“EXPERIMENTAL SETUP OF VAPOR ABSORPTION REFRIGERATION SYSTEM BY USING NH3-H2O REFRIGERANT WITH VARIOUS PROPORTION”

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ABSTRACT

This paper focuses on the construction of ammonia fluid absorption refrigeration unit, intended to operate in an atmospheric environment. Vapor absorption systems, unlike vapor-compression systems, use a heat source to facilitate refrigeration. Ammonia fluid absorption refrigerators use electric based heater installed generator and no moving parts, such as pumps and compressors, and operate at a single system pressure. In this paper we have compared the performance of VARS that are used for refrigeration temperatures are below atmospheric temperature. Since the most common vapor absorption refrigeration systems (VARS) works on NH3-H2O solution with H2O as the absorbent and NH3 as the refrigerant, research has been devoted for the betterment of the performance of NH3-H2O absorption refrigeration systems in recent years. The highest COP was found as a function of the absorber, generator, condenser, and evaporating temperature. The objective of our paper is to present empirical relations for evaluating of the performance of a single stage vapor absorption system and to check the performance of system with respect to proportion.

Keyword: - *VARS, Ammonia-Water, Refrigeration, COP, Pump, Condenser, Evaporator etc….*

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1. INTRODUCTION

Refrigeration is a process to keep a cool element or to reduce the temperature of one element below that of the other. Almost everyone has a household refrigerator, but not many know of the process required to produce the drop in temperature that we know as refrigeration. Nature works much like a heat engine, heat flows from high-temperature elements to low-temperature elements. As it does this, work is also done to its environment. The refrigeration process is, in essence then, a reverse heat engine, where heat is taken from a cold element to be transferred to a warmer element. In recent developments of thermal engineering, the Refrigeration technologies play an important role in today's industrial applications. But as far as COP of this refrigeration system is concerned; it is always a challenge to the researchers to significantly increase the COP for these systems. The most popular refrigeration and air conditioning systems at present are those based on the vapor absorption systems. These systems are popular because they are reliable, relatively inexpensive and their technology is well established. Most of industrial process uses lots of thermal energy by burning fossil fuel to produce steam or heat for the purpose. After the process, heat is rejected to the surrounding as a waste. This exhaust waste heat can be used as refrigeration by using a heat based refrigeration system, like a vapor absorption refrigeration cycle. Despite a lower coefficient of performance (COP) as compared to the vapor compression cycle, absorption refrigeration systems are promising for using inexpensive waste energy from industrial processes, geothermal energy, solar energy etc.

1.1 CYCLE DISCRIPTION

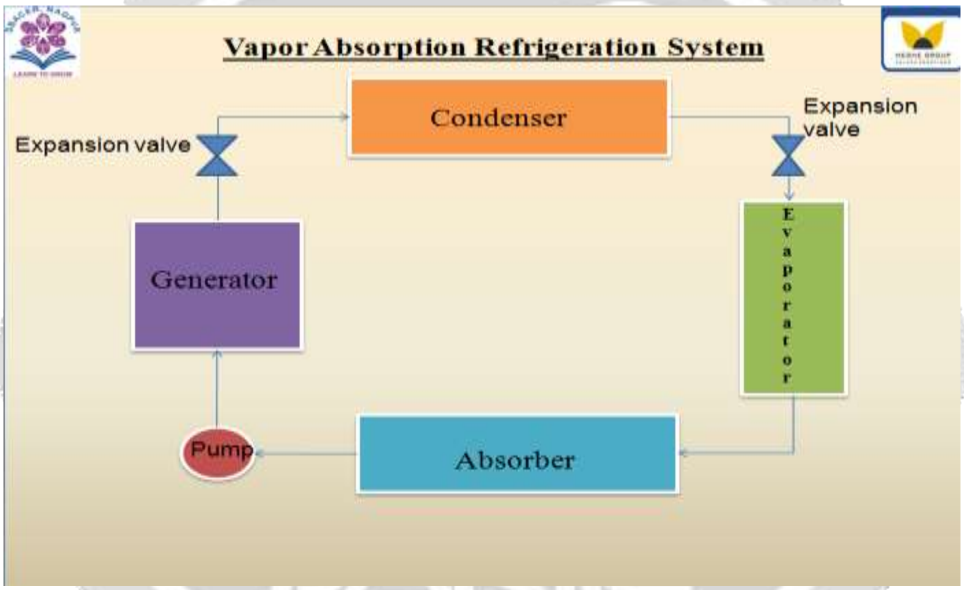

Fig-1: VARS CYCLE

1.1 CONDENSER

Just like in the traditional condenser of the vapor compression cycle, the refrigerant enters the condenser at high pressure and temperature and gets condensed. The condenser is of water cooled type.

