

SWAMI VIVEKANANDA SCHOOL OF

ENGINEERING & TECHNOLOGY

SUBJECT NOTE – REFRIGERATION & AIR CONDITIONING

SEMESTER – 5TH

LECTURER NAME – ER. KUNAL PRADHAN

Defination: The term repriseration may be defined as the process of removing heat show a suggestance used controlled conditions. It is also includes the process of reducing and maintaining the terms of a body below the general terms of its surroundings. In other words, the herrigeration means a continued retraction of heat from a body whose terms is already below the terms of its surroundings.

R. M.

The Practical unit & ressignation is expressed in terms & town & ressignation (TR). A town of hessignation is defined as the amount of ressignation effect produced by the whitem melting & one town (1000 b) & ice from and at 0°C in 24 haves.

Since the latent heat of ice is 335 k3/4g,

.' 1TR = 1000 × 375 kJ in 24 heurs = $\frac{1000 \times 335}{24 \times 60}$ = 232.6 kJ/min In actual Practice, one timbe & reprizeration is taken as equivalent to 210 kJ/min '08 3.5 KW (3.5 KJ/See).

O Application: Today it is used for the manufactures of ice and similar Product. It is also widely used for the cooling of storage chambers in which teristable foods, drinky and medicines are stored. The result by also wide application in pubmasive shifts, circrapts and societs.

O Air conditioning: The air conditioning is that branch of engineering scince which deals with the study of conditioning of air ine, sufflying and maintaining of conditioning of air ine, sufflying and maintaining desirable internal atmospheric conditions for the men desirable internal atmospheric conditions. The following and the four infortant factors for ample air conditioning: (1) Temperatore of air (2) humidity of air 3) Parity of air and (4) motion & air.

@ Application : It deals with the conditioning & ails for industrial rarposes, ford processing, Storage & food and aller materialy. O Heat engine: In a heat engine of shown in sigose cas the best sufflied to the engine is converted into ageful worke. It & if the heat pufflied to the engine and &, is the beat rejected from the engine then the net work done by the engine is given by - WE = 92-91 T2 (high kend) T2 Hot bedy that body T2 1 g2= 91+ HR A (itte 15) 10 is an Heat x 92 Heat hump engine () WE Q1 FTP = LOTE X Ti (Low terme) Ti cold body cold body TI TI L'Te and the contraction of the second TI ?Ta a (5) The Personnance of a heat engine is expressed by 11 ity efficiency. We know that the efficiency of coefficient & festormance & an ergine. 32-91 $h_E or (c.o.P)_E = \frac{Wark done}{Heat sufficed} = \frac{W_E}{g_2} = \frac{g_2 - g_1}{g_2}$ $\int o_{E} heat = \frac{Wolk done}{heat abstribed} = \frac{T_{1} - T_{2}}{T_{1}}$ A refrigerator as shown in Figure (6) is a reversed heat engine which either cool or maintain the temp of a body (T1) lower than the atmospheric temp (Ta). This is done by extracting the heat (3,) from a cold body and delivering heat to a hot Parisy

body (B2). In doing so work we is required to be done on the system. According to sisse law of thermodynamics, WR = 92-91

The Pastasmance of a sathigerates is expressed by the satio of amount of heat taken from a cild body (81) to the amount of obox sequired to be done on the system (WR). This satio is called calficient of Performance. mathetically, col of a setsigerator,

 $(c \circ P)_R = \frac{q_1}{w_R} = \frac{q_1}{q_2 - q_1} \qquad \left[(c \circ P)_R = \frac{T_z}{T_1 - T_2} \right]$

Any reprised tion system is a heat pund as shown in signer (c), which eatrach heat (91) show a cold body and delivery it to a hat body. They these is no difference between the cycle of operations of a heat for p and a reministrator. The operations that heat for p and a reministrator. The operations the heat for p and a reministrator. The operations temperatures. A sex works between the cold body temp (Ti) and the atm temp (Ta) and the whereas the heat hum operates between the hot body whereas the heat hum operates between the hot body tenp (Tz) and the atm (Ta). A repriserator used to colding in former can be used as a heat form? It heating in winter.

In the similar way, of discussed too repriperator, we have, WP = 92-9,

The forformance of a heat find is expressed to be hatio of the amount of heat delivered to the het body (9e) to the amount of work required to be done on the system (Wp). This hoted is called cool or anoggy responsible statio (E.P.R) of a beat pump, (C.O.P) or E.P.R = $\frac{92}{WP} = \frac{92}{92-91} \left[T = \frac{TE}{T1-T2} \right]$ $= \frac{91}{92-91} + 1$

From above we see that e.o.p may be less than One of Sseater that one or greater that one defending on the type of regargeration system used But the c.o. 9 of heat pamp is always greater than 1. O coefficient of performance of a refrigerator: The C.O.P is the ratio of heat extracted in the retrigelator to the work done, on the refrigerant. It is also known as theoritical C-O.P. nathematically Theoritical CO.P = W Where, g = Ameryst of rethigeration Produced or the capagity of the retrigerator. W = Amount of work done 1) The COP is the Rediffocal of the efficiency (1/2) of a heat engine. It is they obvious the value of e.o.P is always greater than whity. 2) The satis of actual COP the theoritical C.O.P. is known of Relative c-o.P. 1 Air Rethigeration walking on reversed carnot cycle? In reprigerating system, the carriet cycle considered is the reversed carnot cycle, we know that the heat engine working on carnot cycle is the lighest Passible efficiency. Similarly a retrigeration system watering on the neversed carnot cycle, will have the manimum possible coefficient of Performance. We also know that it is not possible to make an engine wolking on the carnet cycle.

