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VAS AC Refigeration System by Exhaust of Automotive Engine

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Abstract*— Air conditioning cabin of a transport truck is a new concept in India and has not been addressed. But in summer, the temperature in some parts of India is very high and results in unbearable cabin temperatures. In such conditions, an air cooled cabin for transport truck is a necessity. It is observed that much work has not been done in the field of cabin cooling of transport truck. The available options in heat generated cooling have been critically reviewed. The vapour absorption refrigeration cycle is found to be suitable for automobile air cooling especially for transport trucks. The heat potential in the exhaust has been analyzed and found to be sufficient enough for powering the proposed air conditioning system. The significance of the work is that it will provide space cooling for the truck driver and thereby enhances his performance and efficiency without affecting performance of the engine essentially the fuel economy. Further the vapor absorption cycle use non CFC refrigerant and thereby have little effect on environment. The present work is focused towards the design and development of an air cooling system for the cabin of truck using waste heat from exhaust. This document gives information about how much important is waste heat and using this we can develop a refrigerant system without taking input from battery, also design is developed based on vapour absorption refrigeration system which demands for future. In this article, we design different parts of the system and there basics behind this.
Keywords*— AC refrigerator, Engine exhaust system.

I. INTRODUCTION

In India road transport is a major mode of transport for goods over large distances. The atmospheric temperature in some parts of India touches 45oC.In such condition studies shows that the temperature inside the cabin of a transport truck even exceeds 55oC (Alam, 2006) [1]. The operation in such hot condition for the truck driver is extremely difficult. Further this extreme heat reduces the working efficiency of the drivers and delays the transport duration over the road. The delay further affects the economy, which is unacceptable. So some measures have to be taken to reduce the temperature inside the cabin of the truck and to provide comfort to the driver. Considering present energy crises all over the world, it is very much necessary to explore new technology and potential to satisfy the need of society. At the same time the efficient management of the production and energy conservation is also equally important. In case of truck large amount of heat as input around 25% of the total heat supplied is going away with exhaust gases at very high temperature and around 25% is going away with cooling water. So if this waste heat can be utilized for powering an air conditioning system it will be economical and the fuel energy can be used effectively. Considering all the above factors different alternatives have been studied and the vapor absorption system is found to be the most promising alternative. The paper deals with the preliminary design of Ammonia water vapor absorption refrigeration system and a simulation model has been developed for both the systems to predict the performance of the systems, designed for given operating conditions, under various off-design operating conditions. The significance of the work is that it will provide space cooling for the truck driver and thereby enhances his performance and efficiency without affecting performance of the engine essentially the fuel economy. Further the vapor absorption cycle use non CFC refrigerant and thereby have little effect on environment.

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,

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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

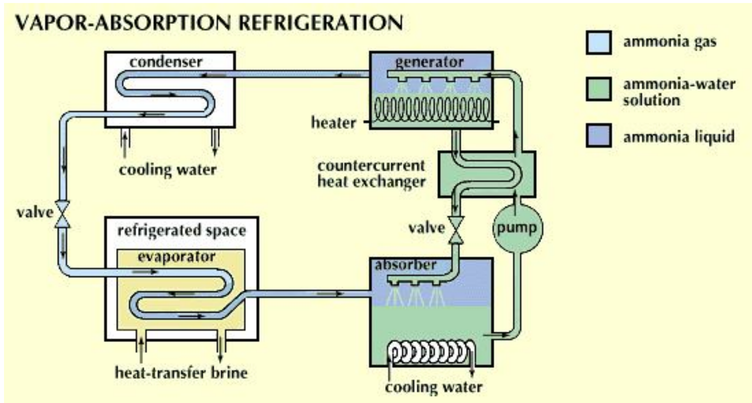

Fig. 1. Vapour Absorption Refrigeration.

III.WORKING MODEL

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 (figure. 2). The working fluid is usually an Ammonia water or Lithium bromide solution in water.

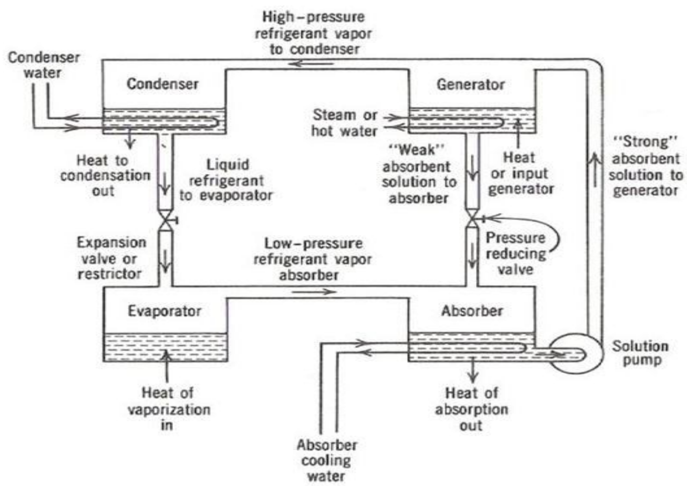

Fig. 2. Vapor Absorption System.