1.2 EXPANSION VALVE

When the refrigerant passes through the expansion valve, its pressure and temperature reduces suddenly. This refrigerant (ammonia in this case) then enters the evaporator.

1.3 EVPORATOR

The refrigerant at very low pressure and temperature enters the evaporator and produces the cooling effect. In the vapor compression cycle this refrigerant is sucked by the compressor, but in the vapor absorption cycle, this refrigerant flows to the absorber that acts as the suction part of the refrigeration cycle.

1.4 ABSORBER

The absorber is a sort of vessel consisting of water that acts as the absorbent, and the previous absorbed refrigerant. Thus the absorber consists of the weak solution of the refrigerant (ammonia in this case) and absorbent (water in this case). When ammonia from the evaporator enters the absorber, it is absorbed by the absorbent due to which the pressure inside the absorber reduces further leading to more flow of the refrigerant from the evaporator to the absorber. At high temperature water absorbs lesser ammonia, hence it is cooled by the external coolant to increase it ammonia absorption capacity. This part of the article describes how the absorption refrigeration system. The absorption refrigeration system comprises of condenser, expansion valve, evaporator, absorber, pump and generator. The refrigerant leaving the evaporator enter the absorber, where it is absorbed by the absorbent. The strong solution of refrigerant-absorber enters the generator with the help of the pump. The initial flow of the refrigerant from the evaporator to the absorber occurs because the vapor pressure of the refrigerant-absorbent in the absorber is lower than the vapour pressure of the refrigerant in the evaporator. The vapor pressure of the refrigerant-absorbent inside the absorbent determines the pressure on low-pressure side of the system and also the vaporizing temperature of the refrigerant inside the evaporator. The vapor pressure of the refrigerant-absorbent solution depends on the nature of the absorbent, its temperature and concentration. When the refrigerant entering in the absorber is absorbed by the absorbent its volume decreases, thus the compression of the refrigerant occurs.

1.5 PUMP

When the absorbent absorbs the refrigerant strong solution of refrigerant-absorbent (ammonia-water) is formed. This solution is pumped by the pump at high pressure to the generator. Thus pump increases the pressure of the solution to about 10bar.

1.6 GENERATOR

The refrigerant-ammonia solution in the generator is heated by the external source of heat. This is can be steam, hot water or any other suitable source. Due to heating the temperature of the solution increases. The refrigerant in the solution gets vaporized and it leaves the solution at high pressure. The high pressure and the high temperature refrigerant then enters the condenser, where it is cooled by the coolant, and it then enters the expansion valve and then finally into the evaporator where it produces the cooling effect. This refrigerant is then again absorbed by the weak solution in the absorber. When the vaporized refrigerant leaves the generator weak solution is left in it. This solution enters the pressure reducing valve and then back to the absorber, where it is ready to absorb fresh refrigerant. In this way, the refrigerant keeps on repeating the cycle.

The pressure of the refrigerant is increased in the generator, hence it is considered to be equivalent to the compression part of the compressor.

