VAPOUR ABSORPTION AC IN AUTOMOBILES USING RADIATOR

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ABSTRACT

Over the past few decades, energy is the backbone of technology and economic development. The possibility of exploiting waste heat from the automobiles has been of great significance in view of ever increasing energy demand and environmental constraints. Today's automobiles use the technology of vapour compression system to run the air conditioning system. But however the rising fuel cost and the load supported on the combustion engines limit prove to be disadvantages. Contrary to this system, the attempt to have a vapour absorption system for air conditioning may prove to be an advantageous alternative. It will not require a power input from the car's engine as well. The high degree of waste heat from engine is ample enough to run a decent capacity absorption system and maintain optimal temperature conditions in the automobiles

KEYWORDS— Compressor, Condenser, COP, Generator, Refrigerant, Vapour absorption.

INTRODUCTION

THE vapour absorption refrigeration system operates on heat. This is older than the vapour compression system. In the early nineteenth century, kerosene burners were popular for this system. When CFC's were introduced and electric power was cheap, compression system having better COP got popular. With increase in the electricity charges and the phase out of the CFC's, the absorption system is again becoming popular in large capacities. In both the system we have the evaporator and the condenser. The process of evaporation and condensation takes place at two different pressure levels in both the systems. They also differ in the manner in which the evaporator is circulated in the system. In contrast to the vapour compression system which utilizes a mechanical compressor; the absorption type makes benefit from an 'absorber 'and a 'generator'. A solution called the absorbent that has an affinity for the refrigerant is used. The absorbent in the absorber draws or sucks the refrigerant vapour formed from the evaporator thus maintaining low pressure in the evaporator to enable the refrigerant to evaporate at low pressure. In the generator the absorbent is heated to release the refrigerant vapour as a high pressure vapour, to be condensed in the condenser. [1]

Absorption machines are thermally activated and for this reason, large amount of input mechanical power is not required. In this way, where power is expensive or unavailable, or where there is waste, gas, geothermal or solar heat available, absorption machines provide reliable and quiet cooling. A number of refrigerant-absorbent pairs are used, for which the most common ones are water-lithium bromide and ammonia-water. These two pairs offer good thermodynamic performance and they are environmentally benign. Adsorption refrigeration systems have many fundamental advantages besides environmentally friendly refrigerants and electricity saving. Briefly, there are: simplicity, low maintenance, high temperature heat input capability, low pump power, inherent flexibility in operation, with a system performance insensitive to ambient temperature. The adsorption system has no rotating component or machined surface. Compared with vapour compression refrigeration systems, no solution pump is needed in adsorption refrigeration systems in which there is no crystallization or rectification problem. So adsorption refrigeration systems are suitable for vibration, incline, and rotation occasion.

LITERATURE REVIEW:

Refrigeration is the process of cooling a space or substance below environmental Temperatures. A refrigeration system utilizes work supplied by an electric motor to transfer heat from a space to be cooled to a high temperature sink (place to be heated). Low temperature boiling fluids called refrigerants absorb thermal energy to get vaporized in the evaporator causing a cooling effect in the region being cooled. While comparing the advantages and disadvantages of various cooling systems, two most important parameters i.e. the operating temperature and the coefficient of performance are of vital importance in these systems. These systems can be evaluated using energy and exergy analyses which are based on first and second law of thermodynamics, respectively. Satish Maurya, Saurabh Awasthi and Suhail A. Siddiqui[3] studied cooling system for an automobile based on Vapor Absorption Refrigeration cycle using waste heat of an engine. They concluded that out of total heat supplied to engine in the form of fuel is 30-40% is converted in mechanical work and remaining expelled to environment through gases. The availability and possibility of waste heat from IC engine also describe law of exhaust gas energy.

Satish Raghuvanshi and Govind Maheshwari[4] studied Analysis of Ammonia Water Vapor Absorption Refrigeration System based on First Law of Thermodynamics. They concluded Coefficient of Performance of the system decreases with increasing inlet water Temperature to generator keeping the outlet water temperature to generator is constant. Also the COP of the system decreases with increase in generator, absorber and Condenser Temperatures, the COP of the system decreases. Subhash Kumar and Dr. R. R Arakerimath[5] Comparative Studied on Performance Analysis of Vapor Absorption Refrigeration System using various Refrigerants. They concluded that the performance of NH3-H2O, LiBr-H2O as working fluids for refrigeration temperature below atmospheric were presented in that paper. The preferable working fluid can be considered as a solution with the highest COP, lower required generator temperature and circulation ratio as low as possible. It is evident that COP strongly depends on working conditions such as generator, absorber, condenser and evaporating temperature.

HEAT SOURCE

Vapour absorption air conditioning system requires only heat to operate, and the waste heat from engine can be successfully utilized for cooling purpose. In study it is found that in automobile engines, the heat dissipated from exhaust and from radiator is same but extracting heat from exhaust may be quiet complex in design and manufacturing and costlier in maintenance. The temperature of engine coolant from engine to radiator may lie anywhere between 100 to 200 degree Celsius. This is rich source of heat and suitable for running and working the generator of a vapour absorption system.