An optimization analysis is presented for estimating the proper size of absorption type automotive air conditioning system that use waste exhaust heat as input. In vapour absorption refrigeration system as shown in , the compressor is replaced by an absorber, a pump, a generator and a pressure reducing valve. These components in the system perform the same function as that of compressor in VCR system. The vapour refrigerated from evaporator is drawn into the absorber where it is absorbed by the weak solution of refrigerant forming a strong solution. This strong solution is pumped to the generator where it is heated utilizing exhaust heat of vehicle. During the heating process the vapour refrigerant is driven off by the solution and enters into the condenser where it is liquefied. The liquid refrigerant then flows into the evaporator and the cycle is completed.

IV.FABRICATION

The primary components of the refrigeration system are

A. Generator

According to the requirements specified in the design segment, we purchased a 3 liter, mild steel cylinder (it is usually used to

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carry refrigerants). this cylinder was purchased from go bind refrigerator &air conditioning equipment's ,banger. Operations performed: Drilling : Drilling of four holes of dia 1.5cm at the specifies spots for the inlet and outlets and one hole of dia 2.5 cms for the connection of thermocouple was performed on a vertical drilling machine. Welding: Arc welding was done to weld four 1.5cms and one 2.5 cm mild steel, internally threaded nuts which get mated with the bronze adapters for inlet and outlet connections and one for the thermocouple.

B. Absorber

Another 3 litre, mild steel cylinder similar to the generator is used for the purpose of absorber. It was purchased along with the generator. Operations performed: Drilling: Drilling of three holes of dia. 1.5cm at specifies spots for the inlet and outlets were performed on a vertical drilling machine. Welding: Arc welding was done to weld four 1.5cms mild steel, internally threaded nuts which get mated with the bronze adapters for inlet and outlet connections *Charged-Coupled Assembly.*

C. Condenser

As specified in the design segment, assuming the natural convection coefficient (h) to be 10W/mK and theoretical mass flow rate(m) to be 8*10^-5 kg/sec, the calculated length for a 1/4th inch mild steel was five meters. The pipe was bent at into several turns with the help of 180degrees bending tool to make it compact and also to enhance the drop in pressure which eliminates the requirements of any throttling device such as a capillary tube.

D. Evaporator

A 6mm thick glass container (24x15x6 cm) was ordered n purchased from a glass works shop at r.no 3 BANJARA HILLS. This container is used as an evaporator cabin which is filled with water and the water is expected to be cooled to 10 degrees centigrade as a result of the refrigeration cycle. The same 1/4th inch mild steel tube is wounded in the form of a coil and sent through this evaporator cabin.

E. Pump

A special purpose 20w dc pump used in air-conditioning equipment is used in this cycle. The purpose of this device is to pump the solution (strong in water) from the absorber to the generator. This is the only mechanical device being used in the whole system. An adaptor is provided along with this pump to convert the 220v AC power input to 24V DC supply to the pump.

F. Frame

All the components are attached to a frame made of 18mm thick plywood frame shown below. The generator is clamped by two 6inch mild steel strips with the help of 1 inch screws firmly. The absorber is also clamped with a single similar 6 inch mild steel strip which is screwed to the frame and a support at the bottom. The condenser is similarly fixed to frame and the frame is cut behind the condenser to enhance the convection heat transfer from the condenser. The evaporator is supported at its base with a wooden frame. The pump is screwed to the frame with two small screws. The heating coil is fixed to the frame below the generator

G. Pipes

The pipe used throughout the system is ¼th inch, mild steel pipe. The length of total pipe used for the refrigeration system was 10 m. The piping was done with assistance from the technician at NATIONAL PIPE WORKS, AFZAL GUNJ*Frame.*

H. Valve, Gauge And Connecting Adapter

One stainless steel steam valve is used at the outlet of generator to control the mass flow rate of steam coming out of the generator. Three ball valves, one each for the three outlets of generators is used. Out of these three, one is used to control the flow of weak solution(weak in water) from the generator to the absorber, second one is to control the flow of solution coming from the pump and the third one is used for initial filling of water-lithium bromide solution into the generator. Two gauges, on pressure gauge (range 760mm of Hg vacuum to 0mm of Hg) and one temperature gauge (thermocouple range 0-200 degree centigrade) are mounted on the generator to check the state of steam before allowing it to flow through the system. All the connections are made with the help of bronze connecting adapters of ¼th inch diameter and provided with brass washers on both sides. All these connections are sealed using Teflon and to ensure it remains leak proof. All of these valves, gauges and connectors were purchased from UNIQUE CONTROL SYSTEMS, RANIGUNJ

V. DESIGN IMPROVEMENT

A. Design Of Energy Supplying Network To The Generator

The prime motive behind this project was to utilize low grade thermal energy which is released by many industries and

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manufacturing units that go unused. This energy should be tapped and supplied to the generator. A proper system should be designed for this purpose. Also the solar energy should be properly supplied as an input to the generator to provide refrigeration and air conditioning for domestic purposes.

