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Solar Powered Vapor Absorption Refrigeration System Using Adsorbate and Adsorbent Working Pairs

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ABSTRACT:
This paper gives the review of solar powered vapor absorption Refrigeration System Using Absorbate and Adsorbent Working Pairs, In the review we firstly deal with review of solar ammonia Absorption Refrigerator (SAAR), secondly we deal with Solar Technology and Energy for Vital Economic Needs (S.T.E.V.E.N), thirdly we deal with The Use of Direct Solar Energy in Absorption Refrigerator, fourthly we deal with Review of Solar Absorption Refrigeration System Using Li-Br and Water, in fifth section of literature review we deal with Low Cost Solar Cooling System and finally the conclusion.

Keywords: Solar, Refrigerator, low cost cooling, analyzer, pump, Heat Exchanger.

I. INTRODUCTION

Solar energy is the widely used source of energy as it is a non conventional source of energy; we can use solar energy for heating water, cooking food, charging batteries etc. Here solar energy is used for getting refrigeration effect. Temperature is decreased using solar energy and this drop in temperature is used for making ice and if the temperature drop is less this can be used for food preservation etc.

II. LITERATURE REVIEW

A. Solar Ammonia Absorption Refrigerator (SAAR)

Due to temperature spoilage nearly half dozen of vaccine go waste, especially in remote region where transportation problem and electricity problem is more. To solve this problem SAAR student developed solar based absorption system which is based solar energy. They designed system in such a way that system must give temperature range of 2 to 8℃ for medicine and vaccine. SAAR designed system which does not consist any moving parts and which is easy to reconstruct and operate and no maintenance required for years.

Design concept of Solar Ammonia Absorption Refrigerator

SAAR provides refrigeration using solar energy and other heat sources having low grade like gas heaters and camp fire. This system operates in climate up to temperature of 35-50℃ which will operate at pressure of 10.5 bars which the pressure of household refrigerator, for safety pressure operation of refrigeration unit, safety factor must be 2:1 so that maximum operating pressure up to 14 bars set.

SAAR decided goal of ice production of 20 pounds per day. Realistic goal is that weight of ice per unit cost. Weight designated for system of 20 Kg, thermal chest size of 0.5m3, to move person around and load up on truck for transportation.

Design parameters

1. Design parameters were created to better define our Solar Refrigerator/Freezer:
2. 0.5m3 Thermal Chests
3. Maximum component weight 20 Kg
4. Maximum operating pressure 14 Bar
5. Operational on alternative fuels
6. Adaptable to a range of heating sources
7. Ambient cooling of components

B. Solar Technology and Energy for Vital Economic Needs (S.T.E.V.E.N)

The S.T.E.V.E.N design consists of three main components:

1. a generator for heating the calcium chloride ammonia mixture,
2. a condenser coil in a water tank,
3. an evaporator tank that is placed inside of an insulated chest.

The generator is a three-inch non-galvanized steel pipe that is at the focus of a parabolic trough solar collector that will heat the pipe when the sun in out. When the ammonia is boiled out of the generator it moves into the condenser coils that are immersed in a water bath and then turned into liquid ammonia inside the evaporator tank. This system is a stationary unit that operates on a two cycle process that consists of a day and night cycle. During the day cycle the sun produces the energy to boil the ammonia out of the generator, and the night cycle allows for ambient cooling of the generator to allow the ammonia to evaporate back into the calcium chloride causing the refrigeration effect capable of yielding around ten pounds of ice in a single process/day. Because of the simple design this unit is capable of operating without any human assistance. The total cost is $510 and is able to be constructed of materials that are readably available in most third world countries, the unit in about 10 feet in length and 6 feet in diameter

C. The Use of Direct Solar Energy in Absorption Refrigerator

Apparatus

The systems consist of generator using stainless plate having 2mm thickness (316) black painted to improve solar radiation absorbing capabilities. Rectangular section having dimensions (25 cm x 25cm x 5 cm) and at 20° inclined angle. The volume of 2.5 liters. Steel is used because other nonferrous metal reacts with ammonia. All side of generator was insulated. Coil type condenser is used (1cm diameter and 20 cm length 0.2 cm thickness) was immersed in cold water bath . receiver is used to collect liquid condensate outside of the condenser. And the evaporator is stainless steel pipe 1cm diameter and 10 cm length and 0.2 cm thickness

