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AUTOMOBILE ENGINE COOLING USING SOLAR POWERED LITHIUM BROMIDE ABSORPTION REFRIGERATION SYSTEM

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ABSTRACT

Solar power is one of the most stable and clean sources of renewable energy. Being a non- polluting and free source of energy, solar energy is the fuel of the upcoming future. In automobiles, only about 30% of the energy supplied by the fuel is converted into useful work and around 30% of the energy is absorbed by the engine itself in the form of heat which increases its temperature and this heat has to be removed to keep the engine temperature under control for proper functioning, efficiency, and life of the engine. At present, we generally use a water cooling system to remove this heat from the engine. In water cooling engines the cylinder and the cylinder head are enclosed in a water jacket which is connected to a radiator. Water flows in the jacket and absorbs heat from the engine and rejects it in the atmosphere. If the heat from the water is made to be rejected to the atmosphere more efficiently, the fuel consumption and thus the overall efficiency of the automobile can be increased. The main objective of this paper is to develop a cooling system for an automobile engine which utilizes the energy of the sun for its functioning2. We can use the Lithium Bromide absorption refrigeration system that will work by utilizing solar energy to cool the water of the radiator in the water cooling system more efficiently and thus can be a more suitable automobile engine cooling system.

Keywords: *Cooling system, Lithium Bromide absorption.*

I. INTRODUCTION

Unlike fossil fuels, the energy of the sun is a totally inexhaustible and free source of energy. It is renewable, sustainable and completely eco-friendly. In short, solar energy is the route to a clean energy future. Solar cooling is a significant application of solar energy utilizing technologies [1]. In solar cooling, thermal energy from sunlight is utilized to act as a power source for a refrigerator. There are basically two main types of refrigeration systems i.e. vapour compression and vapour absorption refrigeration system. In vapor compression refrigeration system, mechanical energy is required to change the condition of the refrigerant in the compressor.

However, in the vapour absorption refrigeration system, heat energy is required to change the condition of the refrigerant [2]. Solar energy can be the source of the heat required in the vapour absorption system and achieve the desired refrigeration effect. Solar powered vapour absorption refrigeration system has many benefits in refrigeration or heat pumping application. One such application can be cooling of heavy automobile engines. In heavy automobiles, the temperature of the burning gases in the engine cylinder reaches up to 1500 to 2000°C, which is above the melting point of the material of the cylinder body and head of the engine. Thus, it is desired to dissipate the heat or it would result in the failure of the automobile engine. The film of the lubricating oil oxidizes and produces carbon deposits on the surface that results in seizure of piston if the engine is subjected to very high temperatures. Also, due to overheating, distortion of the engine components due to the thermal stresses set up may occur. Higher temperatures also lower the volumetric efficiency of the engine and hence the overall efficiency of the automobile engine. Overheating may also cause pre-ignition as it creates hot spots inside the combustion chamber that can be a source of ignition for the fuel. Therefore, it is necessary to keep the temperature variation to a lower level by continuously dissipating heat from the engine components. The main objective of this paper is to establish a solar-powered refrigeration system that can dissipate the heat generated in the automobile engine. However, the heat input for this system is required at temperatures higher than 100°C. Thus, high-performance solar collectors are needed to supply sufficient solar energy input.

II. COOLING SYSTEM IN INTERNAL COMBUSTION ENGINE

In internal combustion engines, only about 30% of the energy supplied by fuel is converted into useful work and about 30% of the energy is lost in overcoming the friction of the mating components and as exhaust heat. The remaining energy supplied by the fuel results in heating of the engine component and hence, increasing the temperature of the engine components above the safety limit. Therefore, there is a need for a cooling system in automobile engines. The cooling system must be capable to remove heat at a faster rate when the engine is hot.

Types of Cooling System
There are basically two types of cooling systems: (i) Air cooling system and (ii) Water-cooling system.

Air Cooling System: In the air cooling system, the heat which is generated in the automobile engine is dissipated by the air stream, which is obtained from the atmosphere by the means of radiation and conduction. Fins are provided around the cylinder and cylinder head to obtain efficient cooling by increasing the contact area. The amount of heat dissipated by the air stream depends upon the following factors: (i) temperature difference between the fins and the air stream, (ii) total surface area of the fins and (iii) velocity and amount of the cooling air stream. Air cooling system is generally applied for less horsepower motorcycles, scooters and small automobiles where the motion of the automobile gives good air velocity to cool the engine.

