A STUDY ON UTILIZATION OF EXHAUST HEAT FROM IC ENGINE FOR AIR CONDITIONIG IN VEHICLES

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***Abstract*:** With the rapid changing environment and atmospheric effect, the air conditioning of the moving vehicle has become a necessity. In the same time consumers are incapable to bear the increasing operating cost of the vehicles due to continuous raise in fuel prices, component costs and maintenance costs associated with vehicles. Approximately 30 to 40% of total energy supplied in internal combustion engine (ICE) is converted to useful mechanical work. The remaining energy is expelled directly to the environment through engine cooling systems and exhaust gases resulting into entropy rise and serious environmental problems. Exhaust gas stream from ICE carries away about 30% of the heat of the combustion. An exploration has been done to research the possibility of waste heat recovery and its subsequent utilization in air conditioning system of a vehicle without increasing the component cost, weight, number of component and bring improvement in vehicle by making it luxurious.

Keywords: vapor absorption refrigeration, ammonium hydroxide, generator, exhaust, IC engine.

I. INTRODUCTION

Energy is an important entity for economic development of any country. Most of this energy consumed in power conservation devises and electricity usage. There is a significant increase in this energy consumption in heating, ventilation, and air conditioning (HVAC). Due to serious problems of energy shortage and global environment issues, utilizations of waste heat and renewable energy become one of the most interesting research fields. HVAC refrigerants in traditional cooling systems contain Chlorofluorocarbon (CFC) and hydro chlorofluorocarbon (HCFC). Such components with high ODP (Ozone depletion potential) and GWP (global warming potential) accelerate the depletion of the Earth's ozone layer. Therefore, alternative solutions to current cooling systems are required. A cooling technology known absorption cooling system powered by waste and/or renewable energy sources is an attractive solution. Absorption cooling systems powered by solar energy have attracted much attention in recent decades due to its matching between sun shine and the required cooling effect. Absorption cooling system has numerous advantages, such as using low grade heat source temperature, employing of natural refrigerants such as water, less moving mechanical parts, noiseless, Low maintenance and environment-friendly. Available energy in exit stream of many energy conversion devices goes as waste, if not recovered or utilized properly. [1]

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The technology of absorption refrigeration plants has been used for cooling purposes for over a hundred years now. In a vapour compression cooling machine, the refrigerant evaporates at low temperature and low pressure. The vapour is extracted from the evaporator, than transformed to a higher pressure by compressor and liquefied in the condenser. The main difference between a compression and an absorption cycle is that the former needs mechanical energy as a driving source for the compressor and the latter needs thermal energy for the Absorber and only a small amount (2% of the driving energy) of electricity for the liquid pump. A Vapour Absorption Refrigeration (VAR) System is similar to a Vapour Compression Refrigeration (VCR) System. In both systems the required refrigeration is provided by refrigerants vaporizing in the evaporator. However, in the VAR System, a physico-chemical process replaces the mechanical process of the VCR system and heat rather than a mechanical and electrical energy is used.[2]

II. AMMONIA- WATER ABSORPTION CYCLE

An Absorption Cycle can be viewed as a mechanical vapour-compression cycle, with the compressor replaced by a generator, absorber and liquid pump. Absorption cycles produce cooling and/or heating with thermal input and minimal electric input, by using heat and mass exchangers, pumps and valves. The absorption cycle is based on the principle that absorbing ammonia in water causes the vapour pressure to decrease.

The basic operation of an ammonia-water absorption cycle is as follows. Heat is applied to the generator, which contains a solution of ammonia water, rich in ammonia. The heat causes high pressure ammonia vapor to desorb the solution. Heat can either be from combustion of a fuel such as clean-burning natural gas, or waste heat from engine exhaust, other industrial processes, solar heat, or

any other heat source. The high pressure ammonia vapor flows to a condenser, typically cooled by outdoor air. The ammonia vapor condenses into a high pressure liquid, releasing heat which can be used for product heat, such as space heating. The high pressure ammonia liquid goes through a restriction, to the low pressure side of the cycle. This liquid, at low pressures, boils or evaporates in the evaporator. This provides the cooling or refrigeration product. The low pressure vapor flows to the absorber, which contains a water-rich solution obtained from the generator. This solution absorbs the ammonia while releasing the heat of absorption. This heat can be used as product heat or for internal heat recovery in other parts of the cycle, thus unloading the burner and increasing cycle efficiency. The solution in the absorber, now once again rich in ammonia, is pumped to the generator, where it is ready to repeat the cycle [3]

III. PROPERTIES OF AMMONIA REFRIGERENT

The main properties are:

- Ammonia (refrigerant) and water (absorbent) are highly stable for a wide range of operating temperature and pressure.
- Ammonia has a high latent heat of vaporization, which is necessary for efficient performance of the system. Its latent heat of vaporization at -15℃ is 1315kJ/Kg.
- Its boiling point at atmospheric pressure is -33.3 ℃ & freezing point is -77 ℃.
- It has highest refrigerating effect per Kg of refrigerant. The leakage of this refrigerant may be quickly & easily detected by the use of burning sulphur candle which in the presence of ammonia will form white fumes of ammonium sulphite.. It is environmental friendly. [4]

IV. WORKING PRICIPLE

Vapour absorption cycle is a refrigeration cycle (VAR) which produces refrigerating effect by using heat as input and a very little mechanical work is required to operate VAR cycle. The working fluid is usually an Ammonia water. Figure below schematic diagram of vapour absorption air conditioning system using waste exhaust heat.

