°C F, 15+293 = 288 Kund 101 n=1.2, d=1.4,1-,1) = 400 [(I - I Cp. (- I KJ / Kg K - x -Let , T2 and Ty = temperature at the end of (101-836)-(EDE-DEN) MI Composition & expansion (sence, the compression follow the law pr'y -c therefore, s. 1 1-1 2-10 XNO.1 $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{1}{2}} = \left(\frac{5}{1}\right)^{\frac{1}{1+\frac{1}{2}}} = \left(\frac{5}{1}\right)^{\frac{1}{1+\frac{1}{2}}} = 1.585^{\frac{1}{2}}$ Ta Fin Tix 1.585 = 424.8K i salling goald repartient of to Mussing & of rologing Similarly, the emponision follows the law pr'=1 which therefore n=1 n=1 is not be by n=1 and n=1 is the property of t $\frac{3}{74} = \frac{288}{14} = \frac{5}{12} = \frac{12-1}{12} = 2012.000 \text{ mm}$

1. Wonk done per kg of act by compresson 1-2 We know that the work done by compresson 1-2 We = 1 XIR (T2-T1) & monthly believed

 $= \frac{1.4}{1.4-1} \times 0.287 (424.8 - 268) = (Takin R = 0.287)$ and work done by enponder during the process 3-y per kg of air pout $W_E = \frac{n}{n-1} \times R(T_3 - T_9)$ $\frac{1\cdot 2}{1\cdot 2-1} \times 0.287 \times (288 - 220) 101 \text{ (}$ = 118.3 KJ/Kg Abill UDIN IN Treat - + + (1.9.5) 1, -2491: ='. Net work done by the system per ky ofair WELLWE WE houd winder to support Mu PI(1) = 159-118.3 = 40.7 Kg/Kg Ans - (- (. Q.)) 2. - COP of the plant P-D $C \cdot D \cdot P = \frac{CP(T_1 - T_4)P_4}{W^{PPG} = F} \xrightarrow{\phi} \frac{48}{48}$

= 1.18 Ans

Auss: Refrigerator using carnet cycle require 11.25 km
per tonne el subjection de contration to maintain a temperature
of -30°. Fieldijcop of carnet subject and (11)
-temperature at which heat is sejected (11) + leat
siguided per tonne d'refrigeration.
Colum Gréver data:
WR = 1.35 KW = 1.35 KJ foel = "251.25 X60 = 35 KJ

$$T_1 = -20^{\circ}C = -20 + 27.2' = 3.43 K$$

Il we know that heat extracted from the cold
body
 $R_1 = 810 \text{ KJ/Mg/mEN} + X = \frac{T_2 = 7}{49.2}$
 $0 CoP off carnet refrigeration $T_1 = -20^{\circ}C = -20 + 27.2' = 3.43 K$
 $(COP)_R = \frac{A_1}{M_2} = 2.8$
 $Me Know that frigerates $T_{-CT} = W_{0} = \frac{R_1}{T_1 = 20^{\circ}K}$
(1) Temperature of which heat is subjected to the first subject of the first $T_1 = -20^{\circ}K = 2.8$
 $(T_1 = -20^{\circ}K = 2.8 + 5.4)$
 $(T_1 = -20^{\circ}K = -2.8 + 5.4)$
 $(T_1 = -20^{\circ}K = -7.7 + 5.4) = -100$
 $R_2 = \frac{A_10}{T_2 - 5.4} = 2.8 + 5.4$
 $(T_1 = -20^{\circ}K = -7.7 + 5.4) = -100$
 $R_2 = \frac{A_10}{T_2 - 5.4} = -7.7 + 5.4$
 $R_3 = -7.7 + 5.4$
 $R_4 = -7.7 + 5.4$
 $R_4 = -7.7 + 5.4$
 $R_5 = -7.7 + 5.4$
 $R_7 = -5.43 = -7.4$
 $R_7 = -7.43 = -7.4$
 $R_7 = -7.43 = -7.43$$$

C

 $\frac{2y_3}{12.8} = \frac{2y_3}{12.8} = \frac{2y_3}{12.8$ = 329.7K = 56.7K Ame work sch Cherry Right Dire (iii) Heat siejerted per tonne of refrigerateon Qg = WRTQ, 1 2 = 3 75 + 210 = 285 KJ/min Ang Rues A refrigeration system working on Bell coleman receives dirightion cold chamber at -5°c and comprise it from 1 bar to 4.5 bar. The compressed air és then cooled to a temperature of 37°C before If its expanded in the expander. calculate cop of the system when expansion and compression are

(i) Isentropeic (ii) follow the law $PV^{25} = q$

Solur Geven data; $M_{1} = \frac{1}{2} \int_{1}^{\infty} \int_{1}^{\infty}$

Let, 72 and Ty = Temperature at and of componension and the second of appression sespectation of appression

(i) cop of the system when compression and expansion and exentropec NF6) 1 2 12 1966 We Know that $\begin{pmatrix} P_{2} \\ P_{1} \end{pmatrix} \xrightarrow{7-1} = \begin{pmatrix} y \\ -y \end{pmatrix} \xrightarrow{1.9} \begin{pmatrix} y \\ -y \end{pmatrix} \xrightarrow{1.9}$ Ta = TIX 1. q = 268 XT. y = 875.2 K and, $\frac{T_3}{T_4} = \left(\frac{P_3}{P_4}\right)^{\frac{\gamma}{\gamma}} = \left(\frac{4\cdot s}{1}\right)^{\frac{1}{\gamma}} = 1\cdot 4$ Ty = to fight to the state of the state of the Ker colorialos GUNZ CON preservation in the list of reading may $= \frac{1}{\left(\frac{4\cdot5}{1^2}\right)^{-1/9}} = \frac{1\cdot86}{1\cdot86} + \frac{1\cdot6}{1\cdot6} + \frac{1\cdot6}{$ istop advisal (ii) COP of the system when follow the law pr'22C We know that $\frac{T_{D}}{T_{1}} = \left(\frac{P_{2}}{P_{1}}\right)^{\frac{n-1}{n}} = \left(\frac{4.5}{1}\right)^{\frac{1.25}{1-25}} = \left(\frac{4.5}{1}\right)^{\frac{3.5}{1-25}} = 1.35$ courseques la bas la subantimation l'him pour l'him pou