Water Cooling System: In the water cooling system, the cylinder and cylinder head of the automobile engine are enclosed in a water jacket. A radiator is connected to this water jacket and water is allowed to circulate in the water jacket. Water absorbs the heat from the engine and gives up this heat in the atmosphere. This cooling system has four types of systems:
(i) Direct or non-return system, (ii) Thermo-Siphon system,
(iii) Hopper system , (iv) Pump /forced circulation system

The main components of Pump/forced circulation system are:

(i) Water Pump: It is a centrifugal type pump. The function of the water pump is to circulate the water in the water jacket. The power is supplied to the pump spindle from a pulley mounted on the end of the crankshaft.

(ii) Fan: It draws atmospheric air through the radiator and thus decreases the temperature of the water and also it throws fresh air over the outer surface of the engine, which takes away the heat conducted by the engine components and thus increases the efficiency of the entire cooling system.

(iii) Radiator: Radiator works as a heat exchanger as it provides large cooling surface area to cool down the water received from the engine.

(iv) Thermostat: It is a kind of check valve which opens and closes according to the change of temperature. It is fitted in the water outlet of the automobile engine. During the warm-up period, the thermostat is closed and the water pump circulates the water only throughout the cylinder block and cylinder head and when the normal operating temperature is reached, the thermostat valve opens and allows hot water to flow towards the radiator.

Here we can connect a solar powered vapour absorption refrigeration system to assist in the heat dissipation from the automobile engine to increase the rate of cooling and thus, contributing in the increase of overall efficiency and life of the automobile. Also, fan can be eliminated from the system in this arrangement.

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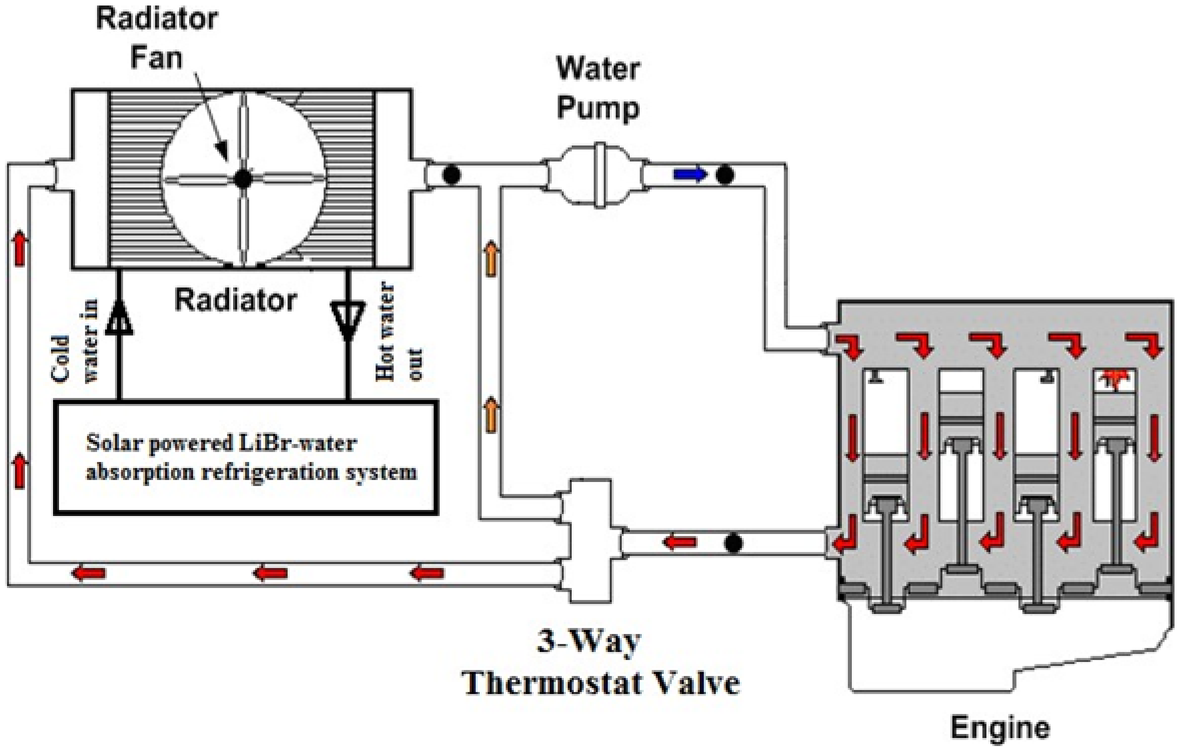