2. GRAPHICAL REPRESENTATION

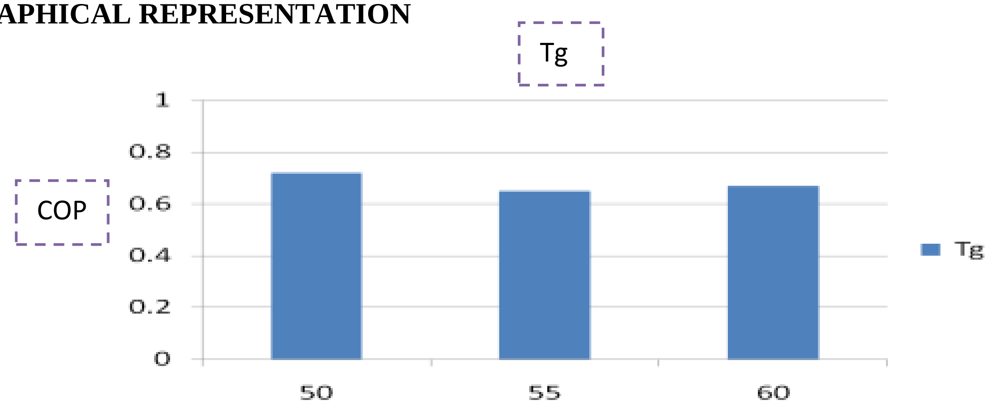

Chart -1: COP vs. Tg (Temp of Generator)

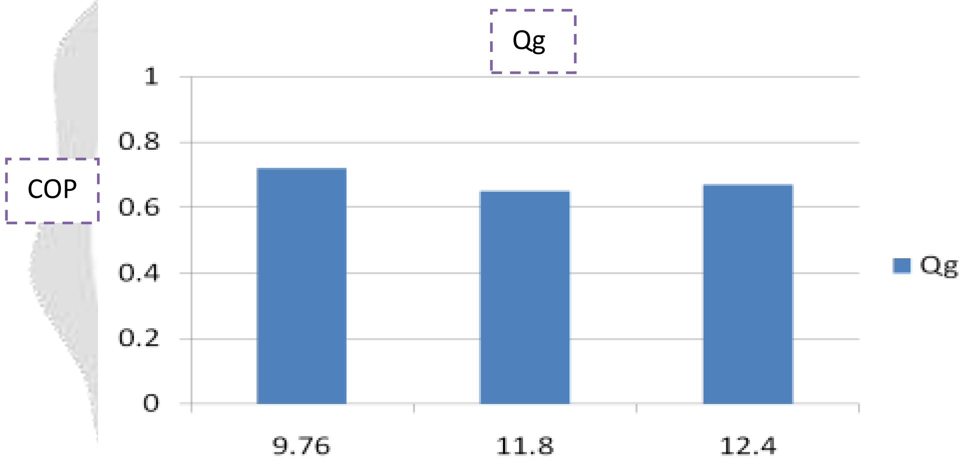

Chart-2: COP vs. Qg (Heat of Generator)

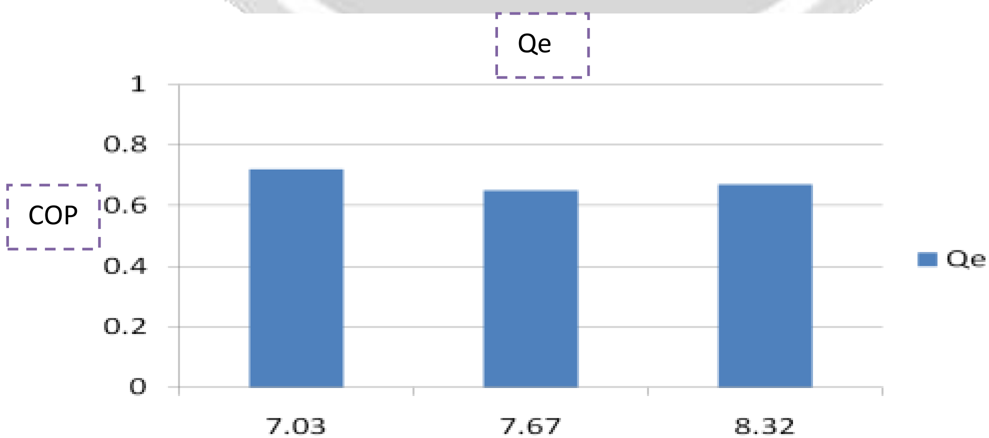

Chart-3: COP vs. Qe (Heat of Evaporator)