and , $\frac{T_2}{T_4} = \left(\frac{P_3}{P_4}\right)^{\frac{D-1}{2}} = \left(\frac{9.5}{1.25}\right)^{\frac{D-5}{1.25}}$ after she known fis in malage with an halles so .i. HCOP tel montante $\left(\frac{n-1}{1-n}\right)\left(\frac{\gamma}{\gamma-1}\right)\left(\frac{\gamma}{\gamma}\right)$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12}$ springing materia into home formally . 111; nor310, -329.5 most reap processing H.992 proves i the former for the form roi parpir lore foi in a tap to resident in the page a 1:01 : a Proch B.H. - I al Brod- 11-1 : pl: ASES - Falling - Sod E JA F & B & B F D A - 1

apres la pois la musicipais : 111 pois aris 12.2

Ques A dense ain machine operater on reverse Brayton cycle and is required for a capacit of 10TR. The cooler pressure is 4.2 bar and refrigerator pressure et 1.4 ban. Thea is cooled in the cooler at a timperature of: and the temperature of air at in let to compressor is - 20°c. Determine for the ideal cycle: 1. cop; 2. mass of ain circu perminute; 3. theorietécal piston displacem of compression; 4. theoritical di piston displace ment of expander; and sinet power perton of refrigeration

Sola"; Gieven data; Q = LOTR

 $P_2 = P_3 = 4.2 - bar$

P1 = Py = 1.4 -bar

 $T_3 = 50^\circ c = 50 + 273 = 323 K$ T1 = -20+273 = 253 K

Let, To and Ty = temperature at end of compansion

$$T_{2} = \left(\frac{P_{2}}{P_{1}}\right)^{\frac{1}{2}-\frac{1}{2}}$$

$$\Rightarrow \frac{T_{2}}{A_{53}} = \left(\frac{4\cdot 2}{1\cdot 1}\right)^{\frac{1}{2}+\frac{1}{2}} = 1.369$$

$$\Rightarrow T_{2} = \frac{1.369}{1.1} = 1.369$$

$$\Rightarrow T_{2} = \frac{1.369}{1.1} = 1.369$$

$$\Rightarrow \frac{323}{T_{4}} = \left(\frac{4\cdot 2}{1\cdot 1}\right)^{\frac{1}{2}+\frac{1}{2}} = 1.369$$

$$\Rightarrow \frac{325}{T_{4}} = \left(\frac{4\cdot 2}{1\cdot 1}\right)^{\frac{1}{2}+\frac{1}{2}} = 1.369$$

$$\Rightarrow \frac{325}{T_{4}} = \left(\frac{323}{1\cdot 3}\right)^{\frac{1}{2}+\frac{1}{2}} = 1.369$$

$$\Rightarrow \frac{325}{T_{4}} = \left(\frac{323}{1\cdot 3}\right)^{\frac{1}{2}+\frac{1}{2}} = \frac{1.369}{1\cdot 369} = \frac{1.369}{1\cdot 369} = \frac{1.369}{1\cdot 369}$$

$$\Rightarrow \frac{325}{T_{4}} = \left(\frac{323}{1\cdot 3}\right)^{\frac{1}{2}+\frac{1}{2}} = \frac{1.369}{1\cdot 369} = \frac{1.369}{1\cdot 369}$$

$$\Rightarrow \frac{325}{T_{4}} = \left(\frac{323}{1\cdot 3}\right)^{\frac{1}{2}+\frac{1}{2}} = \frac{1.369}{1\cdot 369} = \frac{1.369}{1\cdot 369}$$

$$\Rightarrow \frac{325}{T_{4}} = \left(\frac{1.2}{1\cdot 9}\right)^{\frac{1}{2}+\frac{1}{1\cdot 369}} = \frac{1.369}{1\cdot 369} = \frac{1.369}{1\cdot 369}$$

$$\Rightarrow \frac{325}{T_{4}} = \left(\frac{1.2}{1\cdot 9}\right)^{\frac{1}{2}+\frac{1}{1\cdot 369}} = \frac{1.369}{1\cdot 369} = \frac{1.369}{1\cdot 369}$$

$$\Rightarrow \frac{325}{T_{4}} = \frac{1.53}{1\cdot 369} = \frac{1.369}{1\cdot 369} = \frac{1.2}{1\cdot 369}$$

$$= \frac{1.63}{1\cdot 369} = \frac{1.2}{1\cdot 369} = \frac{1.2}{1\cdot 369}$$

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$$= \frac{1.63}{1\cdot 369} = \frac{1.2}{1\cdot 369} = \frac{1.2}{1\cdot 369} = \frac{1.2}{1\cdot 369} = \frac{1.2}{1\cdot 369}$$

$$= \frac{1.63}{1\cdot 369} = \frac{1.2}{1\cdot 369} = \frac{1.2}{1$$

.....

=
$$\frac{2102}{14}$$
 KO/min
We know that,
theat extended $\int kq = CP(T_1 + T_1)$
 $= 17 \text{ KO/Kg}$
and $Q = 10\text{ TR} = 10 \times 210 = 2160$ KJ/min
 $Ma = \frac{2100}{13} \text{ KJ/Kg}$
 $= 17 \text{ KO/Kg}$
 $Ma = \frac{2100}{13} \text{ KJ/Kg}$
 $= 1283.5 \text{ KJ/min}$
 $= 1233.5 \text{ KJ/min}$
 $= 12.3.5 \times 250$
 $= 12.3.5 \times 10^{2} \text{ KJ/min}$
 $= 12.3.5 \times 250$
 $= 12.3.5 \times 10^{2} \text{ KJ/min}$
 $= 64.00 \text{ m}^{3}$
 $= 64.00 \text{ m}^{3}$
 $= 64.00 \text{ m}^{3}$
 $= 64.00 \text{ m}^{3}$
 $= 1000 \text{ KJ/min}$
 $= 1000 \text{$

Ty = Trulique michareperture reit le Fine Ma 236 - 253 Hopepphar to Find 64×236 - 60.09 m3 NIP(1) 253 (i) give leading i is in it would up (iii) (1) STACE for motion conferences in program of some for the (V) Net power per tonne of retaigeration. we know that net work done on refrigorations machine per min. have a ant-an ma (Heat rejected - Heat absorbed) (1) (1)

 $Z = \frac{1}{2} \frac{1}{2}$

741 KJ min

Net power of sufrigeration machine = 741/60 Ka La Innorabolicaq & havisition wal = 12.35 KW Net power per tonne of refine 112.35/10 117-2:35 Merit of Air refrigeration system -

(i) The air is available (easily) and their is no cost of neutregenant

(ii) The ain is non-toxic and non informeable.
(iii) The leakage of air is small amount is tollered.
(iv) Since the main compression is employed for the compressed air sources, therefore is no problem for space for extra compresson.
(v) The air is light in weight per tonne of refrigered.
(vi) The chilled air is directing used for cooling there, by eleminating the cost of separate evaluation.
(vii) Since the pressure in the whole system is quite low there the piping, dusting etc are quite signile to design, fabricate and maintain.