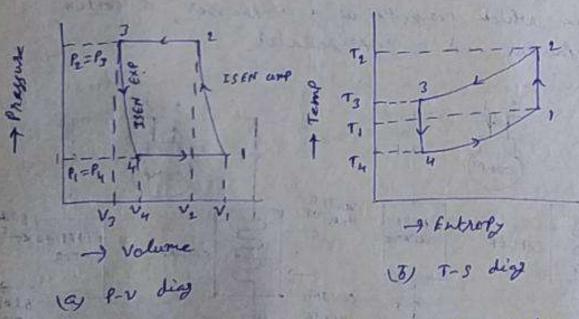
similarly it is not possible to make a septigesating mechine working on reversed carnot excle. However, it is used as the ultimate standhad of comparison A neversed carnot cycle using air of working medium (or retrigeration) if shown on P.V and T.S dieg, in Fig (a) and (5) reflectively. agenter the the The same to a light from the case of The and 3 ISO GOMP T,=T3 13 1 20 5-Pressure Pr Temp. TSER 1 71774 14 come PH A La strand 1 (3 - 10 0/2' P1 54=53 V4 V2 V2 Vi - Valance - futroly (a) P.v dias (3) T.s dias The tour processes of the cycle are of followed: (1) Isentrefic confression Process: This Process is Represented by 1-2 on P-V and T-S diagrams. During this process, the pressure of air increases from P, to P2 IP. valume decreases from up to ve and temp increases drem TI to T2, WR know that during isentropic compression, no beat is absorbed or rejected by the air (2) Isothermal confression Process : The aig is now confressed isothermally (i.e, at conft tent Ti=T3) of thewh be the culture 2-3 on P-V and T-S dightery. During this process, the pressure of air increases from Pe to Ps and specific volume decreeses from vy to vy. We know that the heat rejected by the air during isothermal comp per up of air, 9R = 92-3 = Area 2-3-3'-2' = T3 (52-53) = T2 (52-53)

(3) Isonthefic expansion process . The ail is new expanded igentrofically as shown by the curve 2-4 on P-V and T-S diag. The Pressure of air decreases show by to 14, St. val increases show it to in and temp decreases from T3 to T4. We know that during igentistic enfangion no beat is absorbed of Rejected by the ail. (4) Ifatual enfansion shocess; The ail is how enlanded isothermally (at cont. temp T4 = T1) as shown by the curve 4-1 of P-12 and T-S digg. The Priessule of air decreated Py to P, and SP. val incheases show Un to U. . We know that the absorbed by the air (or heat extracted from the cold body) during iso - that mad enfansion per 10 of air, 2A = 24-1 = Area 4-1-2'-3' $= T_{4} (S_{1} - S_{4}) = T_{1} (S_{2} - S_{3})$ We know that the work dore during the sycle Per ig of air, Up = Heat rejected - Heat absorbed $= T_2(S_2 - S_3) - T_1(S_2 - S_3) = (S_2 - S_3)(T_2 - T_1)$: C.O.P of the Reprizeration system walking Real Press A CONTRACT IS on reversed carnot cycle (c-0:P) R = - Heat absorbed = 24-1 Wolk done = 22-3 - 94-1 and she and the property and $T_{1} = T_{1} = T_{1} = T_{1} = T_{1} = T_{1}$ the base reproded to the sam through reputically

The c-o P of the reversed cannot gycle may be improved by (a) decreasing the higher temp (temp of het bedy Je) (To) increasing the lower temp (tool & cold body, Ti). @ The c.o. P & domestic ressignator is less that COP of a donestic air anditional () Air ressignated working a a bell alemon gole (or neversed prayter of Joule grele): A bell-colonna ais regriseration mechine was developed by belt colorer and light Fost by reversing the powle air spell. It was one of the earliest types & negregeratory used in shifs carrying shozen neat Fig thows the schenetic ding of such a mechine which conjects of a compression, a contex an expander and a neprigerator. comp COPP COLLENA HER CALLING REFREAK-CALING RRATHE WATER 3 HED EN EN Open cycle Bell-colemon closed cycle of dance ais Reprigerator bell-aleran Ret I at her wat that had been and . It of it shalls

of reversed carnot grele. The cycle is shown on I p-is and T-s dig in Fig (2) and (5). At point 1, Let R, UI, TI be the prassure, well and Tranf of air reflectively. The sour processes & the cycle are of dellowes :

(1) Isentrofic compression Process ; The celd eik then the representor if drawn into the compression goldder where is confressed isentropically in the comp of them by the curve 1-2 on fivane T-s dig buring the and stroke, both the pressure and increases and the if. value of air at delivery from confressor reduces from vito 12. We know that during isentropic comp process, we know that during isentropic comp process, to heat if abserted of rejected by the air.



2) constant Pressure cooling Precess: The warm air trem the amplessor is new Passed into the cooles where it is cooled at constant Pressure P3 cooles where it is cooled at constant pressure P3 (equal to P2), reducing the temp prom T2 to T3 (equal to P2), reducing the temp prom ty the ourve (The temp of cooling water) as shown by the ourve (The temp of cooling water) as shown by the ourve (The temp of cooling water) as shown by the ourve (The temp of cooling water) as shown by the ourve (The temp of cooling water) as shown by the ourve (The temp of cooling water) as shown by the ourve (The temp of cooling water) as shown by the ourve (The temp of cooling water) as shown by the ourve (The temp of cooling water) as thous by the ourve (the temp of cooling water) as the solution of reduces the temp of the temp of the the treat resected by the ait during constant Pressure par by of air,

 $2_R = g_{2-7} = c_P (T_2 - T_7)$

(3) Iscutzefic enfansion Process: The air them the color is now drawn into the enfander extinder where it is expanded isentropically them Prossure P, to the reprizedable Ps P4 (The temp much below the caling water, T3). The expansion Process is shown by the curve 3-4 m The expansion Process is shown by the curve 3-4 m the P-V and T-S disgrams. The St. Val^m of air at entry the Reprizedable increases them V3 to V4. We know to the Reprizedable increases them V3 to V4. We know

(4) constant Pressure attangion Process; The cold air from the expander is now lassed to the leprise rates where it is expanded at court Pressure P4 (equal to P). The tend IF the air increases from T4 to T1. This Process is shown by the curve 4-1 on the P-V and T-S Process is shown by the curve 4-1 on the P-V and T-S Process is shown by the curve 4-1 on the P-V and T-S process is shown by the curve 4-1 on the P-V and T-S process is shown by the curve 4-1 on the P-V and T-S process is shown by the curve (1-1 on the P-V and T-S process is shown by the curve (1-1 on the P-V and T-S process is shown by the curve (1-1 on the P-V and T-S process is shown by the curve (1-1 on the P-V and T-S process is shown by the curve (1-1 on the P-V and T-S the heat absorbed by the air (heat extracted from a the heat absorbed by the air (heat extracted from a the heat absorbed by the air (heat extracted from a the heat absorbed by the air (beat extracted from a the heat absorbed by the air (beat extracted from a the heat absorbed by the air (beat extracted from a the heat absorbed by the air (beat extracted from a the heat absorbed by the air (beat extracted from a testigerator of the restrict is -

$$2_{A} = 2_{H-1} = c_{P}(T_{1} - T_{H})$$

coefficient of best mance,

7

an close ward

$$= \frac{e\rho(\tau_1 - \tau_4)}{e_{\ell}(\tau_2 - \tau_3) - e_{\ell}(\tau_1 - \tau_4)} = \frac{(\tau_1 - \tau_4)}{(\tau_2 - \tau_3) - (\tau_1 - \tau_4)}$$