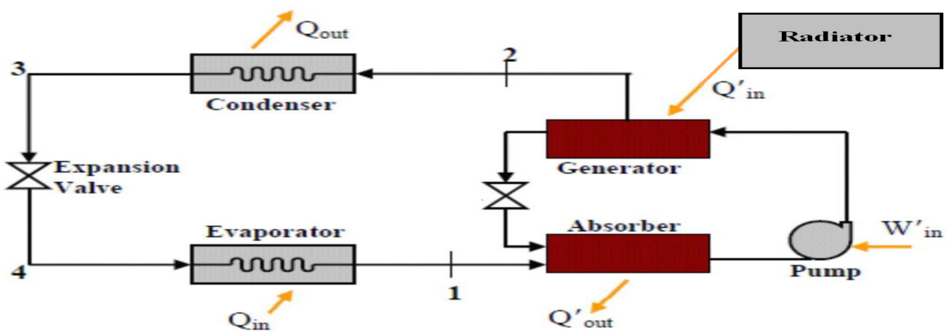

Fig.1. Flow chart of the system

PROPOSED SYSTEM AND WORKING PRINCIPLE

Figure 1 shows the schematic block diagram of a simple absorption refrigeration system it consist of an absorber, a pump, a generator and a pressure reducing valve to replace the compressor in vapour compression refrigeration system. The other components of the system are same (condenser, evaporator and expansion valve). In this system the NH3 or LiBr can be used as a refrigerant and the water can be used as an absorbent. In this system the low pressure ammonia vapour refrigerant leaving the evaporator enters the absorber {1}, where it's absorbed by the cold water in the absorber. The water has an ability to absorb a very large quantity of ammonia vapour, and the solution thus formed is known as aqua ammonia solution.

The absorption of ammonia vapour in water lowers the pressure in the absorber which turn draw the more ammonia vapour from the evaporator and thus raise the temperature of the solution. Some form of cooling arrangement (usually water cooling) should be employed in the absorber to remove the heat of solution evolved, this is necessary in order to increase the absorption capacity of water, because of higher temperature water absorb less ammonia vapour, the strong solution thus formed in absorber is pumped to the generator by the liquid pump. The pump increases the pressure of solution up to the 10 bar. The strong solution of ammonia in the generator is heated by some external source. This source is heated engine coolant passing through thermostat from engine. This coolant will surround generator and exchange heat. During the heating process ammonia vapour is driven off from the solution at higher pressure and leaving behind the hot week solution in the generator. The weak ammonia solution flows back to the absorber at low pressure after passing through the pressure reducing valve. The high pressure ammonia vapour {2} from the generator is condensed in the condenser to high pressure liquid ammonia thus liquid ammonia is passed to the expansion valve through the receiver {3} and then to the evaporator {4}. This is the complete working of proposed vapour absorption refrigeration cycle.

ENERGY CONSIDERATIONS

The rating of a refrigeration machine is obtained by refrigerating effect or amount of heat extracted in a given time from a body. The cooling capacity of refrigeration units was in horse power. The horse power is actually a theoretical unit of energy. One horse power is the amount of energy requires raising 1497 kg to 305 mm in 1 minute. Another term used to describe the capacity of the air conditioner is ton. A ton of refrigeration was generally considered to be the equivalent to 1 horse power.

The rating of the refrigeration machine is given by a unit of refrigeration known as ''standard commercial tonne of refrigeration'' which is defined as the refrigerating effect produced by the melting of 1 tonne of ice from and at 0°C in 24 hours. Since the latent heat of fusion of ice is 336 kJ/kg, the refrigerating effect of 336 × 1000 kJ in 24 hours is rated as one tonne, i.e.,

$$1 \text{ tonne of refrigeration (TR)} = (336 \times 1000) / 24 = 14000 \text{ kJ/h.}$$

Using American units this is equal to removal of 200 BTU of heat per minute, and MKS unit it is adopted as 50 kcal/min or 3000 kcal/hour. In S.I. units its conversion is rounded of to 3.5 kJ/s (kW) or 210 kJ/min.

$$1 \text{ tonne of refrigeration} = 14000 \text{ kJ/hr } (1 \text{ ton} = 0.9 \text{ tonne});$$

$$1 \text{ ton refrigeration} = 12600 \text{ kJ/hr}$$

Hence, one ton of refrigeration is thus equivalent to 12600 kJ/hr. Most motor vehicles (MVAC) systems are rated well over a ton of refrigeration. Because of the tremendous heat load in the vehicle, a unit rated 8000 to 10000 kJ will very well do the job[2]. The design of such a system would carry a major modification that includes structural and design modifications and the requirement of a heat transfer system to transfer the heat from radiator to the generator. Now, the range of C.O.P for the aqueous ammonia system is (0.1 - 0.8) when the generator temperature is up to 65°C and the range of LiBr-H_2O system are (0.1 - 0.7) when the generator temperature is up to 95 °C. (When range of NH_3 and LIBR is 15% maximum)[5].

On a rough thought considering a cooling requirement on 1 Ton at a COP OF 0.6 the heat needed would be 1x12,600 kJ/hr and then divide the same by COP

$$\text{i.e. C.O.P} = 12{,}600/0.6 = 21{,}000 \text{kJ/hr.}$$

The actual heat supplied by the engine coolant may be studied by with the help of thermostat. Although some short comings may be that the radiator will not supply heat at idle conditions and thus not carry the load of the system at idle conditions.

FUTURE PLANS

I plan to do an experimental study and analysis on the above stated theoretical hypothesis and analyze the outcomes.

CONCLUSION

Such a system can replace conventional vapour compression refrigeration systems and would vastly help take of the compressor load of the vehicle engine and would prove a great percentile of energy saving. It will thus take away the need for the extra fuel burnt for the same purpose, as well. The satisfaction of using vast amounts of energy earlier let out into the environment untapped is thus gained.

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