Demeriets of air refrégeration system :-(i) It has low co-efficient of performance (C.O.P. (ii) The nate of air circulation és relatively lay

and the second of the second second

Methods of Air Ref. System. The varieous methods of air retrigerateon used for aircrafts those days are the follows. Simple air cooling System 1-Semple air avaporative cooling system 2.1 3. Boot strap air cooling system 4. Bout strap der evaporrative cooling system Reduced air ambient air cooling system S. Regenerative air cooleng system. 6. based and frage and and and TO THE ANS amuerre a (Mile), , cardson delicated. (1-02); 3 4 / here d'élénére (509) with subjective the abb - base through the other ton but un contration with one particular and the system - alteronately condition on type UJ in a taris

in now a days which the had independent of purpose of the

(i) to be fait to be the providence of the providence of the particular of the providence of the providence of the particular of the parti

SIMPLE VAPOUR COMPRESSION REFRIGERATION SYSTEM (i) A veptier verse is an improver type of air refrigeration system in which an swetable wort substance fermed as refrigerant is used. (ii) Since the low pressure vapour refrige from the evaporator is changed high pressure vapour refrigerant in the compressor them. force it is named as vapour compressor retruig. atéonlosgistem (vers) la sin prophait Engenerration ais containq system. (iii) The refrigerant are used in their system are ammonéa (NH3), carbon dionède (Co2), sulpher déonide (sog) (iv) The refrigerant used does not leave the system but it cinculated throaghout the system alternately condensing and ovaportating (V) The vapour compression refrigeration system is now a days used for all purpose. Refrigeration Refrigeration ((vi) It is generally used for industrial purp from a small domestor refregeratore to a big der conditioning plant

Heat out Heat For Engine THE R. A. 18 12 8 11 71 802 11 HUD 72. compression b(10) 11 -Filmi 19910 01 1. Evaporcettion 3. Condensatio 4. Entension K 2 513 Enpansive valve condensor Evaporcator It is on the shell to provide all possil Engîne - drievène vapour compressor heat pump) Advantages, and Desadvantages of VCRS over a ain refrigeration system ; balous 21 MARY while provide the provert prize of a liver traces Lout hustol sta 10 win Advantages :-(i) It has smaller see for the geven capacity of refrégeration. is) It has less running cost. i) It can be employed over allarge range of pemperature in a mi bande il recus in The C.O.P is quete high which must Sylov not 2000 Disadvantages : Pular Plustan i) The ineteral cost is high. ii) The preventation of leakage of the refrigerant es the major problem in vapour compression

Date: 23/09/2022 Mechanism of sucks

1 Compresson :-

The low pressure and temp. vapour referêgerant from evaporator is drawn into compressor through the inlet on successon value (1), where it is compressi to a high pressure and temperature. That vapour refrégerant és déscharged into the condenser through the delivery on descharge value (B)

[wip4]]

Perd in .

2. Condenser saugnas nuogov mivuels - migal

The condenser on cooler consist of coils of pipe in which the high pressure and temp. vapour refrigorant is cooled and condensed. The refrigerant while passing through the condenser geves up éts latent Meat to the surrounding condensing medium which normally air or water

3. Receiver à

From pressing and soil FE C The condensed liquid refrigerant from the condenser is storied in a Vvessel, known as reciever friors where it is supply to evaporator through the expansion value on refrigerant contevely value

M. Engansion Nalve: Int és also, called throttle valve on refrégerant control value. The function of the expansion

value is to allow the liquid retrigerant under righ pressure and temperature to pass at a contralled nate after reducing its pressure and temperature. some of the lique'd retrigerant evaponates at it passes through the expansion value bout the greater part as vapounded in the evogorator at low pressure and temperature. I million for the second of the second of the property of the second of th 1-2 in 15th P-A diagram the An evaporator consist of coils of pipe in which the liquid vapour réferégerant at low temp. & pressure is evaporated and change into vapour refrigerant at law temperature and low pressure. In evaporating the liqued vapour refrigerant absorbs its latent heat of vapourcisation strom the medium (Aer, water, brine) which de to be cooled * Breine es weed as et hab a very low freezing Types of rapour compression cycles 5 1. cycle with drysaturated vapour after compression cycle with wet vapour, compression cycle with superheated vapour after compression д. 3.

cycle / with superheated vapour before compression 5. Cycle with under cooling on sub cooling of

* Theoritical vapour compression yde with dry satural vapour after compression? ratte dertan o to have

1. comprussion process :-

The vapour refrigerant at low pressure P & + emperature T, is V compressed isentoupically to dry saturated vapour as shown by vertice line 1-2 on T-s déagnam and by curve 1-2 on Pet p-h diagrain the presures t'emperature rieses from upplito P2; and T,-1 respectively. The work done during scentropic compression per Kgrofst wild negerant is given it by 100 low = white his price all marter as variation for tast faited h1= Enthalipy of vopour retrigerantat - emp. h2 = Enthalpy of the vapour retrigerant et T2= 12_ 3 (cond.) 2 7 P_= B 2 Cond 2 to the second the second second the second s

T-s diagor am)

a condensing process in the importation of the high pressure and temporature vapour retrigerer. The high pressure and temporature vapour retrigerer. Thom the compressor is passed through the condenser, where it is completely condensed of constant pressure P2 and temporature T2 as shown by the enter horizontal line 2-2 on T-s and p-n diagram. The vapour retrigerant change into liquid retrigerer the retrigerant passing through the condenser gives its latent heat to the surrounding condensing Medium

3. Expansion process:

The liquid refnigerant at priesure Ps=Pz the and temprosts = T_2 en is empanded by throtting proless through the expansion value to a low pressure Py=P, and temperature Ty=T, as shown by the curve B-Y, on T-s and P.h diagriam.

We have already discussed that some of the liqued refrigerant as it is passes through the expansion value but the greater pontion is vapourcised in the evaporator. We know that during the montheing process no heat is absorbed on rejected by the liqued refrigerant

Note: In case of empansion cyclinder is mediaf is used in place of throuthle or expansion value to enpand the lequed refregerant

then the two refrigerant will enpand isentropica as shown by the I doted vertical. line on IT-s deagrammet ipoural la pourant innorge d' maranger des is the isentropic expansion reduces the enternal woork being expanded in scenning the comp. resson and increases the restrigenating impire offect. Thus, the net result of using the expansion cylinder is to Encrease the C.O.P Modern domestic réfriquentore, capélary is used in place of expansion value

3. Ladiansten Adates :

dy. Vapourising process inorpiciture burgit 217 The liquid hapour menture at constant evaporiated and change into the vapoure refrigereent at constant pressure and temp, as shown by horezontal line y-, on T-s déagneen, and P-h déagram.

