Design and Development of Absorption Air-conditioning system for Passenger Car

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Abstract- *Now a day's engineers are looking for the recovery of the waste heat that came from the exhaust of the engine and other source. The absorption system is essentially an air conditioning system that will use the heat from the exhaust to create cooling effect in automobile. This system will enable us to increase the thermal efficiency of the automobile as we are using the waste heat. This further will reduce the load on the engine, as there will be elimination of compressor work performed by the engine for cooling purpose of passenger space. Most importantly the absorption system will have eco-friendly refrigerant being used for its operation. So there will be no harmful gases will be discharge in the environment. This application of system will enlighten the importance of use absorption air condition system in automobile. This system will be cost effective and easy to implement in cars and as well as heavy duty cold storage transport vehicles.*

Keywords- Air conditioning, Absorption system, Exhaust gas, Waste heat recovery

I. INTRODUCTION

As our country is situated near the equator, we experience more amount of solar energy of sun in form of heat. These heat can be utilised in various form of overcome our energy cries. The second important thing is also a reason for uncomfortable living of human in summer and in its people range. To overcome these we use air-conditioning and reform system, which consumer a large amount of energy in form of electricity. And as our living standard is getting increase, the use of this energy is increasing rapidly. And these systems are also harmful to our environment causing global warming and greenhouse effect, and its effects are so dangerous which can limit our existence on this planet. The absorption system is an air conditioning and refrigeration system which uses this heat to produce cooling. And these system works on low or waste quality of heat energy. The application of absorption system is to be in thermal power plant, automobile and in providing comfort in homes and restaurant by using solar and waste cooking heat. Out of these our application is in automobile section, which currently is in more demand and we also know the fact the in I.C engine 40-45% of heat goes waste to environment. On the other hand a lot studies has been done on absorption cycles and its flexibility of providing air conditioning by using exhaust gas [1]. Our study is concern about the fabrication and installation of the system in the real environment, so as find out its working feasibility and also to overcome its drawbacks by using efficient engineering practices.

II. HEAT AVAILABLE FROM EXHAUST GAS

To calculate the cooling potential is need to estimate the heat energy available in the exhaust gas. Fig. 1 shows the exhaust gas temperature and its flow rate with the speed of the passenger car.

Assuming that all the exhaust mass inducted in a cycle is expected in the exhaust stroke the total energy available in the exhaust gas Qex is

$$Qex=Mex*Cp\ (Tex-Ta)$$

Where Mex is the exit gas flow rate,Cp the specific heat of the exhaust gas and Tex and Ta are the exhaust and ambient temperature respectively. The coverage of the utilizable heat will depend upon the effectiveness of the heat exchanger (regenerator in the case)

Assuming the effectiveness, E of the heat exchanging duct, the regenerator thermal input becomes.

$$Qo=E.Mex*Cp\ (Texi-Texf)$$

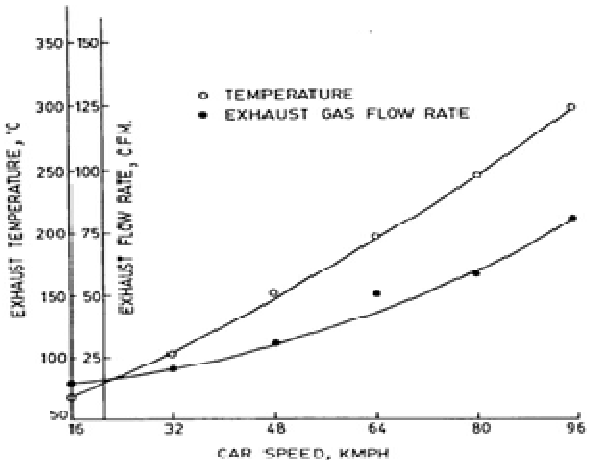

Fig.1.Temp. & flow rate V/s Car Speed [1]

III. COOLING LOAD CALCULATION

The heat balancing method (HBM) is used for estimating the heating and cooling loads encountered in the vehicle cabin. We consider a lumped model of a typical vehicle cabin. The net heat gain by the cabin can be classified under nine different categories. The total load as well as each of these loads can either be positive (heating up the cabin) or negative (cooling down the cabin) and may depend on various driving parameters. In the following, the models developed for each of these load categories are presented and discussed. Some of the correlations used in the present model are based on experiments performed on certain vehicles, which are used here for general validation of the model.

New correlations can be readily plugged into the present model can be tailored to any new vehicle, after specifying those correlations for the case.

The summation of all the load types will be the instantaneous cabin overall heat load gain. The mathematical formulation of the model can thus be summarized as

$$\dot{Q}_{Tot} = \dot{Q}_{Met} + \dot{Q}_{Dir} + \dot{Q}_{Dif} + \dot{Q}_{Ref} + \dot{Q}_{Amb} + \dot{Q}_{Exh} + \dot{Q}_{Eng} + \dot{Q}_{Ven} + \dot{Q}_{AC}$$

Q_{Tot} = 1.13 kW

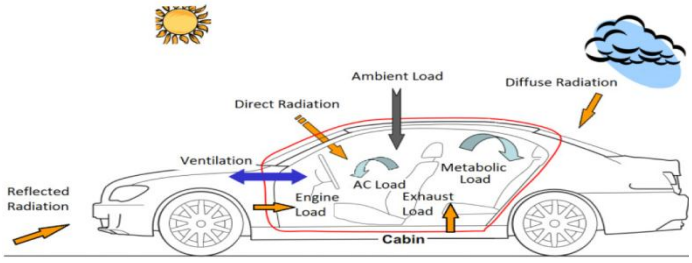

Fig.2.Various Heat load on car [2]

IV. MODELLING AND SYSTEM ANALYSIS

(A) Calculation Of Mass Flow Rate

1.5kw Aqueous lithium bromide absorption system. Assumption needed to be taken for the system.