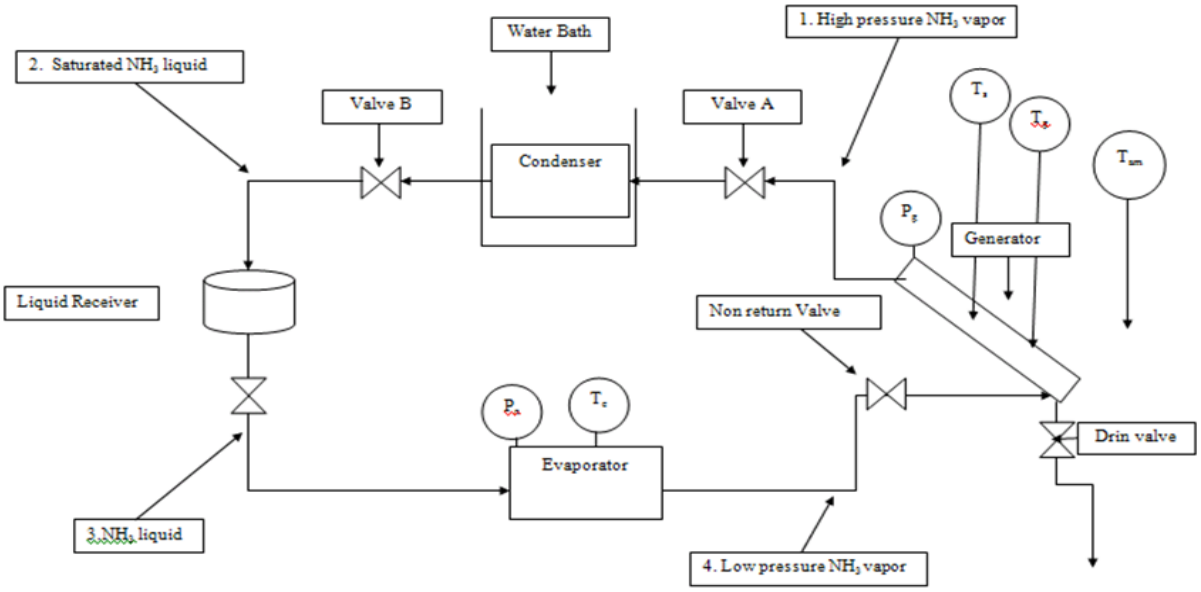

Figure 1. Experimental procedure

System consist of water cooled condenser, generator, flat plate collector, evaporator, liquid receiver, two valve, non return valve. System uses ammonia-water as working pair, in which ammonia used as refrigerant and water as absorbent. Ammonia in the generator is heated by hot water in the collector which is due to the solar energy absorbed from sun.dut to heating high pressure ammonia vapour is produced. During the process both the valve is closed. Ammonia vapor is then condensed into condenser which surrounded with water to keep it cool and pressure is uniform. During this valve a closed and valve B is opened to collect liquid ammonia into receiver. Liquid ammonia is then passed to the evaporator at low pressure which is maintained through expansion valve. Refrigeration effect obtained in evaporator by absorbing heat from surrounding. Refrigeration effect obtained till all ammonia liquid completely vaporize.

.D. Review of Solar Absorption Refrigeration System Using Li-Br and Water

The solar-powered absorption system consists of four major parts, i.e., a generator, a condenser, evaporator and an absorber. These components connected by using three parts heat exchanger, two expansion valves and a pump. Schematic Diagrams of the solar-powered cooling system are shown in Figures 2