> During evaporation the liquid vapour respriger absorted ets latent heat of napouries ation from the medium (ain, water, brine) which is to b cooled

Thes heat which is absorve by the refrigerant avov éxincalled refrigerating offect (RE). - Frier operations Buspil with form for

we know that the netrigerating effect for heat absorved on reject entrated (by the liqued vapour refrigerant during evapore teon per Kg of net riger ant is geven by Ro-hi-hu: hi-his (ihu-his) Where, hf3 = sensible heat at temp. Tz i.e. enthalpy of liquid refrigerant NP .S. 1. K. 194 2011 Leaving condenser. C.D.P = Refrigeriation ettect 18.93. (1 9. 5. 6 B. 6 1 Work don $\frac{h_1 - h_f z}{h_2 - h_1} = \frac{h_1 - h_2}{h_2 - h_1}$ 12. Mz-h, 1. -) - 181 -- pr - 17 The natio of vapour compression cycle to the C. D. P of carnot cycle ik Known as melti reforgeration effecter on performance inder (PI) ABPS- EFETZE - 126 - pt-et johob minin JED DREEG FOR SOUTH THIST piles proper appl PALEA MP 22311 = 2 PAN 840 = 1.184 & KJ 179 6.1. + 105.251 + 11.A

the Know that in and-nightaria all cost does Ques The temperatur limêts of an ammonia retriger 142314 system are 25° c and -10° c. If the gas is idry of the end of componence on calculate the ico p of the ye assuming no under cooling of the lique'd ammonia. me the following toble ton the properties of ommonia. Liquid latent heat Lequid Temp (oc) dicteres No. 1 heat 1166.94 25°C 298.9 1.1242 Circ land -10°C 0.5443 1297.68 135.87 IT ATLES NUR - 9-9.9 Mobil Solan :1 T 1.d - M $P_{1} = P_{3}$ 1 N Tg= T3=250 $P_1 = P_1$ gy zerudanos reporter hr, hrashy 2:1- 01-1 2/12

there is now if it shows to move the second second

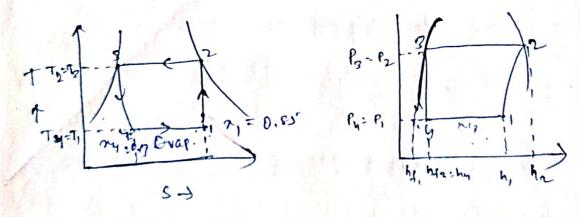
hlg, = 1297.58 KJ/Kg hand to private
Sf, = 0.5443 KJ/Kg hand to private
Let
$$n_1 = dayness floaters at point 1$$

We know that entropy 124 point 1
 $S_1 = Sf_1 + \frac{n_1 hfg_1}{T}$ which to be
 $= 0.5443 + a_1 \times \frac{1297.68}{263}$
 $= 0.5443 + 4924 \times \frac{1297.68}{7}$
 $= 0.5443 + 4924 \times \frac{1297.68}{7}$
 $= 0.5443 + 4924 \times \frac{1297.68}{72}$
 $= 1.1242 + 1166.99$
 $= 5.04 KJ/Kg K - 1 - - - 0$
We know that $= 12.2341$
 $\delta_1 = 52$

$$\frac{3}{41} = \frac{5.04 - 0.5443}{4.934} = 0.911$$

hfg = latent heat of gas File to stranger t the print to the print and digner provide i leas i l'adding approvident class is the second to get the terms with it to be all and and and the state of the White printer proves channes of a state of the I AT AT FOLD IN DI Lin and Indah il A a pole vito and A 1 1 2 3 1 1) ET 14 1 3 1 / Sin 12 a bind 19 + griting +

And In an ammonic vapour compression system The pressure in the evaporator is 2 bar. Ammonia at onit is 0.65 dry and at entry out its drynesstrattion is 0.19. During compression the work done per Kg of ammonia is 150 KJ. Calculate the c.o.p and the volume of the vapour entering the compresson per minute If the state of ammonia conclution is 4.5 kg. The latent heat and the specific volume of a bar arce 1325 KJ/Kg and 0.58 m²/kg srespectively



Criven data; 50/00 hfg = 1325 KJ FS Py=P1 = 2barc V = 0.58 m3/FS ma = 4-5 kg/ M1 = 0.85, My = 2.19 W = 150 KJ/Kg CO.P = Better. A h.1 - hy

Thromandal of the thirt will variation for

let, Enthalpy at point 1 htg. = 0.85 × 1325 = 1126.25 Unthalpy at point y KJ/Kg

 $h_{y} : n_{y} \times h_{fg} := 251.75 \text{ KJ}/\text{Kg}$ $\therefore Re : h_{1} - h_{y} := 1126.25 - 251.75 \text{ KJ}/\text{Kg}$ $\therefore C.0.P : h_{1} - h_{y} := 1126.25 - 251.75$

Wighter 16720 150 194/101 2088.0 14 2 5.83 (Ams) 101/102 28.188 14 101/102 88.188 14

(2) Volume of the vapour

= Mai XI specific volume

 $= \frac{9.5 \text{ Kg}}{\text{min}} \times 0.58 \text{ m}^3/\text{Kg}}{\text{min}}$

A of it retters

Theoretecal cycle with wet vapours compression Q. Find the theoretecal COP for a CO2 machine working between the temp. nemge of asec and - 5°C. The drapers fraction during of CO2 gas during the suction stroke it (0.6 NO KG following properties of Cozaro. gêlen 4 2 F. 126 - P1X X 12" 12-N1-3 hfs= hf2== 162377 Kg/Kg-10 26.12 hfize hfile 72.57 KJ/Kg/Kg Sf2 = 0.5978 KJ/KgK 6fi : 0.2862 KJ/Kg K (MA) h2 = 282.23 KJ/Kg hí : 321.33 KJ kg 32' = .0.9918 KJ/KgK /0 Si' = 1.2146 KJ/KgK hfg 2 = 117.16 KJ/Kg = 248.76 KJ1.Kg hfg, T2 = 25°C = 257278 = 298 K

