Design and Develop Of Vapour Absorption Refrigeration System Using R-134a (Refrigerant) and Dimethyl Formamide [DMF] (Absorbent)

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Abstract: *Energy assumes a significant job in our quick moving life and monetary improvement. As of late, with the sharp increment in the vitality cost and the high vitality utilization depleted by refrigeration, the vitality sparing refrigeration framework has gotten extensive consideration. Assimilation refrigeration framework, which can be driven by low-potential warm power, as sun oriented vitality, geothermal vitality and squandered warmth, and so forth., have preferences of sparing in vitality and utilizing condition benevolent refrigerant, for instance water/lithium bromide and alkali/water.*

There are additionally a ton of profound solidifying requests in numerous mechanical procedures, for example, sustenance industry, pharmaceutical industry and compound designing. In the vapor ingestion refrigeration framework, despite the fact that they are generally utilized, smelling salts/water experiences poisonous quality, consumption and amendment necessities. Water/lithium bromide experiences confinement of evaporator temperature, vacuum weight in the parts and plausibility of crystallization. R134a-DMF framework considered alluring as the working-liquid pair for the retention refrigeration framework than other R-134a-permeable mixes.

Keywords: *SHE, COP, DMF, R-134a, Refrigeration.*

I. INTRODUCTION

The interest for cooling and refrigeration is expanding a seemingly endless amount of time after year because of expanding want for solace, need of sustenance stockpiling and restorative applications in hot atmospheres particularly in creating nations like India. The ordinary cooling unit utilized for the above design is an electrically controlled vapor pressure framework, which frequently utilizes Chloro Fluoro Carbons (CFC's) or Hydro Chloro Fluoro Carbons (HCFC's) as refrigerants. The Montreal Protocol denoted a defining moment in refrigeration industry and has an emphasis on worldwide duty to end the utilization of CFC and HCFC refrigerants meant to ensure the earth. One of the choices to conquer these downsides is to utilize vapor assimilation refrigeration frameworks utilizing non CFC/HCFC working liquids. The ordinary vapor pressure refrigeration framework utilized for local and business refrigeration purposes utilizes high-grade electrical vitality for the vapor blower. The assimilation framework is seen to be a feasible option in contrast to the vapor pressure framework which results in ecological issues like an unnatural weather change and ozone layer exhaustion. In the vapor retention framework sun based vitality, motor fumes warmth and waste warmth in enterprises can be utilized as a warming source rather than high-grade electrical vitality.

Ingestion refrigeration framework, which can be driven by low-potential warm power, as sun oriented vitality, geothermal vitality and squandered warmth, and so on., have points of interest of sparing in vitality and utilizing condition inviting refrigerant, for instance water/lithium bromide and smelling salts/water. There are additionally a ton of profound solidifying requests (lower than - 40°C) in numerous modern procedures, for example, nourishment industry, pharmaceutical industry and substance building, and so on [1]. In any case, with the conventional cycle is hard to accomplish refrigeration temperature beneath - 20°C. The water/lithium bromide arrangement can be utilized for cooling yet not for cooling and refrigeration as a result of the restriction for the evaporator temperature (>0 °C) and such a framework must work under the vacuum condition. The alkali/water blend can be utilized for cooling and refrigeration (< 0°C) yet by and large for the temperatures surpassing - 20°C. The framework is under high weight for activity and requires high-temperature heat sources. Smelling salts has worthy thermo-physical properties, however it is a lethal, firmly aggravation, combustible refrigerant, and is ruinously destructive to copper. A far reaching survey of the writing on vapor ingestion frameworks, pressure retention framework and vapor pressure framework has been done on different parts of vitality investigation, the sort of cycles examined, working sets utilized and vitality examination. Concerning vapor retention cycles, it is discovered that for the most part the examinations are done on expansive limit frameworks and the examination had been completed with in a constrained scope of framework plan parameters. The writing on little vapor retention frameworks is sparse and not many investigations have been done on littler frameworks. The above investigations are reproduction ponders. Concerning retention frameworks ponders have been done by numerous analysts for the most part systematically and tentatively. The examinations have been done on wet pressure cycles which disposed of the need of arrangement siphon. The writing gives subtleties respect to the utilizations of this cycle. Anyway the writing on vitality examination of such frameworks is insufficient. In CA frameworks, refrigerant – spongy blends are utilized as working liquids which give temperature angle profiles in the safeguard framework.

