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A Mechanical Device Used For Solar Refrigeration

Sushant Sharma[1], Richa Arora[2], Amit Sharma[3]
[1](*Mechanical Engineering Department, Mehr Chand Polytechnic College, Jalandhar, Punjab)*
[2](*Mechanical Engineering Department, Mehr Chand Polytechnic College, Jalandhar, Punjab)*
[3](*Mechanical Engineering Department, Mehr Chand Polytechnic College, Jalandhar, Punjab)*

Abstract: This paper describes a process that relates to switching the conventional source of energy to non conventional source of energy, a mechanical device which for refrigeration purpose uses solar energy. This is a system that works on the Principle of Vapour Absorption System and having five components a heating coil, gas filter, capillary tube, evaporating coil and non return valve and this system is completely filled by a refrigerant. Solar energy is a free source of energy and that energy is directly given to the heating coil by which refrigerant gas becomes vaporized and moves to the gas filter unit, after filtering it moves to the capillary tube where it gets condensed and becomes cool and then moves to the evaporating coil where refrigeration effect has to be given to the surroundings and again that gas moves to heating coil through non return valve and the process is repeated again and again.

Keywords: Capillary tube, Dry saturated gas, Evaporating coil, Non-Return valve, Solar Rankine cycle,

I. Introduction

Mechanical devices in engineering have been in use for many centuries. With it, it is possible to make cooling effect. This cooling effect can also be produced with the solar energy which is much cleaner than most of the conventional sources of energy. The power from Sun is approximately 1.8×1011MW and the total present consumption rate is very less. Solar energy is the most suitable source of energy in the fields of refrigeration and air conditioning. In refrigeration the work is done as transfer of heat from lower temperature to higher temperature to produce cooling effect. Here the mechanical device extracts heat from the system where the cooling effect is to be maintained and rejects heat to the surroundings where already heat is at higher temperature. Solar refrigeration systems are already in use but use only three types of systems [1] which are:

- Photo voltaic refrigeration system
- Solar mechanical refrigeration
- Absorption refrigeration

In photo voltaic system, solar radiations are converted to direct current electricity using silicon diodes having semiconductors. The operation of this type of solar refrigeration cycle is very simple. Solar panels directly produce DC power which operates a DC motor, which is mounted with the compressor. The refrigeration effect is possible with the direct conversion of sunlight with Photo Voltaic (PV) panels [2]. In Solar mechanical refrigeration system, a Solar Rankine cycle is used to drive the compressor in Refrigeration cycle. When Sunlight strikes the solar panel, drives a Rankine cycle and produces turbine works. Absorption refrigeration, uses components like generator, evaporator, condenser, expansion valve, solar panel, absorber, DC battery. Here in this system the compressor is replaced by absorber, generator and pump. Ammonia as a refrigerant in the evaporator absorbs the heat from the system space and gets evaporated. It then moves to absorber where it is dissolved with water which acts as absorbent and pumped to generator. All other refrigeration systems use compressor and batteries but in absorption refrigeration system there is no compressor and batteries [3]. In this system heating coil is directly exposed to solar radiations and by virtue of it, the refrigerant which is in the system gets vaporized and moves to capillary tube through which it gets cooled and moves to the evaporator where it produces the refrigeration effect. This paper gives details about the absorption refrigeration system and all the processes related to this are explained in next section followed by advantages and conclusion of this paper.

II. The Process

This absorption refrigeration system is predicted to the development of a refrigeration system which is based on the system of Vapour absorption system, basically there are five components on which the system works in loop as the cycle continues. The complete process is as follow and figure 1 describes all the parts of system -:

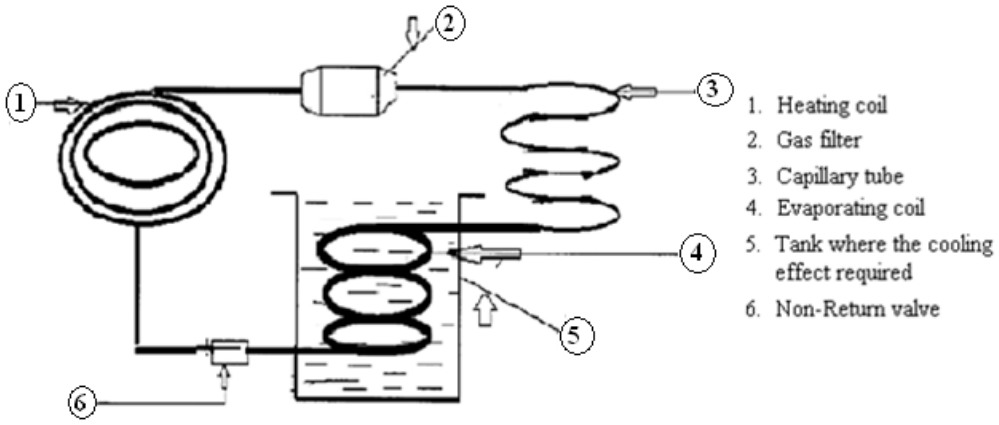

Fig. 1- Detailed Process

With reference to the figure -1 the process of the refrigeration cycle described in this paper attains with the working of the assembled components described as under:-

- Heating coil
- Gas filter
- Capillary tube Heating Coil
- Evaporating coil
- Non-Return valve
- Tank where the cooling effect required

Here the heating coil is directly exposed to the sunlight (solar radiations) by virtue of which the proper pressure is achieved with respect to the expansion of the gas (refrigerant) in the coil (vaporized form) and refrigerant starts moving to the gas filter where the gas filter, filters the gas.

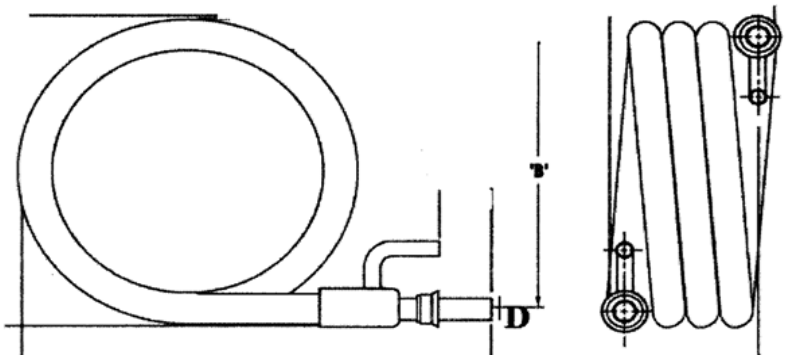

Fig. 2- Heating Cell

The heating coil is made up of copper pipe (tube) where the diameter of the tube is larger than the diameter of capillary tube. In this coil gas absorbs latent heat, the acquisition of heat is at the constant temperature but the phase of the gas or refrigerant changes in vapour form. Detailed drawing of the heating coil is described in figure-2.With reference to above figure-2 a schematic diagram represents the front view as well as side view of the heating coil, where D shows the diameter of the coil tube. The gases commonly used are having very low evaporation points such as Ammonia, Lithium Bromide, CFC's and Carbon dioxide.

Gas Filter After evaporating through the heating coil the gas passes through the gas filter the detailed description is as follows with fig-3

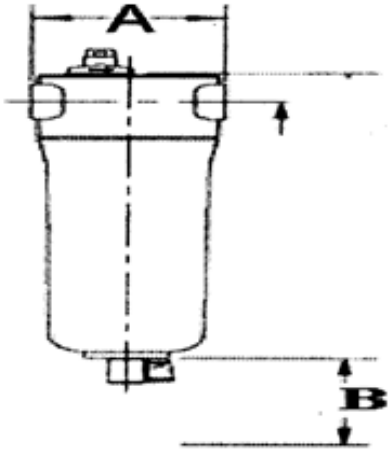

Fig. 3- Heating coil

With reference to above figure-3 of gas filter a detailed diagram is shown that possesses gas filter insertion diameter (A) and also the knob diameter (B) from where the gas goes to the capillary. Filter is a component where the dry saturated gas is purified coming from heating coil. The gas filter stops the slag or sludge coming from coil.

Capillary tube: The diameter of the capillary tube is very small hence it allows the gas to be condensed. The figure is as follows:

Fig.4 capillary tube

According to figure-4, the capillary tube [4] has two ends whose one end is connected to gas filter and other end is connected to evaporating coil where the cooling effect is to be produced. When gas or refrigerant is condensed, becomes liquid.