52 = Sf2 + 22 hfg21 - 11 10. 2 Langinolt. 0.5978 172.01 = 0.2862 + nº 117.46 2 0:99 0.5978+ 0.39 4 N2 $S_1 = \frac{s_{f_1} + \gamma_1 + h_{f_2}}{T_1}$ 0.2862 + 0.6 × 248.76 268 0-84 A 2862 -We Know that a low anisharing reaging book for the will be we want of that in the interesting of the that We know that in also interestion of the well with war reports in the state with war the state interestion in the second of the s pritariu tos Smitsszit alons la lorrid roliniz u si 10/2 01.8 4 = 0.59 0.59 0.59 0.59 0.59 y 0.2 (0) $\frac{3}{100} \frac{1}{100} \frac{1}$ h2 = hf2 talfg 2 = 164 + 1.69 × 117.46 taste markonsplachert = 236.93 KJ/Kg work Hrow

i-dheoridical C.o.p. hr - hyll - here -

 $h_2 - h_1$ $h_1 - h_1$ $h_2 - h_1$ $h_1 - h_2 - h_1$ $h_2 - h_2$ $h_2 - h_1$ $h_2 - h_2$ $h_2 - h_2$ $h_2 - h_2$

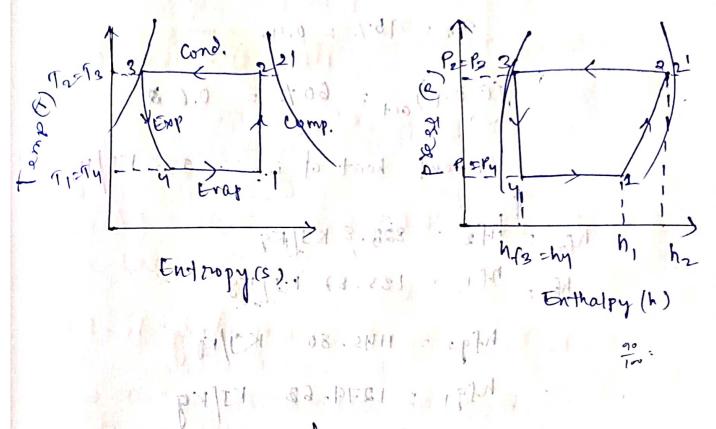
NEMISIU 1. 10 236, 93 - 221.182

= 3.77 (1) Ars

017. Max 210 1- 208 5.0

(1) 7 0 to 1 1 5 3 after compression: A vapouer compression cycle with wet vapour comp is a similar Kind of cycle to dry saturated vapour after compression. Bret in this cycle enthalpy at point 2 towned out with the help of drynessfraction at this point. The dryness fraction at point 1 and 2 may be obtained by equating entropies at point 1 and 2 pin r hiti Now the theoristical c.o.p may be found out S.N. F. Theoris becalf Cruip = <u>hi = has hi</u> pillis and = Reffigeration effect work done

The T-s and P-h diagram of wet vapour comp? is drawn below



dues An ammonia retrigeration machine filled with an aupansion value, works between the temperature limits -10°c and 30°c. the vapour is 95% drag at the end of the esentinopic compression & the flued leaving the condenser is at 30°c assuming actual C.U.P as 60% of theoritical C.O.P calculate the kgs. of ice produce per KW hour at 0°c from water at 10°c Latent offeard of ice is 835 KJ/KS

et	stemp(c)	Pelequid heat (hg) Kilks	(htg) F31 kg	Liquid entropy (SS)	Total Entorpy ofcls.v
	30	329.5 18 11 F	445.80	1.2087	4.9842
	- 10	135.87	1297.68	0.5443	5.4770

Given data; T1=T4= -10° = -10-1273 = 263 K 1 T2: T3: 30°C = 30 + 273 = 303K Az = 95% = 0,95 (C.O.P) oct = 60% = 0.6 × latent heat of ice = 335 KJ/Kg 1 hg = hf = 323.8 KJ/Kg (1) with the = hf1 = 135-87 Kg/Kg 05/17 hfg2 - 1145.80 Kg/kg hfg1 = 1279.68 KJ/Kg the ballit anithorst 100 1000 11 2037 "KJ" KgK 1/ and anaport alt massing = 100.5 442 KJ/Kg K Limits -Inc laws soil the sole shall soil - afinit 2 . 01/05 11/05 2/ Fis 4.98.42 Kalkski The side For it is sit = 5.477 Diviki KgKill witabolistos 4.00 / Difficienti la NOS 20 9.00 Jacking Let dryness fraction at point(1)x; $S_1 = S_1, + \frac{n_1 h_f g_1}{T}$ f_1 f_2 f_1 f_2 f_3 f_1 ant to thomas 263 -= 0.5443+ 4.865 m Es is .1 ANS B. HI 13.50 19442 - 11 3.1.6061

24.9.70 Lunching 412 S2. Sf2 + n2 hfg2 5.838 - p172-31 F. 1. 2037 + 0.95 × 1145-80 303 = 4.796 Notual C.O.P = 0.6× C.L = 2.86 / Miles we know that work to be spent connectionstry = 1,2 10 1 w 1 » 0.5443+4.865 mg = 4.796 Hollo, Kost Ra Ka Ka Ka Pini 796 - 18.0.5443 A 4.865 Fro (903) 11 & Win = qual my 10,9 25.3 × 2013 0:873 EL LEONG KJ hy = hfit mi hfgi fait work ich = 133.87 + 0.87 × 1279.08 - 1249.19 h2: hf2 tazhfg2 = 323.8+0.95 × 1145.80 = 1412.31

Theoretical c.v.p = $\frac{h_1 - h_2}{h_2 - h_1}$ 1249.19 - 323.8 CLINNIN INA 1 ESPUSIZIES - 1249.19 the life at 1 a - 5.6 - PER AN APE.M Actual C.O.P = $0.6 \times 5.6 = 3.36$ (Ans) twitte worth 1work to be spent concresponding to 1 kw hr WE= 3600 KJ 3.14 + 8448.0 6 . Actual heat entracted on net effect Per Kw hour = WX (CoP) of 8 63 =0 SEON × 3.36 = 12096 KJ

We Know that istrict the First of the First

100,01N1 - 01.2N11 X 2P.0 + 3.828 =

Theonitical vapour compression refrigeration system with superheated vapour before compression In this cycle the enthalpy at point 2 is foundout with the help of degnee of super heat. The degree of super heat may be found but by equatery the webropites att points thrand 211 w Now with C.o. p. may be found out as usual from the relation C. D. P = Réfrigenation effect (YOTZE KRITHE) work done = $h_1 - h_{f_3}$ France parts? h2-h1 pressive 1 ald avier 1 ald avier processive 1 ald avier p P2=P3 --- 2 3/ Cond. Fr tring and compile to the pill top will gome Td=T3 to have pit Py y Drap of Fuermantov Tirty Enthalpy i chornshallpill so tout site hyseny sony no A little consideration will show that the caper heating increases the refrigerating effect and the amount of work done in the compressor. since the increase in refrigeration effect is less as compare to. increase in work done therefore the net effect of sceper heating 18 to hat low C.D.P Dask and The Martin