Fig.1 Pump/forced circulation system connected with a LiBr-water vapour absorption refrigeration system

III. SOLAR POWERED LITHIUM BROMIDE-WATER VAPOUR ABSORPTION REFRIGERATION CYCLE

Lithium bromide absorption refrigeration system is widely used for cooling purposes. In this system, lithium bromide is used as absorbent and water is used as refrigerant. As an absorbent, lithium bromide is beneficial as it is non-volatile, resulting in cycle designs that avoid the need of rectifiers. But lithium bromide solution is corrosive and lithium chromate is added in the solution to protect the components against corrosion. Water is also beneficial as the refrigerant because it does not crystallize; its only limitation is that it will make the system work only for refrigeration temperatures above 0°C or even 6°C, due to the freezing point of water but that much of cooling is not required in the automobile engine. Below fig. shows the solar powered lithium bromide vapour absorption refrigeration system that assist in cooling system of heavy automobile.

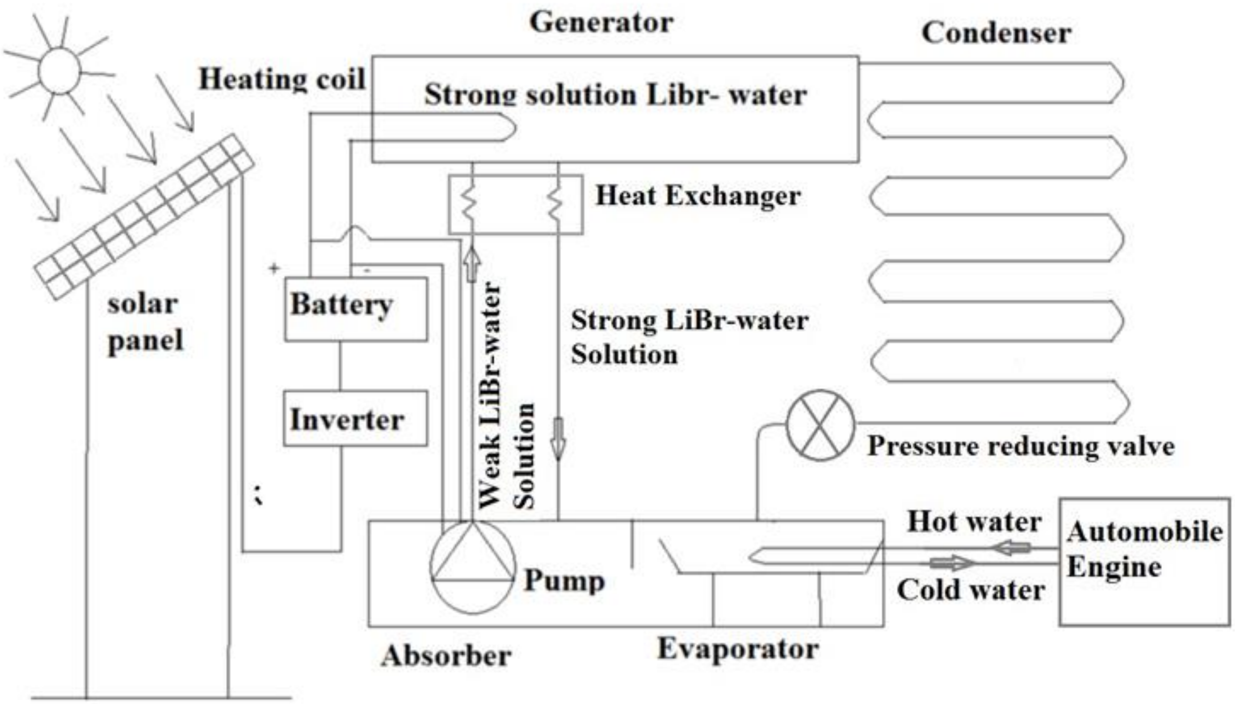

Fig.2 Solar powered lithium bromide vapor absorption refrigeration system that assists in cooling system