II. PROBLEM DEFINED

Re-established enthusiasm for vapor retention refrigeration frameworks (VARS) has expanded because of their potential for usage of waste warmth, sun oriented vitality, and so on. To improve the coefficient of execution (COP) of these frameworks, it is important to think about warmth and mass move forms in ingestion framework parts. Another mix of 1,1,1,2 Tetrafluoroethane (R134a)- Dimethyl formamide (DMF) is utilized as working liquid to beat the constraints of surely understood working sets, smelling salts water and lithium bromide-water.

Significance of vapor assimilation refrigeration framework (VARS) can't be overestimated these days when the world is confronting vitality related issue. Contribution to VARS is dominatingly heat vitality which might be accessible in plenitude by and large as waste warmth from industry or sun oriented warmth. Because of shortage and expanded expense of power VARS is step by step picking up significance. The most regularly utilized refrigerant– spongy sets are ammonia– water and water– lithium bromide. Consideration was attracted to new refrigerants so as to defeat the impediments of these ordinary working liquid sets.

1. Low COP

2. Extensive Size and immense weight

3. Mind-boggling expense

2.1 Necessity of VARs

Vapor pressure refrigeration units require a high evaluation vitality contribution to the type of work by methods for electrically determined blower. This prompts higher power requests from power stations which thusly lead to more CO2 discharges. Retention frameworks utilize a poor quality type of vitality so as to give a cooling impact. This implies the wellspring of info vitality need not really originate from electric power but instead from some other warmth source which is at an adequately high temperature. Aside from being invaluable from this point of view of vitality use, such frameworks additionally give different favorable over vapor pressure refrigeration units utilizing blowers.

In the vapor pressure cycle the limit control of the framework is done from the blower and in the majority of the cases stepwise limit control is gotten. In the event of the retention refrigeration framework it is conceivable to get steeples limit control and zero limit when there is no heap on the framework. In the vapor pressure refrigeration framework the pressure of the refrigerant is finished by blower which can be of reacting to, pivoting or radial sort. In the vapor assimilation refrigeration framework, the pressure of the refrigerant is finished by ingestion of the refrigerant by the retentive. As the refrigerant is consumed, it gets changed over from the vapor state to fluid state so its volume lessens.

2.3 Objective of VARs

Design and develop VARS of 1 kw capacity.

Select appropriate mixture (Refrigerant & absorbent)

To study effect generator temperature on performance of the system(COP)

Study effect of generator temperature on circulation ratio.

Use low grade energy.

Less Power Consumption Device

2.4 Methodology:

1. Review of all the vapor absorption refrigerant system using various refrigerants and its related material.

2. Select appropriate refrigerants for VARS.

3. Make a suitable module for the taking readings.

4. Prepare experimental set up and perform test on it.

5. Compare the result with standards

III. EXPERIMENTAL SETUP AND VARIOUS COMPONENTS OF SYSTEM

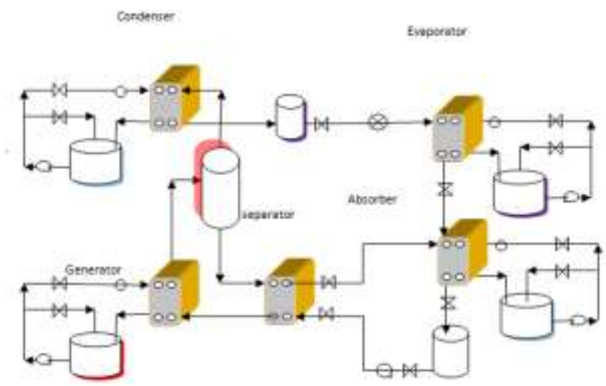

Fig.1 Vapour absorption refrigeration system

In that system the pump drawn out a strong solution from the receiver tank and send it to solution heat exchanger .The solution heat exchanger is provided to increase the temperature of the solution .Then again it passed to generator, where its heated at specific temperature with the help of hot water tank connected to it .These increased temperature solution get come into separator, which separate the vapour at top portion and liquid at bottom portion .The reaming liquid in that separator use as a strong solution and send it back to solution heat exchanger.