In thes cycle the cooling of vapour to will take place in two stages. two knows is a through to perfort as a per ship with an > Firstly it will be condensed to drysacturated stage as unstant preserve Cehown by graph 2-2) and second it will be condensed at constant temp (shown by graph 2'-3). The remaining is same as déscussed in wet vapour after compression * Retrigerant : Desineable properties of an Ideal refrigerant (1) NO: low boeling and freezing point. (ii) Heigh crétieral pressure & temperature. (iii) Heigh latent heat of vapourcisation. -y/all (iii) Hegh (1) 1 Now specific heat of liqued and high protour de specifie qualité d'une mulaire à l'apour A Little avprustow, 11 specific volume of vapour. mousi mi (vi) proptegh thermal and emplicite viety inob prees Non l'connective to metal le mittor pur -2 BD (VU) Mito Will) !" Non "Ptame - able" non - enjolossive Non tonic

(N) Low cost.
(N) Easely and regularly available
(N) Easy to liquity and moderate pressure e
(N) Easy to liquity and moderate pressure e
(N) tasy of locating legs and by odown on suitable indicator.
(N) Ménulal with oil.
(N) High COP.
(N) Dzone freiendly

The standard compression of refrigerant, as resed in the refrigeration industry rebased on an evaporating temperature of -15°C and a condensing temperature of 4 30°C.

CLASSIFICATION OF REFRIGERANTS ?

is a star wife

The refrigerents may be broadly classified as into the following two groups: Derimany refrigerants and;

(2) Secondary refrégerants.

The primary refrigerants which is directly take part in the retrigeration system and called prémary refrigerants. Where as the refrigerants which are farist cooled by primary retrigerants and then used for cooling purpose are known as secondary retrigerants. <u>CH:3</u>

VAPOUR ABSORPTION REFRIGERATION SYSTEM

- The vapoure absorption refrigeration system is on of the oldest method of producing sufficienties effect.
- The system may be used en both domestic & dang Industries refrigerations plant. - The refrigerant that used in vapour absorption
- The vapour absorption system uses the heat energy instead of mechanical energy as in vapour compression system is order to change conditions of the refrigerant required for the operations of the refrigerant required for
- In VARS, the compressor is replaced by an vopour absorber, of a pump, a generator s a pressure reducing value. These components in VARS perform the same function as that of a componessor is vis.

The vapour refrigerant from the evaporator is drawn into an obsonber with where it absonbed by the weak solution of the refrigerant tourning a strong refrigerant. Solution.

) The storing solution is pumped to the generator who it is heated by some enternal source. During the heating process the vapour retrigement. is tog driven by off by the solution and intere into the condensor where it is liquified, The liquid referigement then flows into the evaponator and thus the cycle is completed

SIMPLE VAPOUR ADSORPTION SYSTEM; > Lest of vapour absorption system components:an absorber, a pump, a generator, a pressure reducing valve, condenser, receiver, expansion valve, evaposeton.

- Alter ormer and some the property of a some all and a some and some and some and some and some and some all a some and a some all a some and a some and a some and a some and a some a some and a some a som

> the low pressure ammonia napour leaving the evaporator enters the absorber where it is absorbed by the cold water in the absorber. The water has the abélity to absorb very large quantities of ammonia vapour and then solution thus, formet. is Known as AQUA - AMMONIA.

Southing with first and same alt approxim

-> The absorption of ammonea water lowers the pressure én the absorber which in turn docques more ammonéa vapoure from the evaporator and thus reses the temp of solution -) Some form of cooling arrangement (usually water cooling) is employed for the absorber to remove the heat of solution evolved there also and provide the provide the > This is necessary in order to increase the absorption capturity of water, because of higher temperatard water absorber less ammoniat rapour. > The strong solution thus formed in the absorbed is pursped to the generator by the liquid pump. The pump increase the pressure of the solution rep to 10 m) The strong solution of ammonia in the generator is heated by some external source such as ges on steam. > Diering the heating process, the ammonia rappur is driven off the solution at high pressure deaving behind the hot weak ammonia solution I in the ammoniat. SThe's weak isolution of ammonia floars back to the absorber at low pressure after passi -Phroagh the pressure reducing value.

The high prossure ammonia Vapour from the generator is condensed in the condensor to a high pressure liquid ammonia. This liqued ammones is passed to the inpansion value thorough the reciever and then to the evaporator. This completes the simple vapour absorption cycle.

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supported to the tractal spectrum and a second stand of the tractal spectrum o

avis styre and had altering to any and

Refrigerant:

Refrigerant is a heat canaging medium which during their cycle in the refrigeration cys absorb heat from a low temperature system and discard the heat to a higher temperature system surnounding

Properties of refrigerant:

Ker Eosy of tocating

(i) Low boiling point (ii) Hegh critical temperature (M) Hegh latent freat of vapourcisation (N) Low specific heat of liquid and (N) Low specific heat of liquid and (N) Low specific volume of vapour (N) Low specific volume of vapour (N) Non connossive to metal

(vii) Non - flameable and non explossione (viii) Non - toxic

(x) Low cost. (x) Easy to liquify at moderate pressure and + emperature. (*) Easy to deaks, by by.

(vi) Easy of locating by leaks by odour on suitable indicator. Y leaks by odour on (m) Minds well with dela

1. Califation

classification of refinigerant:

- 1. Primany refrêgerant
- 2. Secondary retrigerant.
- 1. Primary nefrigerant?