We know that isentropic confragation process. 1-2, $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)\frac{\gamma'-1}{p'} = --- (ii)$

Civilially the isouther expansion theorets 3-4,

$$\frac{T_2}{T_4} = \left(\frac{P_2}{P_4}\right)^{\frac{1}{2}+1} = -- (10)^{-1}$$
Since, $P_2 = P_3$ and $P_1 = P_4$, therefore show equation
(ii) and (iii) -

$$\frac{T_1}{T_1} = \frac{T_2}{T_{14}} \Rightarrow \frac{T_2}{T_3} = \frac{T_1}{T_4}$$
Now putstituting this values is equal (i), be
set. $e \circ o_1P = \frac{T_4}{T_3 - T_4} = \frac{1}{\frac{T_4}{T_4} - 1}$
 $= \frac{1}{\left(\frac{P_2}{P_4}\right)^{\frac{1}{2}+1} - 1} = \frac{1}{\left(\frac{P_2}{P_1}\right)^{\frac{1}{2}+1} - 1}$
Where, $P_4 = confraction & explansion ratio
 $= \frac{P_4}{P_4} = \frac{P_1}{P_4}$.
(i) Problem:
(i) Find the conf of a reprised of potential explanation in the exception of the potential exception is the potential exception in the exception of the potential exception is the potential exception in the potential exception is the potential exception exce$

(1) Find the cort of a nethigeration system if the work input if to kolling and reprigeration except Produced is 160 kolling of nethingerent slowing. Solution: airen, W = 80 kolling, $2 \stackrel{!}{=} 160$ kolling We know that cort of a nethigeration system $= \frac{2}{W} = \frac{160}{80} = 2 \frac{Aw}{2}$:

The Physical Street

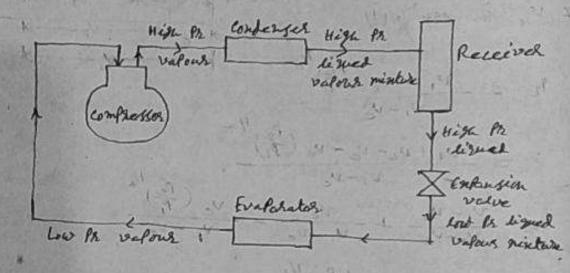
WORk dohe

12) A medicie ordering on a carrier gride theoretics before
365 K and 240 K. Dependence the coop also it is
obstated as: 1. a heritigenting medicie. (9) have himp.
(1) and a heat experies.
Solution: himsel,
$$T_E = 305$$
 K, $T_I = 160$ K
(1) $coop qr a heritigenting medicie.
 $(coop)_R = \frac{T_I}{T_E - T_I} = \frac{160}{305^{-2}co} = 5.78$ Ms;
(2) $coop qr a heat explice.
 $(coop)_R = \frac{T_F}{T_E - T_I} = \frac{365}{305^{-2}co} = 6.78$ Ms;
(3) $coop qr a heat explice.
 $(coop)_R = \frac{T_F}{T_E} = \frac{305 - 260}{305} = 0.147$ My;
 $(coop)_R = \frac{T_F}{T_E} = \frac{305 - 260}{305} = 0.147$ My;
(3) A calculate the coefficient of performance of his
his reprised a gride.
(3) T_F the coefficient of performance of his
his reprised a gride.
(4) T_F the coefficient of performance of his
how many kJ q work is required Performance 7
 $que a number heat four dependes between the
gride, what is coefficient of performance 7
 $(coop)_R = \frac{T_F}{T_E - T_I} = above heat performance 7
(4) How many kJ/nin will the beat have defined at
 300 K if it above the formance 7
(d) the many kJ/nin will the beat Rows deliver at
 300 K if it above the formance 7
 (d) the opticient of performance 7
 (d) the many kJ/nin will the beat Rows deliver at
 300 K if it above 300 KJ/nin at 270 K.
Ans: (a) coefficient of performance 7
 (d) the many kJ/nin will the beat Rows deliver at
 300 K if it above 300 KJ/nin at 270 K.
Ans: (a) coefficient of performance 7
 (d) the many kJ/nin will the beat Rows deliver at
 300 K if it above 300 KJ/nin at 270 K.
Ans: (a) coefficient of performance 40 above 300 K if 300 KJ/nin at 270 K.
Ans: (a) coefficient of performance 7
 $(coeff)_R = \frac{T_1}{T_R - T_1} = \frac{370}{300 - 120} = 9$ My:$$$$$

(5) Warter hequited per second, Let, WR = work requised per second, Heat absorbed at 270 K (ie, T). 3, = 1130 kJ/min = 18.83 KJ/Sec $08, 39.9 = -\frac{18 \cdot 83}{WR} 11 - 319.33$ as, WR = 2.1 KJ/See Aws: () caltticient of performance of cornet heat fund, e o p de a brak average $(c \cdot o \cdot P)_{p} = \frac{T_{2}}{T_{2} - T_{1}} = \frac{300}{300 - 270} = 10 \text{ Aus:}$ (d) Heat delivered by heat fump at 300 k Let, 92 = Heat delivered by heat furt at 200 K have be accordent x 000 to Heat absorbed at 270 K (ie; Ti) 9, = 1130 kJ)rill - 1 (3 $q_1 = \frac{q_2}{q_2 - q_2}$ We know that, $(c \circ P)_P = \frac{q_2}{q_2 - q_2}$ $\frac{-92}{08} = \frac{-92}{92 - 1120} \in \frac{-92}{08} = \frac{-92}{100}$ $\frac{08}{08} = \frac{92}{10} = \frac{92}{1256} = \frac{92}{1256}$ he sport collicion of for summarce of assist markets

O Valour compression repriseration system:

A schemetic diagreen & c simple vefour compression reprigeration system is show in signre. In this system, a putable warning system publicance (unown as reprigerant) such as ammohia, carbou dioxide, sulpher dioxide or seronse is used. It conjusts of the following five executial parts:



() <u>Compresson</u>: The low pressure and temp valous reprizerant prome evaluator is drawn into the compresson through the inlet or suction value R, where it is compressed to a high pressure and temp This high pressure and temp valour reprizerant is discharged into the condenses through the delivery of discharge value B.