Fig -2: Experimental setup of VARS

3. 3D MODEL IN CATIA

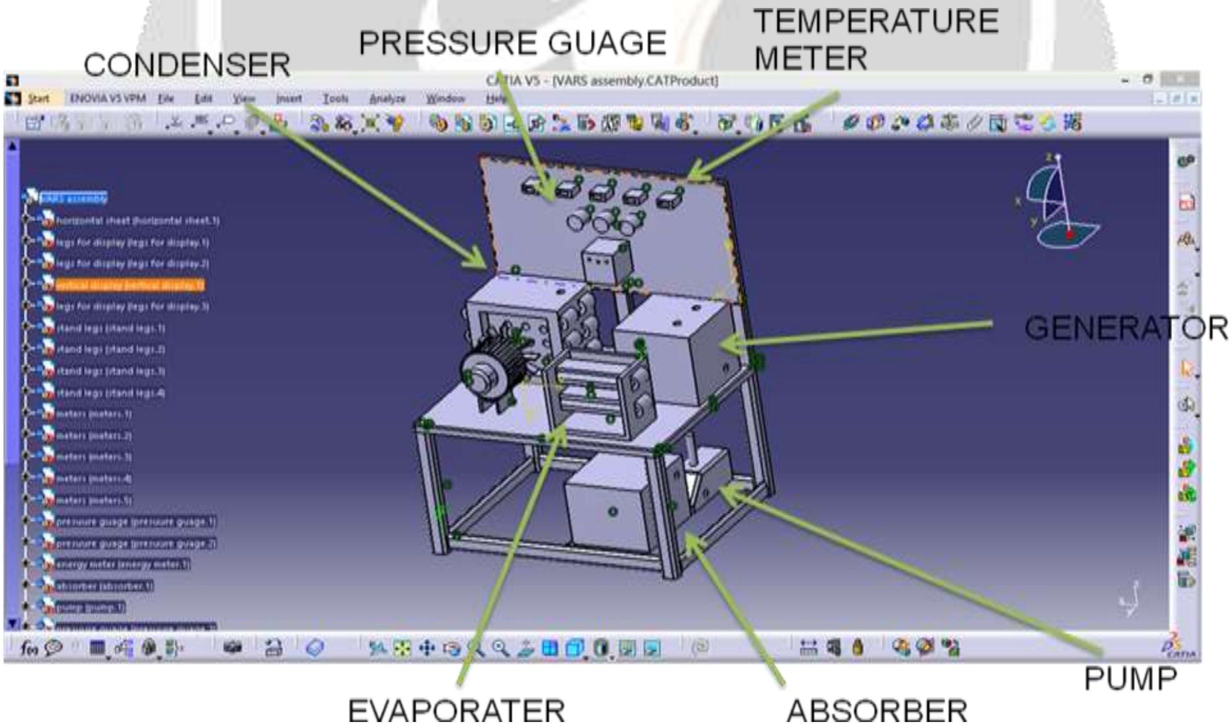

Fig-3: Catia Model of VARS

4. TABLE

Sr No.	Mixture	Volume (lit)	Tg (C)	Te (C)	Pressure (kpa)	Qg (kW)	Qe (kW)	Time (min)	COP
1	NH_3 15% & H_2O 85%	6	50	28	85	9.76	7.03	63	0.72
2	NH_3 20% & H_2O 85%	6	55	27	89	11.8	7.67	66	0.65
3	NH_3 25% & H_2O 75%	6	60	24	97	12.4	8.32	72	0.67

5. CALCULATION

The amount of cooling capacity required for charge air cooling is very much dependent on the temperature reduction of the charge air due to cooling incorporated in the system.

Therefore, the energy transfer from the charge air is:
The heat from the generator and evaporator which can be transferred to the water and the heat gain by water can be Estimated from the following

$Qg= mCv \Delta T$

Where Qg is the generator heat (kW), is Water mass flow rate and Cp: specific heat at constant pressure. To find the Coefficient performance of the absorption cycle

$COP= Qe/Qg$

$Qm= (Q1-Q2)/\ln(Q1/Q2)$

$U =1000 W/m^2$

$Qe= FUAQm$

Area of evaporator = $n*\pi*d*L$

6. CONCLUSIONS

The performance of NH_3-H_2O as working fluids for refrigeration temperature is performed, with various proportions of ammonia and water. The preferable working fluid can be considered as a solution with the highest COP, lower required generator temperature as low as possible. It is evident that COP strongly depends on working conditions such as generator, absorber, condenser and evaporating temperature. We observed, the range of C.O.P for the aqueous ammonia system is (0.5 - 0.8) when the generator temperature is up to 60°C.The range of minimum evaporator temperature is (25°C - 30°C).

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