The high temperature vapour send to the condenser to convert it into liquid and reduce its temperature by the help of cold water tank provided to it. In between condenser and evaporator dryer was provided to achieve pure and clean vapour enter into evaporator .Chilled water tank connected to the evaporator to achieve maximum cooling effect and increase COP of the system.

The separator is used to separate the vapour and liquid. Performance of absorption refrigeration systems is critically dependent on the chemical and thermodynamic properties of the working fluid. A fundamental requirement of absorbent/refrigerant combination is that, in liquid phase, they must have a margin of miscibility within the operating temperature range of the cycle. The Mixture should also be chemically stable, non-toxic, and non-explosive. In addition to these requirements, the following are desirable.

There are five plate heat exchanger used as:

1. Absorber: Ingestion of refrigerant vapor by an appropriate retentive or adsorbent, framing a solid or rich arrangement of the refrigerant in the permeable/adsorbent.

So as to continue dissipating, the refrigerant vapor must be released from the evaporator and refrigerant (water) must be provided. The refrigerant vapor is assimilated into lithium bromide arrangement, which is advantageous to retain the refrigerant vapor in the safeguard. The warmth produced in the assimilation procedure is ceaselessly expelled from the framework by cooling water. The ingestion likewise keeps up the vacuum inside the evaporator

Sr.no	For 14-16/20 Plate Parameter	Values
1]	Design Pressure	3 MPA
2]	Test Pressure	4.5 MPA
3]	Design Temperature	-196 to +225 oc

2. Heat exchanger: A plate heat exchanger is a sort of warmth exchanger that utilizes metal plates to exchange heat between two liquids. This has a noteworthy favorable position over an ordinary warmth exchanger in that the liquids are presented to an a lot bigger surface territory in light of the fact that the liquids are spread out over the plates. This encourages the exchange of warmth, and incredibly builds the speed of the temperature change. Plate heat exchangers are presently normal and little brazed renditions are utilized in the high temp water areas of a huge number of blend boilers. The high warmth exchange proficiency for such a little physical size has expanded the

residential heated water (DHW) stream rate of mix boilers. The little plate heat exchanger has had an extraordinary effect in household warming and high temp water. Bigger business renditions use gaskets between the plates, though littler adaptations will in general be brazed.

3. Generator: Distillation of the vapour from the rich solution leaving the poor solution for Recycling.

4. Condenser: In frameworks including heat exchange, a condenser is a gadget or unit used to consolidate a substance from its vaporous to its fluid state, by cooling it. In this manner, the inactive warmth is surrendered by the substance and exchanged to the encompassing condition. Condensers can be made by various structures, and come in numerous sizes extending from rather little (hand-held) to extremely huge (mechanical scale units utilized in plant forms). For instance, a fridge utilizes a condenser to dispose of warmth extricated from the inside of the unit to the outside air. Condensers are utilized in cooling, mechanical compound procedures, for example, refining, steam control plants and other warmth trade frameworks. Utilization of cooling water or encompassing air as the coolant is basic in numerous condensers.

5. Evaporator: Evaporator is a significant segment together with other real parts in a refrigeration framework, for example, blower, condenser and extension gadget. The explanation behind refrigeration is to expel heat from air, water or other substance. It is here that the fluid refrigerant is extended and dissipated. It goes about as a warmth exchanger that exchanges heat from the substance being cooled to a bubbling temperature. Evaporator of the warmth exchanger.

which assimilates heat in a cooling framework. Evaporator gets cool, low-weight fluid refrigerant from the gadget fluid refrigerant vapor transforms into roughly a similar temperature as the fluid. Warmth substances being cooled expelled as the substance contacts evaporator. The substance might be air, water, other fluid or a strong. In this way, the temperature of the substance is diminished to the required dimension.