(2) condenses: The condenses or coales consists of aily of life in which the high Pressure and tend verfour reprisement is coaled and condensed

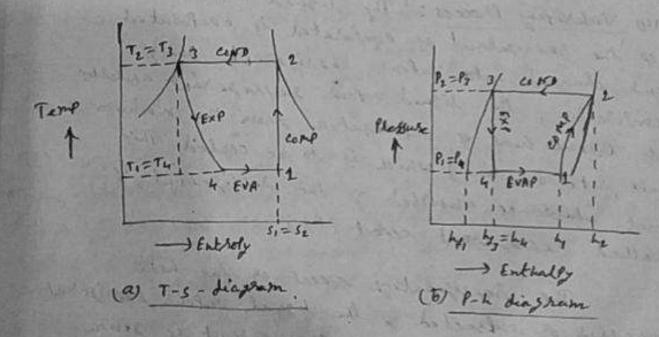
3) Receiver: The andensed liqued reprigerant from the condenses is stated in a vessal known of heceiver from where it is sufflied to be evaporator taxaly the endousin value of reprizerant control value (4) <u>Expansion</u> value: The enfansion value allowed the liqued Reprizerant under high Pressure and tend to Pass at a controlled rate after reducing the Pressure and tend.

(5) Evalorator : An evalorator cryisty of coily & file in which the liqued valour reprigulant at low Pressure and temperature is evalorated and churged into parlow deprigerant at low Pressure and tend.

Mate :

@ Valour compression cycle (theoritical):

A valour contraction gde with dry saturated valour after compression is shown on T-s and P-h diagrams in signific (a) and (I). It essentially consists of confraction, condensation, expansion or tractiling and evaloration of discussed below:



(1) compression process: The Valour Sepsigerant of law Pressure and tend from the evaporator is drawn into the confressor where it is confressed igentrolically. The pressor and terming rises from P, to P2 and T, to T2 pressor and terming rises from P, to P2 and T, to T2 respectively. The wolkdone during igentratic confression respectively. The wolkdone during igentratic confression Per 19 of Reprisedant is given by - w = h2-h1 there, h, = Enthally 7 value reprisement at tend T1, to at suction of the confression, and

he = Buthally of valour ressigerant a i e, at discharge of the combressor (2) condensing Process: The high Pressure and tent valour reprizerant that the compression is passed through the confrequest condenser where it is completely condensed at constant presson and tend The vapour nepsigerait is charged into liqued septigered (3) Enlansion Process : The liqued refrigerant at high tressure and item is expanded by pratting Process through the expansion value to a low Presider and tend some & the liqued reprochant evaluated as it is passed purough the entansis value but the greater Portion is valorised in evalorates! 14 Valorizing Process: The liqued valour ninture of the Resligerant is evalurated is evalurated and changed into valour resrigerant During evaloration, the litered vertour repriserant about its latent weat of valorisation soon the nedium (air, water & bring) which is to be could This heat which is absorbed by the repriserant is called ressigement effect (RE) The Beenigerating effect of the heat absorbed of entracted by the liquel valous herizeras during evaluation Per 42 of refrighting given There and 43 - 11 $R_6 = 13 - 44^2 = 142 - 43$ where, his = Enthalpy of liqued repriserent leaving the condenser A STATE OF STATE cop = Bestigerant effect - 14-hi work done

D simple reafour apportion reprizeration &stern : It is one of the aldest method of Produced ressigerating effect. This system may be used in both the domestic and large industrial repriserating plants The reshigerant commonly used in this system is annohia The valour absorption system uses heat energy, instead of mechanical energy as in valour compression systems in order to dauge the conditions of the regrizedant Required the the oberation of the Reprigeration Gile . Som half the set of all courses in course. and alweither the ways halos and and HEATIN HIGH PRESSURE NHY VAPOUR EJECTED (Se) 1 A Init I I I CONDENSER CANNON AND AND ADDED GENERATOR WEAK WEAK SOLUTION OR A WIRECEIVER HEATING COIL PRESSURE REDUCTING VALVE Spee Colle aga nad. Sevelle my lake. PUMP HEAT ABSORDED (QE) EXPANSION VALUE 4 38-248 17X 10 ABSCRBER EVAPORATOR hard the adapted get get to the STRONG anno PRESSURE AMMONTA VAPOUR SOLUTION CODLING I WATER , WATER , W REJECTED (QA) DE PORT MERSIAN a a design and the second The valour absorption system as shown in sigure consists of an absorber a pump a generator and a pressure reducing value . These components Perform the same sunction of that of a compression in valour compression system. In the valour absorption system, the valour repriserant them the eventorator is drawn into an absorber where it is absorbed by weak solution of the nexisesant deriving

a sitia and an all a

a strong solution. This strong solution is humbed to be generator where it is heated by some external source. During the heating process, the valour repri-Serant is dreven off by the solution and callets late the condenset where it is lightigh. The diqued thus the cycle is completed @ Practical valour appretion system: The simple valour absorption system as discussed in the previous article is not very commertial. The abder to make the system male Practical, it is sitted with an analyser, a. rectifier and two heat enchargers of shown in sigure This accessories help to improve the performance and wolking of the Plant, of discussed below : 1) Analyser; when ammonia is vaforised in the Jenerald gone water is also reported and will show into the condenser along with the ammonia valours in the simple system. If this unwanted water perticles are not renoved before entering into the condenser, they will enter into the expansion value where they sneeze and choke the file line. In order to remove this unwanted festicles slowing to the anderson, as analysed is used. The analyser may be built as an integral last of the senerator or made of a separate Diece of equipment. It consists of a series of tray mounted above the generator. The strong golution from the absorber and the agua from the rectifies are introduced at the top of the analyser and slow downward over the trays and into the senerater. The value is could and most of the water rectour condenses to that mainly ammoria valour (APProx 97%) leaves the top of the analysier. Since the arma is heated by bies valour, less external heat is remited the first tallatte in the generator.

