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Development of Refrigeration System (Water-Lithium Bromide) Working on Solar Energy

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Abstract: Due to rapid depletion of fossil fuels and increasing demand day by day, the fuel prices are increasing rapidly. Environmental issues are also related with these fossil fuels. 70% to 75% house hold electricity is consumed by air conditioning system. Major part of electricity generated is contributed by thermal power plants. To address all these issues, vapour absorption refrigeration system comes in existence and has a good potential to reduce all above concerns. VARS uses low grade energy which can be obtained by sun or any exhaust energy which is going to be waste. The main objective of this work is to minimize the electricity consumption and protect environment. In thisPaper , development of vapour absorption system is presented. It is a two fluid system comprising of water& Lithium Bromide. Instead of a compressor it uses solar energy to run a generator, as opposed to a standard refrigerator. A low grade heat source heats up the absorber-absorbent pair releasing the refrigerant in vapour form. This vapour is air cooled to liquid state at the condenser. Finally hydrogen reduces the vapour pressure of the ammonia liquid entering the evaporator causing the liquid to boil absorbing heat from the cabin and in turn cooling it. The running cost will be negligible and it is eco-friendly also. Design and fabrication of Lithium bromide-water vapour absorption system of 0.5TR is presented. Solar energy will be supplied to system through Solar panel. Other major components of this system are generator, Absorber, Condenser, evaporator and pump. Such system may be used for food preservation and air-conditioning of offices, Schools, where people are in the day only.

Keywords: Solar energy, LiBr-H_2O, VARS, Eco-friendly, Low running Cost.

I. INTRODUCTION

Refrigeration may be defined as the process of achieving and maintaining a temperature below that of the surroundings, the aim being to cool some product or space to the required temperature. One of the most important applications of refrigeration has been the preservation of perishable food products by storing them at low temperatures. Refrigeration systems are also used extensively for providing thermal comfort to human beings by means of air conditioning. The prices of energy have been increasing exponentially worldwide. Industrial Refrigeration is one of the most energy consuming sector. What if a refrigeration system is designed which uses no energy or minimal amount of energy? The solution lies in absorption refrigeration system. By producing an adsorption refrigeration system we are not only cutting down the energy costs but also preserving our environment. This refrigeration system doesn't use any of the CFCs so our ozone layer is safe.

Vapour absorption refrigeration systems utilizing water – LiBr pair are broadly utilized as a part of substantial limit aerating and cooling systems. In this systems water is utilized as refrigerant and a mixture of LiBr in water is utilized as absorbent. Since water is utilized as refrigerant so utilizing these systems it is impractical to give refrigeration at below zero temperatures. Subsequently it is utilized just as a part of applications obliging refrigeration at temperatures over 0^0 C. Hence these systems are utilized for aerating and cooling applications. The investigation of these systems is moderately simple as the vapour produced in the generator is very nearly immaculate refrigerant (water), dissimilar ammonia water systems where both smelling salts and water vapour are created in the generator. In Vapour absorption refrigeration system we have developed our generator which consist of a cylindrical vessel and borocill tubes.

These tubes are used for heating the solution present in the generator. Li-Br solution present in the generator is used as absorbent.it consist of five outlets as shown below. We have developed our absorber and evaporator combined in single vessel .The upper part of the vessel contain the evaporator which have coils which are used for cooling the hot water. The lower part of the container contain the absorber in which lithium bromide and water weak solution is present which is pumped to the generator. In Evaporator the cooling is produced by the endothermic reaction of li-Br with water. The weak solution pumped into generator develops the water Vapour in the generator. This Vapour is sent to the condenser. The strong solution

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present after the vaporization is again sent into the absorber. The Vapour condensed into water and it then produce cooling in the evaporator .

II. METHODOLOGY

To develop a single stage vapour absorption refrigeration system based on H20-LiBr has a refrigeration capacity of 175 (0.05) watts. The system operates at an evaporator temperature of 5 degree centigrade (Psat =8.72mbar) and a condensing temperature of 30 degree centigrade (Psat=32.3 mbar). Assume 100 percent effectiveness for the solution pump, exit condition of refrigerant at evaporator and condenser to be saturated and the condition of the solution at the exit of absorber and generator to be at equilibrium. Enthalpy of strong solution at the inlet to the absorber may be obtained from the equilibrium solution data.

The assumptions are:
1. Generator and condenser as well as evaporator and absorber are under same pressure.
2. Refrigerant vapour leaving the evaporator is saturated pure water.
3. Liquid refrigerant leaving the condenser is saturated. Refrigerant vapour leaving the generator has the equilibrium temperatures of the weak solution at generator pressure.
4. Weak solution leaving the absorber is saturated.
5. No liquid carryover from evaporator.
6. Pump is isentropic.
7. No jacket heat loss.

Vapour Absorption Refrigeration System

When a solute such as lithium bromide salt is dissolved in a solvent such as water, the boiling point of the solvent (water) is elevated. On the other hand, if the temperature of the solution (solvent + solute) is held constant, then the effect of dissolving the solute is to reduce the vapour pressure of the solvent below that of the saturation pressure of pure solvent at that temperature. If the solute itself has some vapour pressure (i.e., volatile solute) then the total pressure exerted over the solution is the sum total of the partial pressures of solute and solvent. If the solute is non-volatile (e.g. lithium bromide salt) or if the boiling point difference between the solution and solvent is large ($\geq 300^oC$), then the total pressure exerted over the solution will be almost equal to the vapour pressure of the solvent only. In the simplest absorption refrigeration system, refrigeration is obtained by connecting two vessels, with one vessel containing pure solvent and the other containing a solution. Since the pressure is almost equal in both the vessels at equilibrium, the temperature of the solution will be higher than that of the pure solvent. This means that if the solution is at ambient temperature, then the pure solvent will be at a temperature lower than the ambient. Hence refrigeration effect is produced at the vessel containing pure solvent due to this temperature difference. The solvent evaporates due to heat transfer from the surroundings, flows to the vessel containing solution and is absorbed by the solution. This process is continued as long as the composition and temperature of the solution are maintained and liquid solvent is available in the container.