Specification of Brazed plate heat exchanger

Sr.no	For 14-16/20 Plate Parameter	Values
1]	Design Pressure	3 MPA
2]	Test Pressure	4.5 MPA
3]	Design Temperature	-196 to +225 $^{o}{}_{c}$

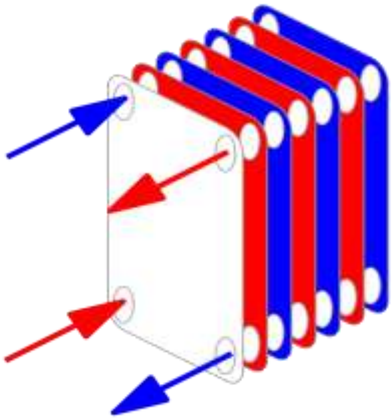

Fig.2 Plate heat exchanger

IV. DESIGNS OF VARS

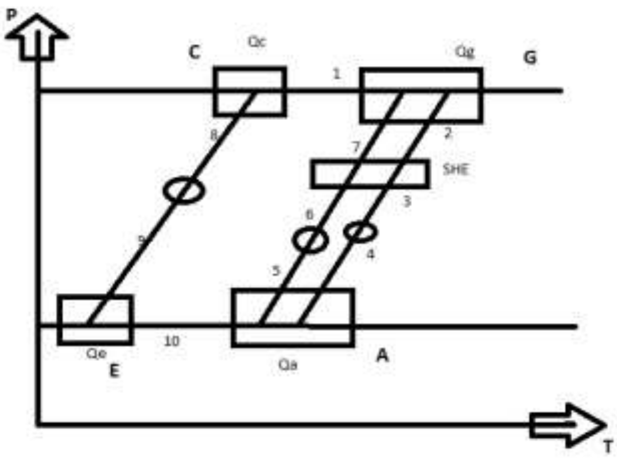

Fig.3 P-T VARS

1] Absorber:

Mass balance $m10 + m4 = m5$

Energy balance   m4h4 + m10h10 =m5h5 +QA

qA =   = h10+ (f-1)h4 – fh5

f = Circulation ratio

2] Pump:

Wp = 5 (P6 –P5)

Wp = (h6 –h5)

Total Wp =ms (h6 –h5)

3] Expansion valve -I:

Mass balance m3 =m4

Energy balance h3 = h4

4] Solution heat exchanger :

Mass balance   m8 = m6 =m7 & m2 =m3 =m4

Energy balance m6 (h7 –h6) =m2 (h2 –h3)

5] Generator:

Mass balance m7 = m1 + m2

Energy balance m1h1+m2h2=m7h7+Qg

6] Condenser :

Mass balance m1=m8

Energy balance Qc = m1(h1 –h8)

7] Expansion valve -II:

Mass balance m8=m9

Energy balance h8=h9

8] Evaporator :

Mass balance   m9=m10

Energy balance   QE=m9(h10-h9)

V. RESULT AND DISCUSSION

In that system we focus on the mixing of the two refrigerants, in which one is liquid (DMF) and other is vapour(R-134a).

The purpose of the mixing of two refrigerants is to increase the overall COP and reuse the cycle. The whole process first carried out on the CFD ANSYS software, after those results we carry forward the process.

Pipe Material	Copper	
R134-a Flow rate	7	LPH
DMF Liquid Flow rate	50	LPH
Inlet Temperature	263.15	K
Inlet Pressure	2	bar
Ambient Temperature	298.15	K
	R134-a	DMF Liquid
Density	10.04	1026.8
Viscosity	5.98E-06	0.000473
SpecificHeat	853.1	2321
Thermal Conductivity	0.01112	0.138
Molecular Weight	102.03	73.09
Standard State Enthalpy	206	241
Reference Temperature	298.15	374
Operating Pressure	2	Bar
Saturation Temperature	274	K

m (kg/s)	Inlet Area (m2)	V (m/s)	Dh	Re
0.00196	7.85E-05	2.49	0.01	4.17E+04
0.014	7.92E-05	0.1722	0.01	3752.559