B. Design Of Solution Heat Exchanger

The efficiency of the system is greatly affected by the enthalpy of solution entering the generator and temperature of the solution entering the absorber. Thus a proper heat exchanger is necessary for enhancement of this refrigeration system.

C. Design Of A Water Cooled Condenser

A properly designed water cooled condenser will reduce the size of the refrigeration system and make it compact, easy to transport and efficient.

D. Design Of Generator And Absorber

Since the system is operating under low pressure, the cylinders for generator and absorber can be properly selected so that mass of the system is greatly reduced and making the system cost .

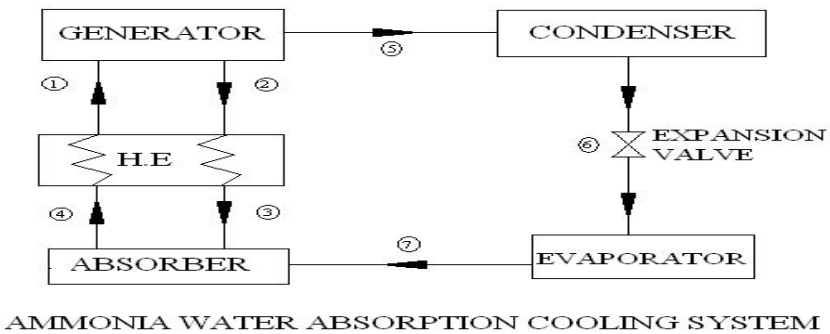

Fig. 3. Ammonia Water Absorption Cooling System.

VI. CONCLUSION

It has been concluded that, for providing cabin cooling for truck using engine exhaust, the vapour absorption systems can be used i.e. ammonia/water vapour absorption cycle. The heat load on the generator can be met very easily by using the engine exhaust for both the systems as available energy rejected by cooling system of truck engine is more than sufficient Hence from the discussion, ammonia/ water vapour absorption system is suggested for the application. Though the COP of the system is less but since waste heat is given as input, it is not a matter of concern.WORKING AND DATA ANALYSIS

REFERENCES

[1] Alam S, 2006, “A Proposed model for Utilizing Exhaust Heat to run Automobile Air-conditioner”, The 2nd Joint International Conference on Sustainable Energy and Environment 21-23 November 2006, Bangkok, Thailand.
[2] Bell I. A, Daini A. J, Ali H. Abdel-Gayed R. G and Duckers L, 1996, “The Design of an Evaporator/Absorber and Thermodynamic analysis of a Vapour Absorption Chiller Driven by Solar Energy” WREC - 1996.
[3] Jakob. U, Eicker. U, Schneider. D and Teuber. A, 2007, “Experimental Investigation of Bubble Pump and System Performance for a Solar Driven 2.5 KW Diffusion Absorption Cooling Machine” Heat Set 2007, Heat transfer in components and systems for energy technologies Chambery, France.
[4] Kim B and Park J, 2007, “Dynamic Simulation of a Single-effect ammonia-water absorption chiller”, International Journal of Refrigeration Vol. - 30, 535-545.
[5] Koehler. J, Tegethoff. W. J, Westphalen. D and Sonnekalb. M, 1997, “Absorption Refrigeration System for Mobile applications utilizing Exhaust Gases”, Heat and Mass transfer 32(1997) 333-340.
[6] Lambert M. A. and Jones B. J, 2006, “Automotive adsorption air conditioner powered by exhaust heat”. Journal of Automobile Engineering. Vol. 220.
[7] Manrique J. A., 1991, “Thermal Performance of an Ammonia – Water Refrigeration System”, International Comm. Heat Mass Transfer Vol. 18, pp. 779 – 789.
[8] Mostafavi M and Agnew B, 1997, “Thermodynamic Analysis of Combined Diesel Engine and Absorption Refrigeration Unit – Naturally Aspired Engine with Precooling”, Elsevier Science Applied Thermal Engineering Vol. 17. No 6. pp. 593-599.
[9] Riffat S. B. and Shankland N, 1993, “Integration of Absorption and Vapor-Compression Systems”, Elsevier, Applied Energy 46, 303-316.
[10] Salim M, 2001, “Technical Potential for Thermally Driven Mobile A/C Systems”, SAE technical paper, no. 2001 – 01- 0297.
[11] Sumathy. K, Huang. Z. C and Li. Z. F, 2002, “Solar Absorption Cooling with Low Grade Heat source – A Strategy of Development in South China”, Elsevier Science Solar Energy Vol. 72, No 2, pp 155 – 165.
[12] Venkatesan. J, Praveen. V. M, Bhargav. V. K and Moorthy. B. B, 2005, “Performance Improvement in Automotive Engines using Vapour Absorption Refrigeration System for Air Conditioning”, SAE technical paper no. 2005-01-3466.
[13] Wicks F, 1989, “Design and Benefits of a Non-Electric Air Conditioner that Combines Compression and Absorption Cycle”, SAE technical paper no. 899180.

