Design and Fabrication of Vapour Absorption Air Conditioning System for Commercial Vehicle by Using Waste Heat of IC Engine

Subodh Kumar Swarankar[1], Vaibhav Kumar Singh[2], Utkarsh Dubey[3]

[1,2,3]Sagar Institute of Science and Technology, Bhopal, India

Abstract— Air-conditioning in the passenger cabin in commercial vehicle is a new concept in India and it has not been addressed. In summer season the temperature in various parts of India goes very high and results in unbearable temperature in passenger cabin of commercial vehicles. Thus, in such conditions an air cooled cabin for passengers and commercial vehicles is necessary. It is seen that much work has not been done in the field of lodge cooling of travelers in business vehicle.The available options in heat generated cooling have been critically reviewed. The Vapour Absorption Air Conditioning System is found to be suitable for automobile and air cooling specially for passengers in commercial vehicles. The warmth potential in the fumes has been investigated and discovered to be adequate enough for driving in the proposed cooling framework. The significance of the work is that it will provide space cooling for the driver and thereby enhances his performance and efficiency without affecting performance of the engine essentially the fuel economy.Further the Vapour Absorption Air Conditioning System used non CFC refrigerant and instead we used R-134a thereby it has little effect on the environment. The present work is focused toward the design and development of an air cooling system for the cabin of vehicles using waste heat from automobile engine exhaust. This document gives an information about how much important is waste heat and using this waste heat we can develop air conditioning system without taking input from battery and also designing is developed and based on Vapour Absorption Air Conditioning System which demands for progressive work in future. In this article, we have designed different parts of the system and there basics behind it.

Keywords— Air Conditioning, Thermal Engineering. Vapour Absorption, Refrigerant.

I. INTRODUCTION

The delay further affects the economy, which is unacceptable. So some majors have to be taken to reduce the temperature inside the cabin of vehicle and provide comfort to the driver. Considering present energy crises all over the world. It is a lot of important to investigate new innovation and potential to fulfill the need the need of society simultaneously the effective administration of the creation and vitality preservation is likewise similarly significant. In vehicle huge measure of warmth as contribution around 25% of the absolute warmth provided is disappearing with exhaust gases at extremely high temperature and around 25% is disappearing with cooling water. So if this waste warmth can be used for controlling an Air molding framework it will be conservative and the fuel vitality can be utilized successfully. Considering all above factor different alternatives have been studied and the vapour absorption system is found to be the most promising alternative. The paper deals with the preliminary design of vapour absorption system and a simulation model has been developed for both the system to predicted the performance of the system, design for given operation condition, under various off - design operation condition. The signification of the work is that it will provide space cooling for the driver and thereby enhance his performance and efficiency performance of the engine essentially the fuel economy. Further the vapour absorber cycle use non CFC refrigerant and thereby have little effect of environment.

In the early years of the twentieth century the vapour absorption cycle using water- ammonia systems became popular and widely used but after the development of the vapour compression cycle, it lost much of its importance because of its low coefficient of performance (about one fifth of that of the vapour compression cycle). The vapour absorption cycle is used only where waste heat is available or where heat is derived from solar energy. Absorption refrigerators are popular alternative to conventional compressor driven refrigerators. Where electricity is costly, unreliable, or unavailable, and noise from the compressor becomes a problem. Absorption cooling was invented by the French scientist Ferdinand Carre in 1858.

The initial flow of the refrigerant from the evaporator to the absorber occurs because the vapor pressure of the refrigerant-absorbent in the absorber is lower than the vapor pressure of the refrigerant in the evaporator. The vapor pressure of the refrigerant-absorbent inside the absorbent determines the pressure on low-pressure side of the system and also the vaporizing temperature of the refrigerant inside the evaporator. The vapor pressure of the refrigerant-absorbent solution depends on the nature of the absorbent, its temperature and concentration.

When the refrigerant entering in the absorber is absorbed by the absorbent its volume decreases, thus the compression of the refrigerant occurs. Thus absorber acts as the suction part of the compressor. The heat of absorption is also released in the absorber, which is removed by the external coolant.

II. METHODOLOGY

The Vapour Absorption Air Conditioning System is a heat operated system. It is quite similar to the vapour compression system. In both the systems, there are heater and condenser. The process of heater and condensation of the refrigerants takes place at two different pressure levels to achieve refrigeration in both the cases. The method employed to create the two pressure levels in the system for heater and condensation of the refrigeration makes the two processes different circulation of refrigerant in both the cases of also different.

In the absorption system the compressor of the vapour compression system is replaced by the combination of the absorber and generator a solution as the absorbent, which is an affinity for the refrigerant used is circulated between the absorbed and the generator by a pump (solution pump). The absorbent is the absorber drawn of (or sucks) the refrigerant vapour format in the heater thus maintaining the low pressure in the heater to enable refrigerant to heat at low temperature. In the generator the absorbent is heated. There by releasing the refrigerant vapour (absorbed in the absorber) as has pressure vapour, to be condensed in the condenser. Thus the suction function is performed by performance by absorbent in the absorber and the generator performs the function of the compression and discharge. The absorbent solution carries the refrigerant vapour from the low (heater-absorber) to the high side (generator-condenser). The liquefied refrigerant flows from the condenser to the heater due to pressure difference between the two valves; thus establishing circulation of the refrigerants through the system.