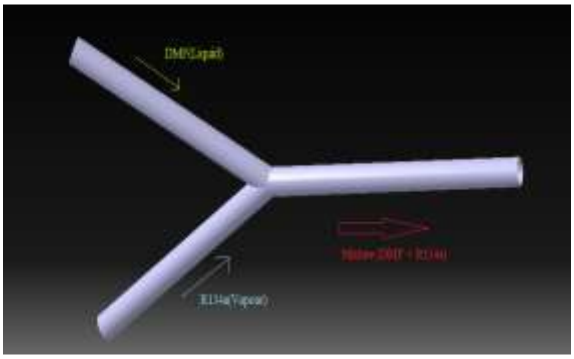

Fig.4 Mixing of two refrigerants

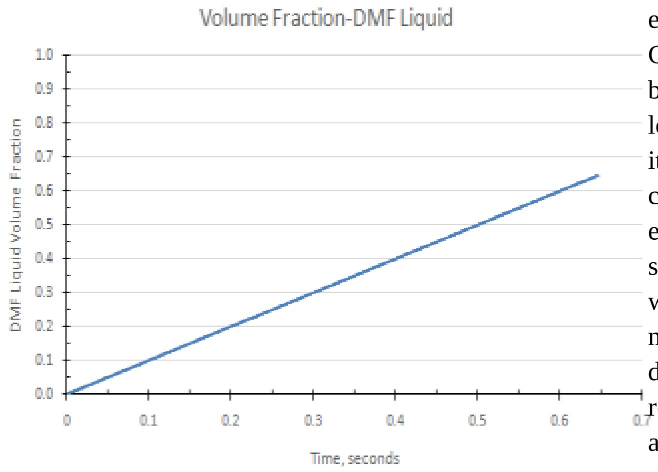

Fig.5 Graph 1

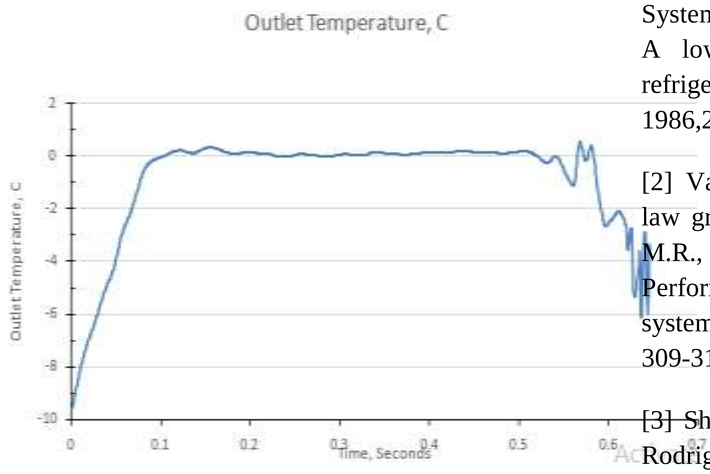

Fig.6 Graph 2

VI.CONCLUSION

The thermodynamic examination of the assimilation refrigeration cycle encourages us to assess the presentation of the refrigeration framework. The relative investigation of cycle exhibitions for different blends demonstrates that the general coefficient of execution of R134a+DMF blend is the most elevated and its dissemination proportion f diminishes with an in- wrinkle in the producing and vanishing temperatures and with a reduction of the engrossing and gathering temperatures. The blend R134a+DMF presents fascinating thermodynamic properties for its application in retention frameworks at moderate gathering and engrossing temperatures (298K-308K).These exhibitions are profoundly valuable for medicinal and nourishment item preserva-tion and for cooling. Hence, the R134a+DMF blend can be considered as a decent competitor working pair for application to sunlight based refrigeration systems.The above examinations are recreation contemplates. Concerning assimilation frameworks ponders have been done by numerous analysts for the most part logically and tentatively. In vapor ingestion cycles, it is discovered that generally the examinations are completed on enormous limit frameworks and the examination had been done with in a constrained scope of framework structure parameters. The writing on little vapor retention frameworks is meager and not very many investigations have been done on littler frameworks. Best blend of the two refrigerants gives the most extreme COP and ideal arrangement on the present issues.

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