For example, Fig.1 shows an arrangement, which consists of two vessels A and B connected to each other through a connecting pipe and a valve. Vessel A is filled with pure water, while vessel B is filled with a solution containing on mass basis 50 percent of water and 50 percent lithium bromide (LiBr salt). Initially the valve connecting these two vessels is closed, and both vessels are at thermal equilibrium with the surroundings, which is at 30^oC.

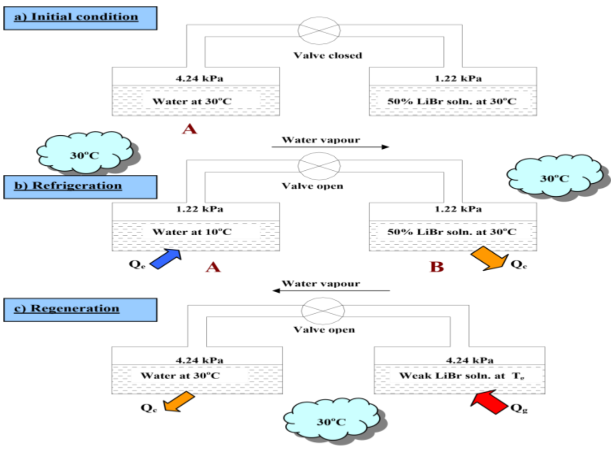

Fig.1: Basic principle of vapour absorption systems [ref.19]

III.COMPONENT OF SYSTEM

Thereare all parts of the system is described with their fabrication process along with specification-

1. Generator

The desorption process generates vapour and extracts the refrigerant from the working fluid by the addition of the external heat from the heat source; i.e. desorption of water out of a lithium bromide-water solution. The refrigerant vapour travels to the condenser while the liquid absorbent is gravitationally settled at the bottom of the generator; the pressure difference between the generator and the absorber then causes it to flow out to the absorber through an expansion valve. Fig.2 shows generator consists basically two parts-

1.1. Generator Vessel- Generator vessel consists Lithium Bromide and water solution. Generator Vessel used for heating strong solution. It also consists 5 reducer valve for different different purpose. The diameter of vessel is 0.44 m and height is 0.35 m respectively. It is puff insulated due to which heat losses is less.

1.2.Borocill Tube- Borocill tubes are used for heating the weak solution in the generator vessel. In this system 3 tubs

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are used. The internal diameter is 48 mm, external diameter is 54 mm and the length of tube is 5 feet. It is placed at 45^0 with the help of stand. The capacity of one tube is 2.8 litre.

Fig.2 complete set of generator

2. Condenser

Condenser is used to condense the water vapour in the liquid form which uses for refrigeration .it consists of copper coil of diameter 10 mm in the condenser copper tube is used in coil form which increases the contact area in the cooling water. So heat loss from vapour is more which is desirable. The length of tube is 15feet. At the outlet of copper coil capillary takes place. Which decreases the temperature and pressure of the condensate. Fig.3 shows the condenser.

Fig.3condenser

3. Evaporator and Absorber

Evaporator is most important part of the system which gives the cooling .it consists copper coil of internal diameter is 0.7 mm and length is 5 feet. The evaporator is made tray like structure. It contains condensate which will go in absorber by absorption process. Absorber is the vessel in which strong solution came from generator and it absorbs water from evaporator. The absorber tank is 300 mm in diameter and 400 mm in height. It is made up of mild steel sheet.

Fig.4 Evaporator and Absorber Tank

The complete setup of our working model is shown in Fig.5

Fig.5 Complete setup of the system

IV.RESULT & DISCUSSION

We have performed some experiments whose readings are listed in table (1&2). These results are taken at different time intervals & at different time reading of absorber and generator temperature are mentioned here.

Table 1: Variance of Generator Fluid Temperature with Local Time

S. NO	LOCAL TIME	AMBIENT Temp. (^{0}C)	GENERATOR Temp. (^{0}C)
1	09:00	30	34
2	10:00	33	36

3	11:00	35	42
4	12:00	37	50
5	13:00	39	62
6	14:00	42	70
7	15:00	42	76
8	16:00	40	74
9	17:00	39	69

Table 2: Temperature of Various part which is taken for calculation-

COMPONENTS	TEMPRATURE (^{0}C) AT 15:00
1.GENERATOR (Tg)	76
2.CONDENSOR AND ABSORBER (To)	58
3.EVAPORATOR (T_e)	26

Where T_g= Generator Temp, T_o= Condensor Temperature, T_o = Evaporator Temp

Coefficient of Performance

COP = { $T_e(T_g - T_o) / T_g(T_o - T_o)$}

=0.4819

The Cop of the system is less due to use of low grade energy (Solar heat).

V. CONCLUSION & FUTURE SCOPE

A working model of Vapour absorption refrigeration system has use on solar energy as heat source, lithium bromide water solution is used, Borocill Tube supply solar energy to solution as a generator part. This system producing refrigeration effect but not as per desired expectations. This system may become more efficient by proper sealing and proper refrigerant usage which can vaporise at lower temperature at atmospheric condition will improve the whole system.

In future one may improve this system by proper selection and use of suitable refrigerant. Capacity of the plant may also increase by using heat exchanger. A more effective solar tube or solar system can be developed to increase the heat transfer from solar energy to refrigerant.

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