(2) Rectified : In case of the water valours are not completely removed in the analyses a closed type valour cooler called rectifies (also known of delydrater) is used it is generally water could and may be of the double like, thell and tail or shell and tube type. It's substitut is to cool surther the annopia valoury leaving the mater analyses so that the remains water valours are condensed. Thus only day of analydrous amponia parauly How to the anderger. The condensate +xom rectifier if seturned to the top of the madyser the drives take tak 533 drif sekusu line taster 1 and the Tomat a CEDLING WATER AND AND MAINTANAND LONG AND states that I'llen the house the a aprila and CONDENSER-Warden of Paral RECTIFIER OR about loss peter DEHYDRATOR BRIP ANALYSER RATE LADORS HEATTNE COILS GENERATOR C RECEIVER WEAK SOLUTION HEAT HEAT EXCHANGER 158 Y a side as " the backs of PUMP. REDUCTING VALUE STRONG SOLUTION 5 1 15 116 13 ADSORDER EVAPORATOR mm EXPANSION there all an all have VALVE We della fait CEOLING WATER

(3) Heat exchangers: The heat exchanger Provided between sums and the severator is used to cost the week but solution returning som the generates to the absorber. The heat removed from the weak solution riges he temp of the strong folution leaving the fump and soing to analyser and generator. This operation reduces the heat at stated fulflied to the serverator and the amount of cooling required to the approve They the seconomy of the Plant increases The heat exchanger provided between the condenses and the evalosates may also be called dirued sub-cooler. In this heat exchanger this liqued reprizerant leaving the condenser is jub cooled by the low tend amoria valour show the sevalatator of thown in figure. This sub cooled liqued is fassed now to the enfansion value and then to the evalorator In this system the net repri-Jerating effect is the heat assorbed by the reprigerant in be evalorated. The total energy sufflied to be system is the forme of wouldone " by the found and the heat supplied in the generales. These tose, the cop of the system is given by This in his manness Heat absorbed in evaluator C.O.P = Wolk done by hums + Heat sullied in gueralds Constraint - - -

(2) Heighburg to the second of the 14 high acting wontrastick and (2) heardle making reputerbands 14 decentry in the ensuine is the part : (4 myle style los niges galides) workeds (5) and maller style (or more garden) contractories It sinciding to the material of these endland? 14 literit drive contractions and (6) belt drive workersers ; ; ; () hearding to the postion of the time nord; (b) sens a discover lie a portal ledy (disect drive, males and untressed in perhaps donitings) and (I) Mussietis energies (& is some laterary) O Revisioning appressions ? These and some as used dot the superior which down continue and low volume tor my and put of amount

a durge successful the state part of announ (R-7193) R-13 have not relige challeride (R/40) The hold Proceeding and relige all available in the hold Proceeding and see about its small beneght superinters and who about small beneght superinters and who about

The set bytes & reciptucity anthemars in in passed in all angle netting sections contracting as suble antig being ater contractors. The right adapt contractors care bails gliedes instanged resting, today of in a Vol is some the sector and speaky of in a Vol is some

See and the DISCHARGE + SUCTION ____ SOLTION CYLINDER PISTON D 0 CONNECTING CRANK . to a (4) (3) (d) PRINCIPLE OF OPERAN OF A SINULE STRAF BINALE BETING RECE COMP Let us consider the Piston is at the lot of ity stroke as shown in figure (as. This is called lof dead centre Position & the Riston. In this Position the justion value is held closed because of the prossule in the cleanance space between the top of the Piston and the cylinder head. The discharge value is also held elested because of the cydinder head prossure acting on the top of it When the fiston movies down word (duling Juction strates) of shown in Fig (5), the représent left in the clearance face expands. Thus the volume of the cylinder (above the fight) incleases and the messare inside the ylinder decreases, when the fressure becomes glightly loss than the suction pressure or also pressure the suction value gets ofened and the watour retrigerant slowy into the cylinder. This plaw continues with the fiston reaches the sollow of its strake (bottom dead centre) At the beltom of the stroke of show in tig (c) the metion value clases because of spring action vous the fighton movey woodd (during compte stroke) the bed in of cylinder decreases and the In impide the cylindes increases when the Pr inside the extender becomes

scates than that on the tot of the discharge value, the discharged value gety speaced and the valain reprisement in dicharged into the conductor and the yele is refeated. 1955 23 1) Rotary compressions: In rating compressors, the valour respigement show the evaluator is compressed due to the movement of blades. The relay comp are positive displacement type comps. since the clearance in ratory and is negligible, merute they have digth we have tric essiciency. These confrictions may be used with repriservents R-12, R-22, R-114 and armonea illig with land have a if attance in this in paymore ant DISCHARGE HOUSTNA EXLENDER - danst and and PECENTRIC IN THE MILLING ROLLER READE 23-1923 + (TAPELLER) + VAPOUR PARA REFRIGERANT KIN 12 (4) COMPLETION OF INTAKE STROKE AND BELIENNING COMP - RETOR SHAFT all in the alternation was in a line a special to the start of SINGLE BLADE (ROTARE) CON STATIONARY RotoR . Whenther I doubt of all allowed recorded to the firm the hypotries throught a tot internet attack SUCTION PORT the shall on man and tel CARYLINDER AND AND AND - El a frant ci lic Lend C' A the state of an inter later BLADES DISCHARGE PORT WITH VALVE MALTE AND AND AND AND AND I that May sorright that Ell- and ROTATING BLADE TYPE ROTARY COMP

coil and the manufer of d The second of the second of the second of the second of the O Bare tube coil qualoratory: The bake tube cil evaluators are also known of Phime-sourface evaloratory because of ity simple construction, the bare tube coil is easy to clean and deforst. A little consideration will show that this type of evalerator others relatively little surface area contact area as compaired to other types of coils. SUCTION DENTE TO COMPRESSOR LIQUED TO THE ATT THE ATT THE AND AND THE ATT THE ATT REFRIGERANT-> the share allowed as a set of the particular and the @ Finned evaluators! The finned evalorator of thosen in tigure consists of bare tubes of coils over which the metal plates or firs are sestened. The metal fins are constructed of this sheets of metal having good thermal conductivity The shape, tize or spacing of the sing can be adorted to provide best rate of heat transfer for a seven application Since the ting greatly increase the contact surfaces for heat thansfer South A State PLATE A LINE VAPOUR 1 to to Strates and REFRILLERANT VAPOUR REFRIGERANT is a formation of the father of FINS -> LIGBED > LIQUID REFACHERANT REFRIGERANT FINNED EVAPORATER PLATE EVAPORATOR

O Plate evaluators:

In this type evaluated, the calls are either welded on one side of a plate or between the two plates which are welded together at the edges. The plate swapprater are generally used in household resrigerators home spreadly used in coders, we cham entimates, backed plants ate.