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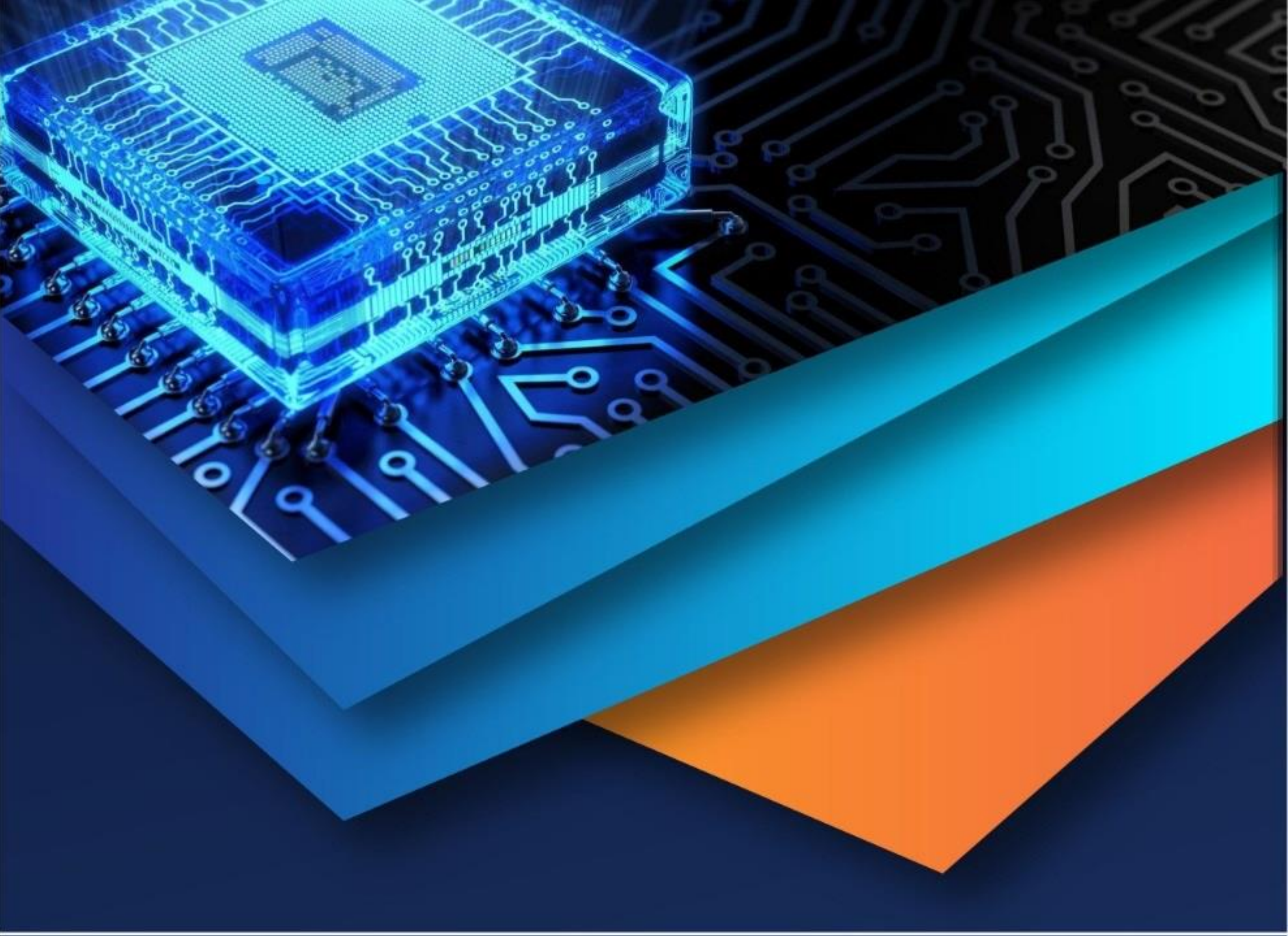

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