Condenser temperature =35°C
Evaporator temperature =7°C
Absorber temperature =37°C
Generator temperature =85°C

Pressure value are taken from ph chart of water as refrigerant for condensing temperature 35°C and evaporating temperature 7°C

Evaporator Pressure =1Kpa
Condenser Pressure =5.696Kpa

1. For Evaporator

Heat load on evaporator
Qe=1.5KW
Qe=Mr*(h1-h4)

Where, Enthalpy at inlet, h1 =2513 KJ/Kg
Enthalpy at outlet, h4=146.6KJ/Kg
Therefore,
Mass flow rate, Mr=0.0006338Kg/sec

2. For Generator

Mass balancing of weak and strong solution

M7=M2+M8

Now, X7M7=M8X8
Assuming
1. Strong M8= 60% concentration of li-br
2. Weak M7=55% concentration of li-br

M7*0.55=M8*.6
(M2+M8)0.55=M8*.6
M2=M8 [0.6-0.55] /0.55
M2=0.0909*M8 [Here M2=Mg=M4
M4=M1=0.000633]
M7=M2+M8
M7=0.0909*M8+M8
M7=1.0909M8

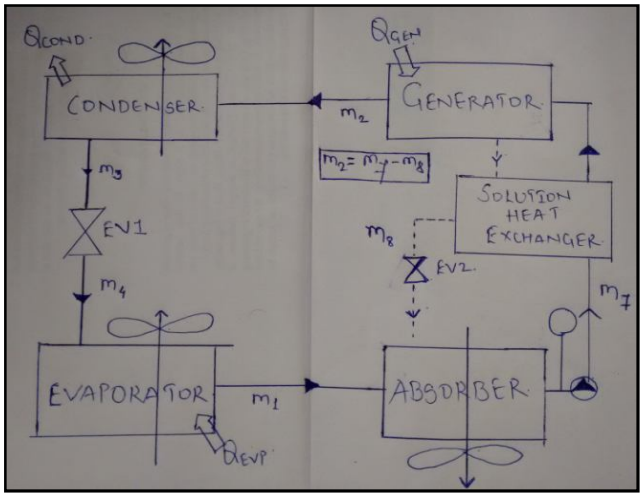

Fig.3. Block Diagram of VAS

Putting the value of above equation in A,
We get,

M8=0.0069724 kg/sec
M7=0.007606 kg/sec
Therefore, M2=M7-M8
=0.007606-0.006972
M2=0.000633 kg/sec
So, the mass flow calculation for the system
M1=M4=M3=M2=0.000633 kg/sec
M7=0.007606 kg/sec
M8=0.0069724 kg/sec

B. Design Of Absorber And Regenerator

As our system is bulky and require more space is major the difficulty in its installation. In automobile VCR system requires very less space as only compressor is used, but in absorption system compressor is replaced by an absorber, a generator and a pump. Hence, locating these components is a major task in implementation of this system in automobile.

a) Absorber

We modified the absorber construction for its efficient working with reduction of its size. The below fig.2 shows the snap shot of the absorbers exploded view in Creo 1.0 format. The absorber will consist of four parts viz. collecting vessel, Distribution hollow conical plate, head cover and copper helical tube.

The collecting vessel is used to store weak solution and has cylindrical section with rectangular fins of max H.T. It has inner diameter of 100mm and length of 100mm with 1mm thickness. The lower section is kept conical so that Li-Br salt should not accumulate in the absorber. Then is an outlet at top of cone which will be connecting to the pump via hoses.

Fig.4.Exploded view of Absorber in Creo

The second part is the distribution plate which is hollow and conical and has holes on upper and lower plate. It will be dipped in the weak solution. It is an outlet for strong solution and refrigerant which is coming from top. Then is a Head cover for packing of the absorber and a helical copper tube which connect the head cover and distribution plate.

b) Generator

The generator is modified by taking consideration of exhaust manifold and constructed such the maximum heat transfer should be allowed so as to vaporize the refrigerant in the generator.

It will be kept simple, just like tube in tube type Heat Exchanger. The outer tube will have two outlet viz. for stronger solution and vapour reference and a single inlet for weak solution. The fig.5 shows the line diagram of the proposed generator.

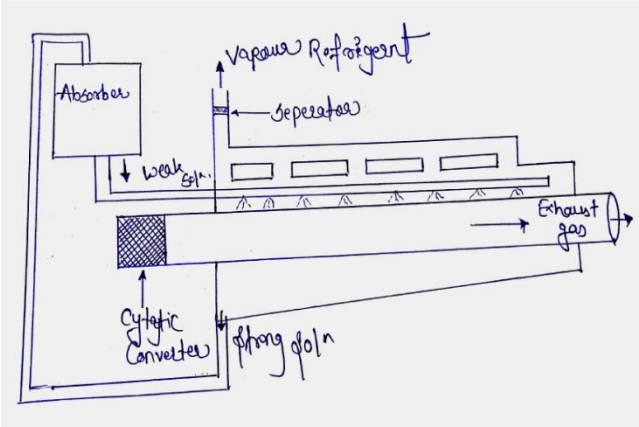

Fig.5.Line Diagram of Generator

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