O shell and twe evaluators:

These evaluation are scherally used to drill water of brine plutions. When it is operated of dry expansion evaluator the heprigeranty ediculated through the twees and the liqued to be could filly the space around the tubes with in the shell these are used for repriserating unity 2 to 250 TR calacity when it is operated of a shooled evaluator, the water or brine slows through the tubes the her they circulates around the tubes these and the her special circulates around the tubes these are her the fits circulates around the tubes these are her the field of a shooled evaluator the her her special while a solution the tubes these are her the fits derated of a state tubes the set of the her the fits around the tubes these are her the fits are stated on a solution the tubes these are her the fits are stated of a solution the states and the

O classification of condensers;

Racording to the condensing medium used the condensers are classified into the following three groups:

and a flamer signed

(1) Aix- coded embasers, (2) water-coaled condensers 13 Evaforative condensers

D Air costed condengess ; An air coded condenser is one in which the Semoved it heat is done by air. It contains as stall & coffen tubing through which the ressigement slowy The size of tubes manges from 6 mm to 18 mm outside diameters, defending upon the fize of combinger . The tubes are usually provided with plate type sing to increase the jurface area for heat thangler of Those in figure. The fins are usually made from aluminium because of its light weight. The ping Africing is quite wide to reduce dust daysing with atax TUBING 10 C. D. Land Star C. C. D. Land DPLATE TUPE FINS and galace as had a for Dr. Sto fie 6 anote andres also men OUTLET Eangent fix or species out about an last equilance of the 10 at 18 who have a an particle, the strang and a @ Water coded condensel : A water cooled condenser is one in which water is used of the contensing medium. These condensers are commonly used in connertial and industrial ressignating white This use cities of the following two water system : owner of the his (1) waste water system 11.6 6. 11.4.22 2) Recirculated water system HOT VAPOUR REFRIGERANT VAPOUR REFRIGERANT WATER COTLED CONDENSER FROM EVAPORATOR compressed LIQUED REFRIGERANT WARE WATER & WATER FROM TO RECEIVER WATER COOLED CONDENSER USING WESTE WATER SYSTEM

VAPOUR REFRIGERANT HOT VAPOUR REFRIGERANT FROM EVAPORATOR UARA LIQUED REFRIGERANT TO RECEIVER WATER CORED CONDENSER WITH RECTREVERTING WATER SYSTEM In a wayte water system, the water after circulating in the conductor is discharge to a sewer This system is used on mall unity and in locations where lafte quantities of sresh menfensive water and a seawer system large erough to handle the waste water are available In a recirculated water system of shown in figure, the same water circulating in the condensed is cooled and used again an again The cooling water towers and spray roads are nost common cooking devices used in a recirculated and a start of the second of t water system in the state produces for a state Atoming the wheel Batomer and another workers surfam. L'INTERE SELECTORES DE LES PORTES DE LES POR and the test of any particular

@ simple reafour ausorption représention estern : It is one of the aldest method of producing ressigerating effect. This system may be used in bath the domestic and large industrial repriserating plants The restigerant commonly used in this system is annohia The valour absorption system uses best energy, insted of mechanical energy as in valour compression systems in order to charge the conditions of the regrigerant required for the oberation of the Refsigeration gele ... and the set of and as coling water . al decolector an in the college the second day for a light for a light HEATING REJECTED (ge) HIGH PRESSURE NHA VAPOUR Ister parties All she front all all a condenser GENERATOR WEAK SOLUTION RECEIVER DORIN JANO HEATTNG COIL 65 PRESSURE REDUCTING VALVE The Bridge of any test minut the a freshind the and Plate Brecher PUMP HEAT ABSORDED (GE) EXPANSION VALUE 4 ABSORBER EVAPORATOR (arread) PRESSURE ballet STRONG SOLUTION AMMONER VAPOUR COOLING WATER HEAT REJECTED (QA) Martin Internal in the The valour absorption system as shown in digure consists of an apporter a point, a generator, and a pressure anter duries of parts reducing value

These confinents Perton the same sunction of that of a compression in valour compression system. In the valour, possistion system, the valour reprisement show the escalobator is drawn into an assorber where it is absorbed by weak polution of the reprisedant forming

ica series to to

a strong toletion. This strong polection is fumfed to the generators where it is heated by some external parce. During the heating process, the valour repri-Serant is driven 44 by the solution and enters late the contenset where it is liquiced. The liqued reprigerant then slowy into the evalorates and thus the cycle is completed. a present dia manager al O Practical valeur apportion system: The simple valour absorption system as discussed in the previous article is not very commertial. In abder to make the system male Practical, it is sitted with an analyser, a. rectifier and two heat enchargers of shown in sigure. This are accessories help to improve the performance and welking I the Plant, of discussed below: 1) Analyser: when ammonia is reforised in the severalish some water is also reposised and will slow into the condenses along with the amaonia valours in the simple system. If this unwanted water perticles are not reneved before entering into the condenser they will enter into the expansion velve where they sneeze and choke the like line. In order to remove this unvanted serticles slawing to the anderson, as analysed is used. The analyter may be built of an integral last of the generator or made of a scherate Diece of equipment. It consists of a series of tray mounted above the generator. The strong galution from the applicant and the agua show the rectifies are introduced at the top of the analyser and show downward over the trays and into the senerales. The valous is could and most of the water rectors condenses to that mainly ammoria valour (APProx 97%) leaves the by of the analyser. Since the area is heated by the valour, less external heat is remited in the Jenerator .

12 Rectified : In give of the water water water not completely removed in the analyzes a closed type valour cooler called rectifies lais known of delydates) is used it is pererally water could and may be & the double like, thell and sail or shell and true the It's substance is to card surther the annopia valoary leaving the motion are condensed Thus only day of analydrous purpose in parameter How to the anderger. The condensate stone be rectifier if seturned to the trif of the mayser by a adamber and share and and disil saturn line Vera Sharil ROUGE GREATER IN ALL ALLAND STRATE A. 18 6 6110 4 10 4 CONDENSER-1 per phillips 67 and the said DEHYPRATOR IRTP AND DANITIER. 111011 WINERMOR G WEAK SOLUTION ane inter the and ANGER W all the A sharely in DUMP STROKU hottujoi RESORDER EVAPARATOR NEEDN THE 1.91 121 2013/52/52 WATER.