The hot water from radiator is pumped through the tubes in the evaporator where heat from the hot water is rejected to the refrigerant water present in the evaporator. The evaporator pressure is maintained very low, thus refrigerant water evaporates. The evaporated water vapours are absorbed by the strong solution of lithium bromide present in the absorber. Therefore, the strong solution of lithium bromide becomes weak and this weak solution is pumped by a pump, which is driven by the energy from the solar panel connected battery, to the generator. In the generator, the weak lithium bromide solution is heated byheating coils, which also get the energy from the solar panel connected battery. A portion of refrigerant water is evaporated and the solution again becomes strong. This strong solution is returned to the absorber passing through a heat exchanger. The weak solution of lithium bromide get heated up by the transfer of heat from the strong solution. This reduces the amount of heat required in the generator to heat the weak lithium bromide solution. The evaporated refrigerant water vapors formed in the generator are cooled and condensed by passing through condenser tubes of high thermal conductivity subjected to atmospheric air stream. The condensate water is supplied back to the evaporator passing through a pressure reducing valve. Therefore, low pressure water enters the evaporator and again takes up heat from the hot water from radiator and the cycle continues.

Solar panels are made up of photovoltaic cells. These cells are composed of semiconductor materials and when sun rays strike the cells, it releases electrons lose from their atoms. As the electrons flow through the cell, it generates electricity. This electricity is used to charge the battery connected to the solar panels and this charged battery acts as the source of power for the heating coils in the generator and the pump in the lithium bromide absorption refrigeration system.

IV. CONCLUSION

- In this system, efficient cooling of the automobile engine is possible which results in the increase of overall efficiency of the vehicle.
- There is no need of the fan in this system, so the fan can be eliminated and thus operation can be quite.

- Since the risk of engine overheating is significantly reduced, failure of the engine components can be avoided and therefore, the life of the engine is increased.
- Proper cooling from this system will also reduce the wear and tear of the engine components and thus, engine maintenance cost is also reduced.
- Overheating of engine results in a decrease in volumetric efficiency of the engine and with the help of this cooling system volumetric efficiency of the engine can be increased. Hence, the engine can develop more power for the same capacity engine and improve the fuel economy.
- Being solar powered; this system does not affect fuel consumption.
- In the absence of sunlight, the battery may be charged from the energy of crankshaft and thus the operation will continue undisrupted.
- As this system can be complex to install and initial setup cost may be high so mathematical modeling can be done. Our upcoming work is to develop a mathematical model to understand the system behavior.

REFERENCES

1. *Henning, Hans-Martin. "Solar-assisted air-conditioning in buildings." Applied Thermal Engineering 27 (2004): 07-1734.*
2. *Moià-Pol, Andreu, Víctor Martínez-Moll, Ramon Pujol Nadal, and Josep M. Rigo Serra. "Solar Thermal Potential for Collective Systems in Palma Beach (Balearic Island's)." Energy Procedia 48 (2014): 1118-1123.*
3. *Srikhirin, Pongsid, Satha Aphornratana, and Supachart Chungpaibulpatana. "A review of absorption refrigeration technologies." Renewable and sustainable energy reviews 5, no. 4 (2001): 343-372.*
4. *Arora, Ramesh Chandra. Refrigeration and air conditioning. PHI Learning Pvt. Ltd., 2012.*
5. *Pongtornkulpanich, A., S. Thepa, M. Amornkitbamrung, and C. Butcher. "Experience with fully operational solar-driven 10-ton LiBr/H2O single-effect absorption cooling system in Thailand." Renewable Energy 33, no. 5 (2008): 943-949.*
6. *Ganesan, V. Internal combustion engines. McGraw Hill Education (India) Pvt Ltd, 2012.*
7. *Rajput, R. K. Refrigeration And Air-Conditioning. SK Kataria and Sons, 2009.*
8. *Arora, S. C., S. C. Arora, and S. Domkundwar. A course in Refrigeration and Air- conditioning. Dhanpat Rai & Company, 2017.*
9. *Mathur, M. L., and R. P. Sharma. Internal combustion engines. Dhanpat Rai Publ., 2005.*