Evaporating Coil: Liquid refrigerant then moves to the evaporating coil, gains latent heat and changes its phase from liquid to vapors and this cools the surrounding system and the refrigerant becomes vaporized (here the cooling effect is to be produced by the system to the surrounding). These vapours pass through the non return valve and then again through heating coil. Following fig-5 [5] shows the evaporating coil.

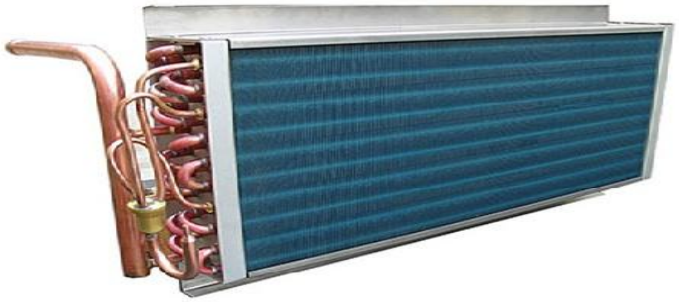

Fig. 5- Evaporating coil

Tank where the cooling effect is to be produced: This is the place where the net cooling effect is to be produced by the system; the whole system is designed to achieve this cooling effect. This we call as a tank because here we can store anything liquid, semi solid or solids.

Non return valve: Non return valve is a one way valve, this is used because the process should be in one direction only that is the gas should pass through a continuous loop. After becoming vaporized form, gas passes through non-return valve and then through heating coil and the process is repeated again and again the cooling effect is produced ultimately with the help of solar radiations that is the driving force. Following figure-6 shows the non return valve.

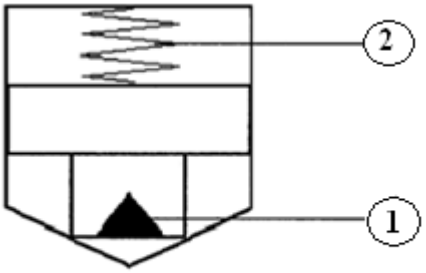

Figure-6

- This part shows the non return valve which is connected to the evaporating coil where the cooling effect is given because the heat extracted by the refrigerant here should move in one direction only i.e. to the heating coil so there is a need for non return valve.
- This is the spring which gives the actual movement to the valve and is connected to the heating coil.

III. Advantages of Solar Refrigeration

Solar energy is the non conventional source of energy that is utilized to run solar refrigerator. So, Electrical power is saved in large amount and it will not produce pollution that would have been added in conventional sources power plants. So it is environment friendly and harnesses the energy of the sun to reduce dependence on fossil fuels and eliminates the need for batteries that can be damaging to the Earth upon disposal. The solar energy is available everywhere as a free source of energy and it is very clean also. This system can operate continuously for years as proven by prototype units tested at various locations around the world. In addition to this, power from the solar collector can also be used for other household products for example air conditioner and also for electric power generation. Where there is an in adequate supply of electricity the solar refrigerators can be used. It is importantly a renewable source of energy. Moreover, this is a scalable system as it suits applications in a wide range of sizes, from portable 50-liter coolers to building-size air-cooling systems[6]. A refrigeration system that works on conventional sources produces harmful gases which pollutes the environment. Whereas, this system can be used to lower the impact produced by the conventional source of energy in the environment. The cost of maintenance of this system is very low as compared to the other conventional source. All these factors encourage to use solar Refrigeration system wherever possible.

IV. Conclusion

The use of solar energy in refrigeration systems can save a huge energy demand and reduce the impact of green house gases. Using solar power in refrigerator system is very cost-effective. The possibility of having a system of cooling, driven by the solar energy is in use in large scale in Jordan (as well as other parts of the world). There are so many circumstances where people do not have access to gas or electricity to power a cooling system. Solar-powered refrigerators are pretty easy to come by these days [7]. An absorption refrigeration cycle employing a single refrigerant as the working fluid has been used in this work. The cycle has been powered by focused solar power source (with glass as focusing unit) to providing a high temperature heat source for absorption cooling system. So it is concluded that non conventional energy source like solar energy can contribute effectively to the supply of heat to the refrigeration load.

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