III. IMPLEMENTATION

In our project we developed a model of a refrigeration system which is working on the principle of Vapour Absorption Air Conditioning System. In this model we used the hollow copper pipe of Dia 1 mm approx and all the part of this system made by this metal itself. Refrigerant used in this is R-134a and the important parts of the system are Collector, Condenser, Capillary Tube (Expansion value), Evaporator and Fan.

Process of the system that we are lacking heat from Radiator of the Engine of the vehicle. As water is supplied to the container in which the collector is placed. Thus, the collector get's heated by the hot water and Refrigerant changes into vapor form. Then the vapor goes into the condenser where some amount of decrease in temperature of the refrigerant occurs then it goes to evaporator through the capillary tube, one fan is placed at the evaporator part which transfers the cool air the cabin of the vehicle.

Collector:- It is made by copper tube by rounding that around 30-35 turns. The main function of this is to store the liquid Refrigerant so that when the heat is provided to the collector from radiator it will be heated and the refrigerant change into the vapor form the collector us directly in touch with the hotwater.

Condenser: - Main function of the condenser is to remove heat and reduce the temperature of vapor Refrigerant discharged from collector. The hot vapour refrigerant consists of the heat absorbed by the evaporator.

Capillary Tube: - Capillary tube is used to reduce the temperature of the refrigerant itchills down the refrigerant and reduces the pressure as well.

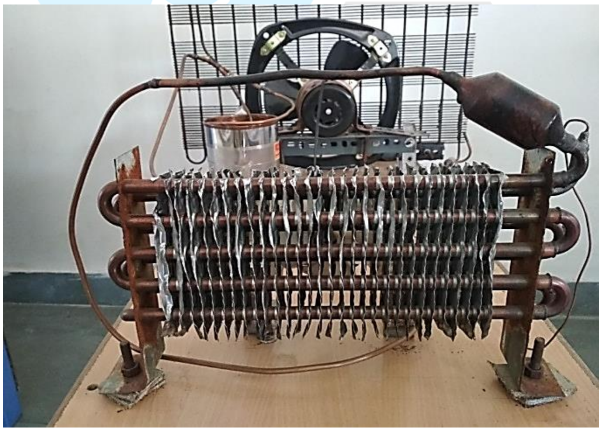
Evaporator: - It is main part of the system which is used to transfer the heat. It takes the cold heat coming from the capillary tube made by forming the zig - zag form of the tube and we placed a fan behind it which will be providing cold air during the process.

Fan: - Two small AC fans are used to transfer the cold heat into the cabin of the vehicle.

Refrigerant used-The R-134a is considered to be the most imported substitute for Refrigerant R-12. Its boiling point is -26.15˚C which is quite close to the boiling point of R-12 which is -29˚C at atmospheric pressure. Since the refrigerant R-134a has no chlorine atom, therefore this refrigerant has zero ozone depletion potential (ODP) and has 74% less global potential (GWP) as compared to R-12. It has lower suction pressure and large suction vapour volume. It is not soluble in mineral oil. Hence for use in domestic refrigerator, suitable synthetic oil is used. Care should be taken to prevent moisture from getting into the refrigeration system. For use in existing R-12 reciprocating compressor, it would require either an average increase in compressor speed of 5%-8% of an equipment increase in cylinder volume.

PROPERTIES OF REFRIGERANT R-134A

Molecular Weight	102.03gm/mol
Boiling Point (1.013 bar)	-26.55˚C
Vapour Pressure (at 20˚C or 68˚F)	5.7 Bar
Critical Temperature	100.95˚C
Critical Pressure	40.6 Bar
Critical Density	512 kg/m^3
Gas Density (1.013 bar at Boiling Point)	5.28 kg/m^3
Specific Gravity	3.25



V. RESULTS

By the testing of this experiment we have got the temperature inside the cabin is almost the low of the room temperature which is comfortable for a driver & co-driver. Second thing we have also got temperature inside the cabin which is not very low and which causes sleeping phenomenon of driver. Our objective is to make effective air conditioning using waste heat of IC Engine of commercial vehicle. Till now every refrigeration system in commercial vehicles is working on Vapour Compression Refrigeration System, in which their compressors are driven by engine power directly, which reduces the engine efficiency in terms of power output and fuel consumption. It also reduces the sudden pick-up of the vehicle, if compressor is working.

- Pollution free system.
- It can be used in food storage plant and automobile cabin.
- One-time investment with minimum running expense.

OBSERVATION TABLE

S. No.	Absorber Temp. (T1)	Condenser Temp. (T2)	Evaporator Temp. (T3)
1	70 - 80	65	-5
2	70 - 80	63	-7

CALCULATION OF COP –

Assuming ideal condition

COP = Lower Temp. / (Higher Temp. – Lower Temp.) COP = 267 / 70 = 3.814

VI. CONCLUSION

It is possible to design an automobile air conditioning system using radiator heat based on Vapour Absorption Air Conditioning System. Also from the environmental point of view this system is Eco-Friendly as it involves the use R-134a as a refrigerant which is not responsible for Ozone layer depletion.

The remaining heat in the Radiator cooling system has no particular used so it is required to utilize waste heat into the useful work. By the completion of this project we able to utilized the heat energy of Radiator into cooling of the cabin of the vehicle. COP of the model comes around 3.814.

They're very end utilization of waste heat not only conserves fuel (fossil fuel) but also reduces the amount of waste heat. The study shows availability and possibility of waste heat from radiator of the vehicle; also describes loss of heat energy of a Radiator. Possible method to recover the waste heat from Radiator is to make Air conditioning system which works on VAACS (Vapour Absorption Air Conditioning System).

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