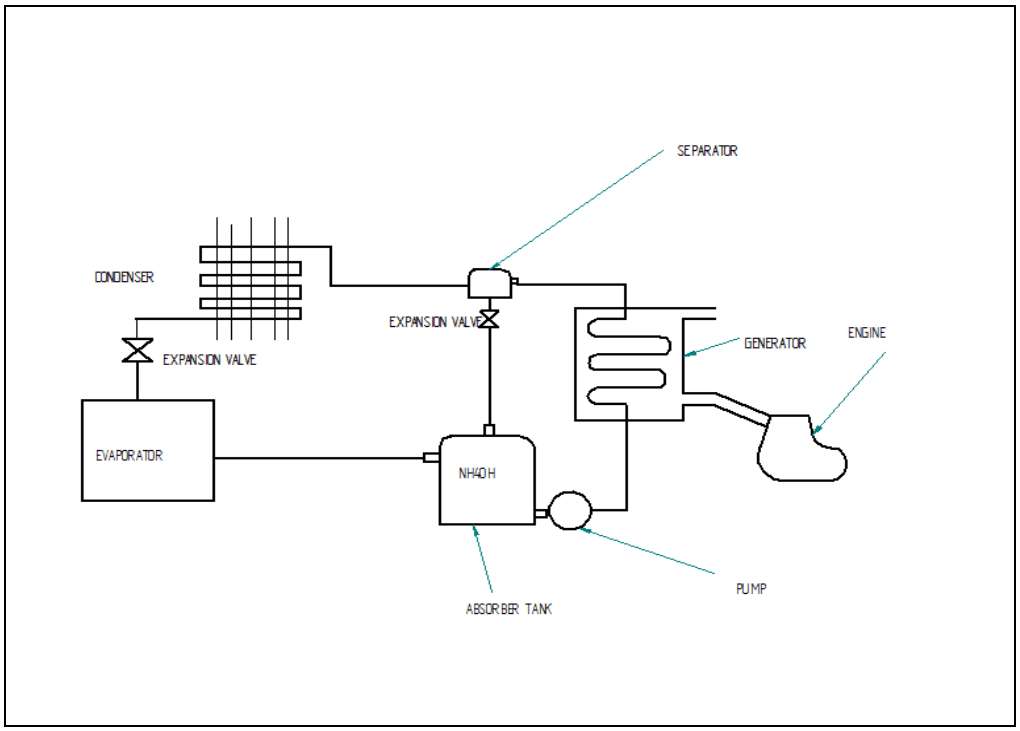

Fig 1. Schematic representation of utilization of exhaust heat for air conditioning

The low pressure ammonia vapour leaving the evaporator enters the absorber where it is absorbed by the cold water in the absorber. Aqua-ammonia solution is formed by the water has the ability to absorb very large quantity of ammonia vapour. To increase the pressure of the solution up to 10 bar the strong solution thus formed in the absorber is pumped to the generator by the liquid pump

By the exhaust heat of automobile the strong solution of ammonia is heated by some external source, in our system. During the heating process the ammonia vapour is driven off the solution at high pressure leaving behind the hot weak ammonia solution in the generator. After passing through the pressure reducing valve, the weak ammonia solution flows back to the absorber at low pressure. The high pressure vapour from the generator is condensed in the condenser to high pressure liquid ammonia the condensed liquid ammonia from the condenser is stored in a receiver valve; it is supplied to the evaporator through the expansion valve. The liquid ammonia is passed to the expansion valve in which its high pressure and temperature is reduced at a controlled rate after passing through it. The liquid vapour ammonia at low pressure and temperature is evaporated and changed into vapour refrigerant. In evaporator, the liquid vapour ammonia absorbs its latent heat of vaporization from the medium to be cooled.

V. ADVANTAGES OF USING VARS

The use of a Vapor Absorption Refrigeration System in the vehicles used on roads. Transport vehicles have the following advantages

- No dedicated IC engine is required for the working of the refrigerating unit.[5]
- No refrigerant compressor is required.
- No extra work is required for the working of the refrigerating unit
- Reduction in capital cost.
- Reduction in fuel cost.
- Reduced atmospheric pollution.
- Reduced maintenance.
- Reduced noise pollution.

VI. CONCLUTION

The possibility to design a air conditioning unit inside an automobile using the waste heat from the engine of the vehicle based on Vapor Absorption Refrigeration System is realistic. Also keeping in mind the Environmental safety view, this system is Eco-friendly as it involves the use of Ammonia (a natural gas) as a refrigerant and is not responsible for Green House effect and OZONE layer depletion. In this way we can conclude, that out of the total heat supplied to the engine in the form of fuel combustion, approximately, 35% to 40% is converted into useful mechanical work; the remaining heat is categorized under the waste heat and expelled out of the system, resulting in the rise of entropy, so it is required to utilize this waste heat into useful work. Possible methods to recover the waste heat from internal combustion engine through the study on the performance and emissions of the internal combustion engine are discussed upon and can be designed. Waste heat recovery system is the best way to recover waste heat and saving the fuel.

VII. REFERENCES

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