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ing

- The primary refrigerants directly take part in the refrigeration system arce called poil mary refrigerants.
- 2. Secondary ref. = apalit sight -
 - The secondarry ref. are fort could by primary refrigerant then used for covering purposes are known as secondarry refrigerants.
- Primary refrigerant fypes ?-Priemary retrigerants are tolloving of groups 1. Halo casibon refrigerant
- 2. A reotrope set. Marine
- 3. Inorganic set.
- 4. Hy droo carbon ref. 1.39 F. 48. 4. 8 4 3 1. 6 3.8 4. 4

O Halpcarbo, 111 +

6 110

The Atoresican society of heating refrigerate and air-condétioning engennere. (ASHRAE). Identify 42-Halocanbon compounds as refrigerants. These are all synthetically produced. I had prite pristance in the

Et -	
Ref. No Chemical Chm Lor Name	mela
R-11 - Tréchloromonofleure - ClyF Methone	(23.77 2)
R-12 - Dé Motro dimosoftuero CCl2F Methène	· (-29'c

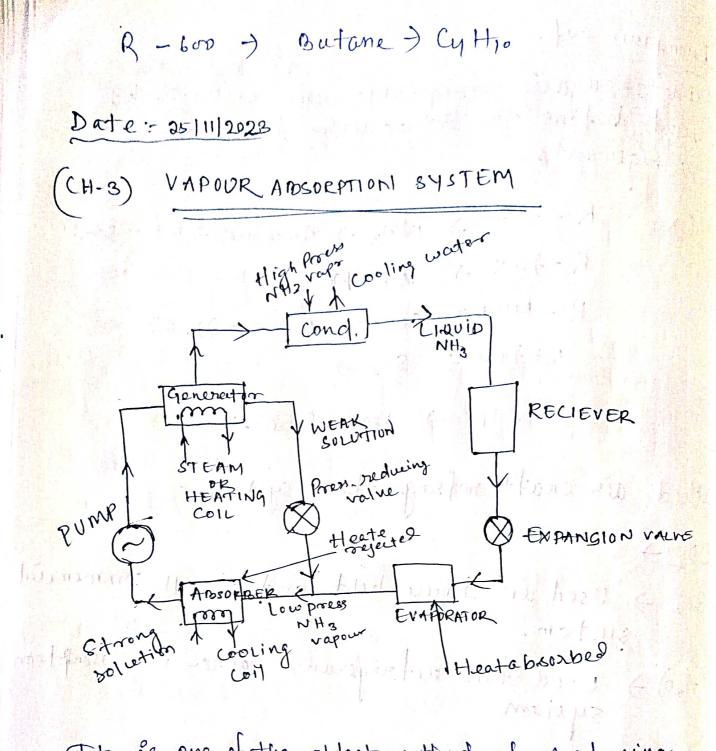
- Monochlone Ra2

marine left biller hat and the protones with stand produce tobe bran and to Anti- produce Azeofrope: proprio production in the

The term areatrispe seters to a stable mentaire of refrigerants whose vapour & léquéd phases worthed identical compositions over a over enge of temperature.

EX + R-500 → 73.8%. R12 + ab. 2%. R152 R-502 - 48.84. R-22 + 58.2.1. R-4

I ronganie ref. The inoreganic refrigerants were enclussively used before the infruduction of Malb carbon sce friger ants MARCINE MODERADORIA SUDTALL R-717) NH3 -> Ammonia -> B.P -> 38-3°C CX F R-729 -> A'En -> " R - 744 7 201 CO2 (7) B.P -> -> B. 6°C R-764 5 802 -> HIVIDRI-118 -> Water (H20) ->; Hed ain craft refrigenation system. (D2 -> MOTERIAT X) + (V) 12:132.16 Sur) Used in thouse held land small commercial system. +120) > Used for viet regerant vapour in absorbteon system Aly doo' cerebine for builtain tribla will a wid in the It's are successfully used in industrial 4 commencial installations. They posses satisfactory thermodynamic properties but are highly tomeable and enplossence Rindigo potethane Di Citto inini R-290 -) Propone - C3H3 R - 1150 -) Esthylene of C2Hy



It is one of the oldest method of producing refrégeration offect. It may be used in both the domestic and large industrial refrégeration plants. NHz is commonty used the vapour absorption system uses heat energy, instead of mechanical energy ar in vapour compression system. In this system the vapour refrigerant form the evaporator is drown into the absorber where it is absorb by weak solution the refroigerant forming a strong solution. This strong solution is pumped to the generator where it is heated by some enternal source then it is intered into the condenser where it is liquified.

(H-5) OF ATR-CONDICIONING 'SYSTEMISTERIOFIER

The air conditioning is a branch of engeneering which deals with the etudy of conditioning of air P-e supplieds and maintaining desireable internal atmospheric conditions for heaman comfort, Innexpective of enternal conditions It also deals with conditioning of air for industrial purposes, food preserving, storage of food and other metarials

Detor effecting ton comfort des conditioning:

1. Temperature of air:

It may be noted that a human being feels confortable when the air is at 21°C with 56% relative humidity. 2. Humidety of air:

In general fon summer ain conditioning the relative humidity should be rest than soy where as for winter air conditioning it should not be 40%.

For the confor of a human-body proper filteration, cleaning, and, purification of air is essential to keep it tree from dust and other impurities. 4. Motion of air: The motion of air current the should be confoolled in order to keep constant temperature the condition space.

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alter and the state that a hours back to have the source of the second and the state of the stat

att are 1 ifference betæven teor cooled end water cooled undenser. water cooled condensor Air cooled " condenser in 191 que construction (i) The construction of of air cooled cond. water cooled condensors is completed, thus " is very simple theirs " the initial cost is the inefficial cost is heigh ICPS ... Fuction hash all (40) Subalt office office 111 (ii) Defficult to handle No hendling problem Air cooled condensor (iii) water cooled condenser donot required piping required piping avragema arrangement for carrying the air NICE AND PRODE AT THE EXAMINED ID (IV) There is a problem there is no problem in disposing of used of disposting the use 2 s. pointer water unlese a air recirculation system es provided Since there is not the (V) since corcression connosion therefore occurs ésides the touling effect és trebe carerying the water, therefore ALCA towing effects are hègh innis and 17 1 - 218 - 22 48 P - 23 Audian just (183183) Leafer & Cal

(i) The wire cooled condensor have how heat transfer Capacity

taking an kind them halons out to respect to harden

(vii) The fan noise es high (VIII) These condensons have high fiendbility

(1x) The destreibution of air On condensing surface ét Non- uniforth. the property performance in

ATTIN RHITIK KIRD PAG

(v1) The water cooled and have high heat transfer capacity (VII) There is no fan noise

8-20-2 14 186 V

(VIII) These condensors have low Flexiberlity (x) The distribution of water on condensing surface is uniform

with statutes in

VID A TO DATEMAL

1 A Calif

CLassification of compressons:

1 A ccorreling to method of compression a) Reciprocating compressions by Rotary compressoos () Centroitugal compressor

2. According to number of struckee all a) single acting compressore ull main Double acting comprissors. 3. According to number of stages. a) séngle stage compressions b) \$ Multistage compressors.