3) Heat exchangers: The heat exchanger provided between hums and the generator is used to cost the week but solution returning from the generates to the absorber. The heat removed from the weak solution rigis the temp of the strong selection leaving the fump and Joing to analyser and generator. This operation heddres the heat at stated fulfilled to the generator and the amount of cooling required for the absister They the seconomy of the Plant increases The heat exchanger provided between the condenger and the evalesator may also be called lisued sub-coder. In this heat exchanger, they liqued ressignant leaving the condenser is got corled by the low tend amoria valour thom the surficiator of thousa in figure. This sub cooled liqued is fassed now to the enfansion value and then to the evalorates In this system the net repri-Jerating effect is the heat assorbed by the reprigerant in be evalorated. The total energy sufflied to the system is the some of wouldone - by the famil and the heat supplied in the generals. mesotose, the cop of the system is given by The MANDANAMAN

C.O.P = Heat assorbed in evalorator

Psychone En : 19 11, 11 A Allen The Asychildricthy is that branch the engineering statute which deals with the standy of maist air. " day air mixed with water report or shamidity. Il abso, includes the study of behavior use day air and water rappul nixbele with mainy soly or conditiony. @ Dry bull terrestature: "They is the terrel of air 1900 recorded by a thermometer when it is not exected I wet bull tensoreture: It is the terr of air is recorded by a tremometer, when it's well is jurrounded by a wet eleft enfosed to the star, such a presented is called, wet buts theremeter, (WBT) O Thermodynamic wet bulk tem/ crature: Thermodynamic wet bulk terre or adiabetic saturation tends. It is the terms at which the air can be prought to saturation state, adiabetically, by the evaloration of water into the flowing air !! O Dew faint temperature: It is the temperature of air interproted by a thermometer, when the reighter (worker wateres) present in it begins to condense In other words dear faint temp is the saturation temp correstording to "their partial pressure of water valuers O Humidity ratio : It is the mass of water valous in 1 19 of day air, and is prerally entressed in

in 1 by of any new of day air (2/109 of dry air), terms of Marm per by of dry air (2/109 of dry air). It is also called specific lumidety.

in the

O Relative humidity: Il is the Satio of actual mays of water valour in a given valume of meight air to the mass of water valour in the same valuere of staturated air at the same temperature and pressure ratio of actual Degree & saturation: It is the ratio of act make of water valour in a whit mays of dry air to the mass of water valoud in the same mass of day with when it is saturated at the same temp and Pressure. In other wards, it may be defined as the ratio of actual specific humidity to the stecific the humidity of gaturated ais at the same dry bulb tent . O Enthally (Total heat) of meigt air : The enthally of maigt air is numerically equal to the enthally of dry ait Plus the, entrally of water vapous associated with dry sit. Let us consider 1 2 7 dry air O The aidabetic saturion Process can be reguled on T-s diagram as shown is the carble 1-2 in the property stands 11 set made with the set of 1 what wated air 1 insaturated air Temp tot the tot all a standing tot and the standing tot faint of unsaturated air at 1. - thomas in the second of the second and the second too all a fille all and a state of the state March reaction Reality has and the

Psydrometsic chart : Million and It is a graphical representation If the various thermodynamic proporties of maist air The \$57 ch cometric chart is very usefull tos finding out the Phoperties of air (which are required in the field of air conditioning) and eleminate but of calculations. There is pright variation in the charty Prepared by different air-conditioning manufactures but basically they are all little. The Psy. chart is normally drawn for standhad atom. Pressure of 760 mine it ty the los 1-01325 bes) had she all good the status action of and acount in the full by 30 35 40 145 25 + pro but tend (°c) mile the free It

(1) Dhy bals tend time : These are welled, it Parallel to the orderable and units may speed of shows in signie i here cally the tend hange of these time o its chest of sheet abic he serve 12) Steakie unnidity & roybus asterd dire 1 These being are polizontal lattadded into the abscitte and the also another preced by shown of these liks of hig warerally reighter a putert ingle As don't if that a is so so so is it is at the bulk vie of (7) Down fait lead ting ! TOTO TO A DE LA PRIME DE The side faily land lad al berigneted so behalled to the response of most and not comparing sheet standard in sig. At any lorit of saturation know the day half and dear sheat we are kend use truck (4) west sale dead lines ? " These forg are victored Charle Stand stanight long and me purisoly spaced of shows at the At the four on the setule carbe () the DAT and wat was estude The values of wet bully tend -> 0 are sorrally given along the patientia cutive clast of them in signie (5) Enthaley (total heat) lives i The enthal (al taked best) lines are inclined manifed ting and withinly should -> 300

Figure. The fing one paralled to the long & while kepp tices, and are dragen upto saturation terrine, solve at the lives saided with the west build beford have also The total indust of statut entrally and given a a scale above the entrepation cuttine and the should in the signer in and and the state (6) slecific volume lines: The stecific velome ling are opliquely inclined Straight lives and whitenily sheed as shear in sig these times are apper dealty is to the saturation curve! The salves of value lines are generally given at the days of the chart of (7) Vislow Pressure lives: The vision of 3 Preserve lives are horizontal and it ? westernly staced benerally, mind it is the valeur Pressure lines are not the BBY scale thracing vapous the stars in more of 11 is siven on the extreme left give of the shart of shows in signing (8) Relative humidity lines: The relative turnidity ling are cutived likes and follow the gataration curve, hererally this lines any drawn with valves 10 %. 20%. 30% ele, tutation and lipto 150 %. The saturation 1 -3. P.BT curve represents 100% selative humidity ! The values of Relative sumidity lines are generally gover along the likes themselves is showed in Kigung 1111 address of the set of the set average of limiter of dealers during and

as in constanty yelon The all considering is that breach of the arguanting which bears with the Hudy of toutikenery a eith i.e. milling and montaining described interard And she considering the halman constants Maessections of external conditions, Th also hands with conditioning is all the transformed moderary seek processing therape of 1000 and atush matalialy I factory estading confact ain conditioning a (1) Tanked abuse of ail ? It may be watch that a burger very seals confidente when the mile is at sie with 58 1. relative lunderly 12) Hundridg of side of the general for summer aix conditioning the notative hursely deals let be lott that coil where the winter all conditionity it thousand be mare they hell (3) fully of ash : too be unjok of a horman body man tilletaken cleaning and tunification of aix is, is attended to very it tree that but and other infunctions by notice of and; the region of establish of air is under inident with that that though be controlled is they to sent constant some receiptions the conditioned these. to suppressing the in all ensitioning typhere : (1) ipulation tan's The mich function of this day is to read with the cash fine the nest 121 her without mit ; 24 & a with which conficts of enders and polomingsging thereases to garmen air condition