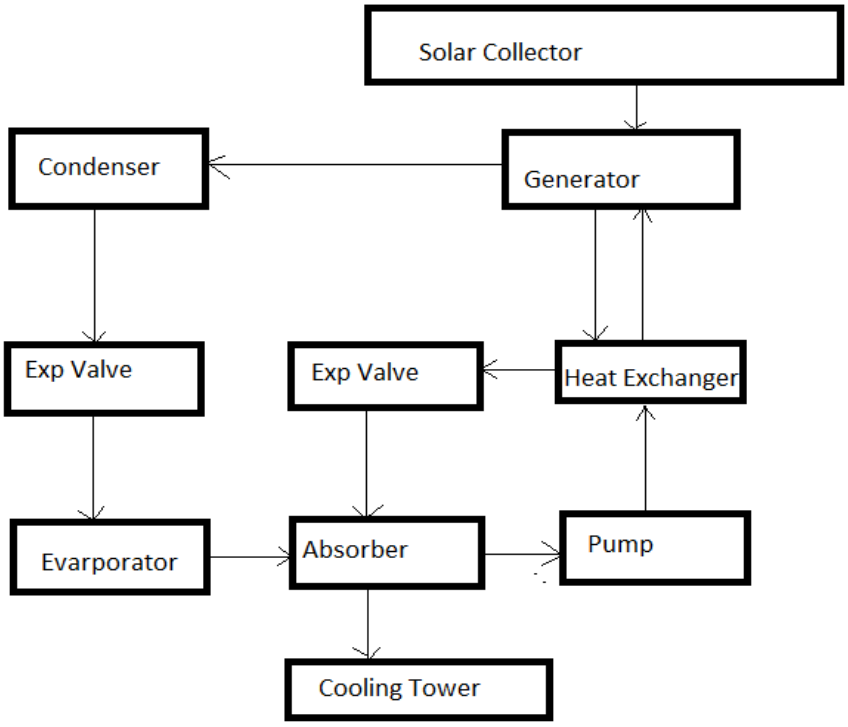

Figure 2. Schematic diagram of the absorption Cycle

1. The collector with flat plate used to receive energy from sunlight called solar energy and heat is accumulated in the storage tank.
2. The solar collector heat is used to separate the water vapor from the lithium bromide solution, in the generator high temperature and pressure generated those results in strong solution of lithium bromide
3. Then, the water vapors passes to the condenser, to cool down water vapor and it get converted into liquid.
4. This high pressure liquid water is passed through the expansion valve to passed the liquid at calculate pressure to the evaporator, where it gets evaporated at low pressure, thereby system provided cooling to the space to be cooled.
5. Subsequently, the water vapors from the evaporator to the absorber.
6. At the same time the strong lithium bromide solution, which leaves from generator, goes to absorber, before coming to absorber it first passed through a heat exchanger in order to preheat the weak solution before entering the generator, and then expanded to the absorber.
7. In the absorber, the strong lithium bromide solution absorbed the water vapor leaving the evaporator to form a weak solution.
8. The weak solution is then pumped into the generator and the process is repeated. Generally, the heat is removed from the system by a cooling tower.
9. The cooling water passes through the absorber first then the condenser.
10. The temperature of the absorber has a higher influence on the system efficiency than the condensing temperature of the cooling tower where the heat is dissipated to the environment.
11. If sun is not shining, another heat source can be used such as electricity or conventional boiler to heat the water to the required generator temperature..

E. Low Cost Solar Cooling System

System consists of solar panel, hot water reservoir, generator, condenser, evaporator, pressure reducing valve, pump, and analyzer is used. Water is heated by absorbing solar energy from sun using flat plate collector. It is designed in such a way that they are liquid flowing through the tubes get heated by absorbing heat from absorber plate which is integral with collector. Collecting tank, solar panel's riser pipes, header pipes and generator coil filled with cold water to raise the hot water in raiser pipe to collect it into hot water tank. Because density of hot water is lesser than cold water hence it gets raised up into hot water tank. Hot water from tank then goes to the generator coil in which refrigerant is filled which get heat from hot water. Due to the absorption of heat aqua ammonia separated out and ammonia gets vaporize and ammonia vapour flows to circuit and then to the condenser, in condenser ammonia vapour heat loss to the atmosphere and vapour ammonia converted to liquid ammonia. Expansion valve is used to reduce the pressure before liquid refrigerant entering to evaporator. The low pressure low temperature liquid refrigerant receives heat into evaporator where we get refrigerating effecting in the evaporator cabinet. The refrigerant gets converted into vapour after receiving the heat. The vapour refrigerant is then goes to absorber where refrigerant is absorbed by water

in the absorber and aqua ammonia solution formed. This solution is pumped to the generator using HP pump. And cycle is repeated

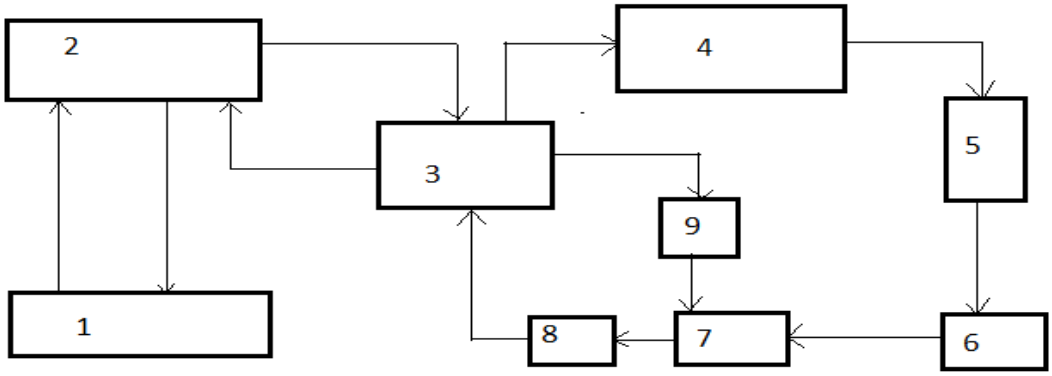

Figure 3

Block	***Description***
1	*Solar Panel*
2	*Hot Water Reservoir*
3	*Generator*
4	*Condenser*
5	*Expansion Valve*
6	*Evaporator*
7	*Analyzer*
8	*Pump*
9	*Pressure reducing valve*

III. CONCLUSION

Here we have heated water in solar collector, heated water will go to heat exchanger where refrigerant is present, in Heat exchanger refrigerant will vaporize by absorbing heat from water i.e. absorbate, then vapor refrigerant will go to condenser where it is cooled and get converted to liquid referent which is at high pressure, this liquid referent go to evaporator passing through expansion valve where pressure is reduced and in evaporator we get refrigeration effect.

Here we have taken various pairs of absorbate and absorbent similarly some more pairs can be used to get cooling effect using solar energy.

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