- A ccording to drive) Direct drive compressors) Belt drive compressors) Belt drive compressors According to ibcation of prime mover Semi hermetience compressor (Direct drive, molor and compressor in separate unesinez) Hermetic compressore (Direct drive; motor and compressore in the same housinge) Hermetic compressore in the same housinge)
- -) It is also known as stricke volume or piston . displacement volume.
- > It is the volume swept by the peston when it not noves from top or inner dead position to bottom or outer dead possition.

Vp = T x D² X L Np = T x D² X L Sin plinneburg child, and all a complete Psychomethic terms: lo anyt all a complete Associations in the complete states of the sta

1. <u>Dry air:</u> A purce dry air és a minture of number I gases such as nitorogen, onggen, carbon dioxide, Hydrogen, Arogon, Neon, Hilium etc.

- -) The pure dry air doesnot ordénaryny energy becaus it always contains come water rapour) The density of dry air is taken as 1.293 Kg/m at pressure 1.0135 ban and at temperature o'c
- 2. Moustair:
 - → It is a miniture of dry air and water vapour. The amount of water vapour » present in the air depends repon the absolut pressure and temperature of the printure
- 3. Saturated air: The is a miniture of dry air and water vapour, when the air has diffused maxin water vapour. The water vapours used occur in the tonm of superheated steam.
- > when the saturated air is cooled, the wat rapour in the air starts condensing and are visible in the torum of moist air, fog of condensation on cold surfaces
- 4. Degree of saturation: It is the ratio of actual mass of water of in a unit mass of day air to the mass of

water vapour in the same mass of dry ail when it is saturated at the same temperature make to at the flood found pick with pate: 30/11/2022 100 11/10 11/0 2010 Fars 11/1-Dry Bull Temp 12 to bignost site is les The temperature of ain measured by ordenany hermometter is Known as drug Bulb tamp of the ain Net Bulb temperature; AFEDINAL ALVISIA The temperature of air measured by a theregometer, when ets bulb is covered with weight wet with is exposed to a current of air is known as wet brelb temperature is great of soit what are Note: The difference between DBT & WBT is Known as, wet bulb depression. Wet bulb depression with be zero when the air becomes saturated. Atomath Without A

Des point temperature:

It is defined as the temperature at which the motisture present in the air begins to condense when the air is cooled. The des point temperature corresponds to the -

Saturation temperature of water vapour in The mintare of air and wet vapour - The dry bulb, wet bulb and dew point Temperature will all be say for Saturated Cèr cpr. Millat. p. 20 Specific Hremidety & Farmer Farmer Mart norializes parts for il It is the mass of water vapour present in one Kg of drong air. sites proved by A congression to a langer Bate Absolute Haemidety: the mass of water vapour present in 1m Honof our les Known les Absolate Hursidity. Degree à caturation : If it destined as the reater of water rapour in unit mass of dry air when it is saturated. 7) (uch helptive Humidity A substance to private to say and It is equal to the natio of actual mass of water, vapour en a geven votreme it moistairs to the mass of water repour of the caturated air lat the same temp

psychometric in propagation all and and the the provide the house established by

The science which deals with the study of the behaviour of air and water vapour menture iek known as psycometry.

the properties of water wapour and air mentione known as spychometric properties.

What is the function of rectifine in vars in case they vapours one not completely remove in the analysies, a closed type vapour coder called rectifierre ex used. It is generally water cooled and may be of the double pipe, stell and coel, or shell and table type. It's function is to cool further the ammonia vapours having the analyses so that the remaining water vapource are condensed thus only dry ammonia vapours flow to the condenser

Les Daplain the working of single acting reciprocuting air compressor with suitable diagram.

Wirking & single acting reciprocating air complessor: The peston is act the top of each stroke this is called Top dead center position of the peston. In this position the suction value is held closed because of the -

Poressure en the clearance space between the top of The piston and the cylinder head. The descharge value is also held to held closed because of the cylind head pressure acting on the top of et. > when the poston moves down-ward, the refrigera left én the clearance space expands. Thus the volume of the cylinder above the piston increase and the pressure inside the cylinder derrea When the pressure becomes slightly less than the successor pressure or atmospheric pressure, the suction raive gets open and the vapour refrigerant flows in the greender. Thes flow contenues unteil the piston reaches the bottom of the stroke. Here the sution value closes. Now when the piston moves repword The volume of cylinder decreases and the pressure Possiste the cylinder increases, when the pression Enside the cylinder becomes greater than that on the top of the discharge par valve, the discha value gets upon and the vapour refrigerant is déscharged in to the condensors and the cycles repeated in the cycles cycled bead in the cycles Discharge The cycles of cuction valve Discharge Priston Connecting god flindar.

(old storage plant: A cool store or cold store is a large refrigerated toos on building designed for storage of goods in an environment below the outer temperature.

Many food products may be stoned at some tomp. above the freezing point. The stonage may be storages stonage on long term storage. The storages which are used for short term storage purposee are known as cold storages. The short terrors storage is usually meant for whether establishment where rapid turnover of the product is expected. The period for short term storage ranges from one to two days on to a week but not morie than 15 days. The long term storage is usually carchied out by holesallers and commercial storage ware houses. The storage period depends on the type of products stored and its condition on entering the storage. The manimum storage period For long term storage ranges from 10 days for sensitive products like ripe tomatoes and upto 0 to 8 months for more durable products such as onions. When perisable fruits are to be stoned for longer period, they should be foresen and stored in forozen storages to rapit in Fille The conditions required for short term storages are More flerible them those required for long (term storcage.

> Pollowing points should be kept in mind while storing the toods in cold storinges. 1. Storage temperature 2. Relative humidety and air notion 3. Mined storcage 4. Condition of products ate the time of entering storage the part - had a toments: Product Chillieng internet Que What are the materials used for constructions duit in an ain condetioning system? 1. Galvanised eron sheet metal 2. All uménéum sheet metal ので其他は、同 Black steel 3. Bluin bonded glass fibre 4. Reserve bonded glass fibre Agree & appredictive store 5. Cement aspestores duit for underground ain distribution. 6. wooden ducts the probating and were all strubber it is a provide the state of a company A en feiter function : The function of all felter is to annest the soled empuritées such as soot, ash, smoke fremes t even living organisms such as vérous, bacterias fungus

classéfication of textitler; 1. Dry air feiltere a. Véscous Propégement feiter 8. Electrostatic feiters p-v diagram and t-s diagram of reversed carnot cycle. Iso Exp. Iso Exp. Iso Exp. Temp. Temp T=Ty B P Pressure Py 14 P, S3= by Entropy V V3 Vy V2 - volume ----> (II) T-s diagoam. (i) P-V déagram