and its besting and have been been thought he wanted air

3) supply duct: It directs the conditioned soon the circulating for to the Bace to be air conditioned at perfer point. 14) suffy outlets: This are grilly which distribute the conditioned wit every in the soon. 15 Return outlets: This are the opening in a room subject which allow the book air to enter the return duct. 6) Filters: The main function of the filters is to semere dust, dist and other hostifull bacteria from the ait. Milt O classification of air conditioning systems: 4. Notelet 10 - 10 (1) According to the Parfose: Hahadall ay comfort air conditioning system. 3 Industrial air conditioning system 12) According to season of the sir : 19 Winter air conditioning system. 3) Summer air conditioning Typtem (3) Year-round air conditioning System. 3) Acurding to the assasgement I equipment : (2) Unitary air conditioning system, 5) central air anditioning system O compost air conditioning system: In compart air conditioning the air blought to the required day sull temp and relative bumidity for the burran heller, comfort and efficiency If sufficient data of the required conditional is not and Closerby

given, thent it is assumed to be give day bulls temp and so 1. relative humidity. The sergiple heat tactor is generally welt as following ? For recidance of Printe File F 0.9 for restaurant or budy thice = 0.8.1 Auditorium of cinema ball = 0.7 Ball room dance ball, etc. F. O. 6 The compatt ail conditioning may be adopted to homes, offices, flats, restaurants, theatres heffitals, schooly etc. @ Industrial air conditioning system : It is now risidertant system of air conditionizy this days in which inside day bulls temp and helative humidity of the air is next constant for the proper research and manufacturing processes some of the sophisticated electronic and other mechines need a Perticular day but temp and relative humidity sometimes, these mechanis also require a festicular method of Psychopetric Processes This tyle & his conditioning system is used in tentiles milly pakes milly machine-lasty manufacturing planty, tool rooms, photo-processing planty etc. an ine we will the second of the second of the second will be inde in root of the land of a block of a block of the horizon have

Winter air conditioning system : In match air conditioning the air I heated, which is servicely accompanied by humidification The schemetic answerent of the system is shown in diguse . MARY AND ROAM 1 Martin Cold RECERCULATED ATA HUMIDIFIER N DAMPER, OUTSIDE ATR FAN FILTER L PREHEATER and alast the second from The outside air flows through a damper and nines up with the recirculated air (which is obtained them the conditioned these) The mixed air lasses prough a little to remove diat dugt and other infurities. The day now Passes through a preheat with in order to Present the possible spressing & mater and the control the evaloration of water in the humiditier. Notes that the air is made to pays through a releat cail to bring the air to the designed dry buls tend. Now the conditioned air is sufflich to the conditioned space by a tan. From the conditioned Hace, a last of the used air is exhauted to the extended to the almosphere by the exhaust than or ventilators, The remaining past of the used ais (known ay recipculated air) is gain conditioned of show in Ligure A Charles and a start of the

The detaile air is guered and made to min with residualated and in obdos to make up tos the loss of conditional (or used) is through an haust says of ventilition show the anditioned space O summer air conditioning restand: It is mast important type of air condition - ing in which the air is could and generally dehumiticied. The starbutic carmy amount of a typical submot are contitionery system it shows in sigure. CONDITIONED SPACE RECTRULATED AIR . OUTSIDE AIR AL TLEAN HEANTINK COIL FILTOR L conting cail The netride his dlong through the damper, and nites up with recipculated air (which is obtained

and mitter up with recipculated an control of opening there is highly spice) The mixed six Passes through a stilled to repuised dett, dust and atter inturities a stilled to repuised dett, dust and atter inturities the six is now lesses through a coship will the exil The six is now lesses through a coship will the find his a tomp model below the hequired day but temp his a tomp model below the hequired day but temp his a tomp model below the hequired there the cost of air of the six in the conditioned these. The cost of air passes through a perforted mapshane and hors its passes through a perforted to he air slightly through a heating cail which heads up he air slightly through and relative humidity. Here and relative humidity. New the conditioned air is possiled to the

D'Air Round air conditioning system ? The year round air conditioning system should be equipped for both the future and accentar sig conditioning. The schematic arhangement of a medern summer Jear hound air conditioning system as shown in sigure Recirculated aite anditioned Damper Filter cosling Humidifier outside air - -O central air conditioning system : This, is most infortant type of ais unditioning system, which is adopted when the ording calabity suguescal is 25 Th of more The earthat ais conditioning system is also adopted when the air flow is make that 300 2) with or different zong in a building are to be air . conditioned and I have a lot and and and a state a hard and have been Start Inderstone and a start

O Air cooler and desort cooler: With the beat wavy firscend into your body and temp shorting up above the and with the crossing at morary level, it is time to relate within daily . The body boty sweating discing there to stick to their homes. The some cooler is the minimum requisite needed than a cestry air conditioner . De water circulation along the And by sum and sotation of the blades makes the hout keep a distance away cooler body: The cooler by y made & A.J. Sheety These sheets are galvanized to lovent it drown sust this verify are provided in the cooler deals the cales tol carling purpose. There could are the cosles the cosling busket. Previded in the cales body, These goods are range & back and both rides & the coller. It leight and width is the same of they sight The depth is to that the installed electric maters and blower could be driven easily The covers are squiffed with cooling Tell Ball Pad in 1 An 1012200 caling kit : (nobr & fump) : cooling with a my sisce of two main Pasty motor and Pamp This is the preset of the water. coder motor: An electric motor is a machine which Converty electrical energy but mechanical duesy, Ity action is based on the Prenciple that when a current carrying conductor if placed in a magnetic field it experiences a mechanical force

In desert air cooler labiculaty single place maters are used such maters are residued to derate a single those fully are manufacture in a large number of types to lestalm a wide variety & useful surface in some. It has distributed states winding and severel age moto rator. When send them a single phase suffy ity states winding produces a thir which is my alternating. An alternating of Inlating slive acting on a stationary souther age motor cannot stoduce solstion. That is way it is not Partial : The Rund used in case of Desert air cooler' is centritugal But But in this centrifugal fund there is no suction fife. They sit lifty the water show actor tank to a centrifigal distributer. This has a intelles which when notate a centrifugal force is developed White This couldingual force lift the water spron lower level to central descributes. The film is ditted at the battom of the water - calacity tank. From lame coupling sets are - calacity tank. From and willied to rober. And a second of the second of Antimate Josephine and stands of the second stands at against house and and the set where the state of the set of a magnetic which it that it was a want of the