International Journal of Advance Engineering and Research Development
Scientific Journal of Impact Factor (SJIF): 4.72
Special Issue SIEICON-2017,April -2017
e-ISSN : 2348-4470 p-ISSN : 2348-6406

Experimental Setup of Automotive Air-Conditioning based on Vapour Absorption Refrigeration System

Viren Bagadiya[1], Kalprajsinh Zala[2], Mayur N. Patel[3]

[1]*Mechanical Engineering Department, C.G.P.I.T*
[2]*Automobile Engineering Department, C.G.P.I.T*
[3]*Mechanical Engineering Department, C.G.P.I.T*

Abstract *— Now a days the air conditioning system which is mainly used in automobile is vapor compression refrigeration system but here this work represents study of air conditioning system in automobile by vapor absorption refrigeration system using lithium bromide as an absorber and water as a refrigerant. An experimental setup is design and fabricated by using different components to produce cooling effect.*

Keywords*- Vapour absorption refrigeration system; Automobile air-conditioning; Lithium bromide; Experimental setup;*

I. INTRODUCTION

The air-conditioning system which is widely used in an automobile vehicle is vapour compression refrigeration system. Automotive air-conditioning system cool the inside air of the vehicle. It mainly consists of compressor which is driven by an engine, condenser which is located in front of the radiator, Expansion valve and evaporator. Qualitative picture of all this components are given in figure as follows.

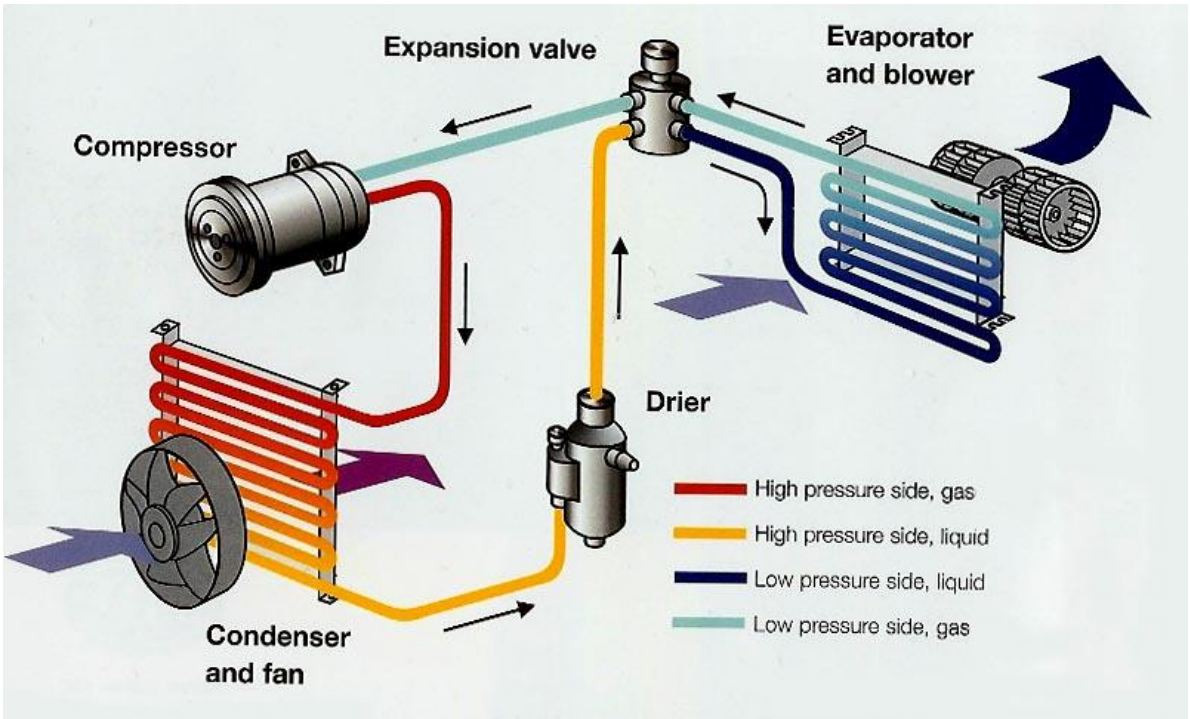

Figure 1.-Vapour compression refrigeration cycle

Vehicle air conditioning system is shown in figure. This system works by compressing the refrigerant using a compressor, it increases the pressure and temperature of the refrigerant and here the refrigerant is vaporized. Now this refrigerant is passed through the condenser where its phase change or we can say its latent heat of the refrigerant is removed and is liquefied. This refrigerant is then passed through the expansion valve where its pressure & temperature are reduced. The chilled refrigerant is then passed through the evaporator to produce sufficient cooling effect. The function of a blower is to blows the air through the evaporator to produce the desired cooling inside the cabin of vehicle. Now this refrigerant absorbs the heat of the air from the compartment & vaporizes, which is then passed through the compressor. Hence cooling effect is produced inside the vehicle. The main hurdle for this system is power required to run the

compressor is taken from the engine main shaft, hence to maintain the same power the engine has to produce more work ultimately the engine consume more fuel.

3.1. Vapour Absorption system

In this experiment we used vapour absorption refrigeration system to produce refrigerating effect. In the vapour absorption refrigeration system, the compressor is replaced by an absorber, a pump, a generator and a pressure reducing valve. The refrigerant, commonly used in the system, is water (H2O). The reason behind using water as a refrigerant because in generator there is a mixture of lithium bromide and H2O but boiling point of lithium bromide is 1265˚C, so in generator water is converted in vapour and this water vapour is used as a refrigerant throughout the system. Where lithium bromide remains in liquid state and return back to the absorber. As an absorber we used Lithium Bromide instead of ammonia. There are main two key disadvantages for not using ammonia as a refrigerant, First ammonia as a refrigerant is not compatible with copper tubes because of its corrosive in nature and second it is poisonous in high concentrations.. The schematic diagram of this vapour absorption system is given below.

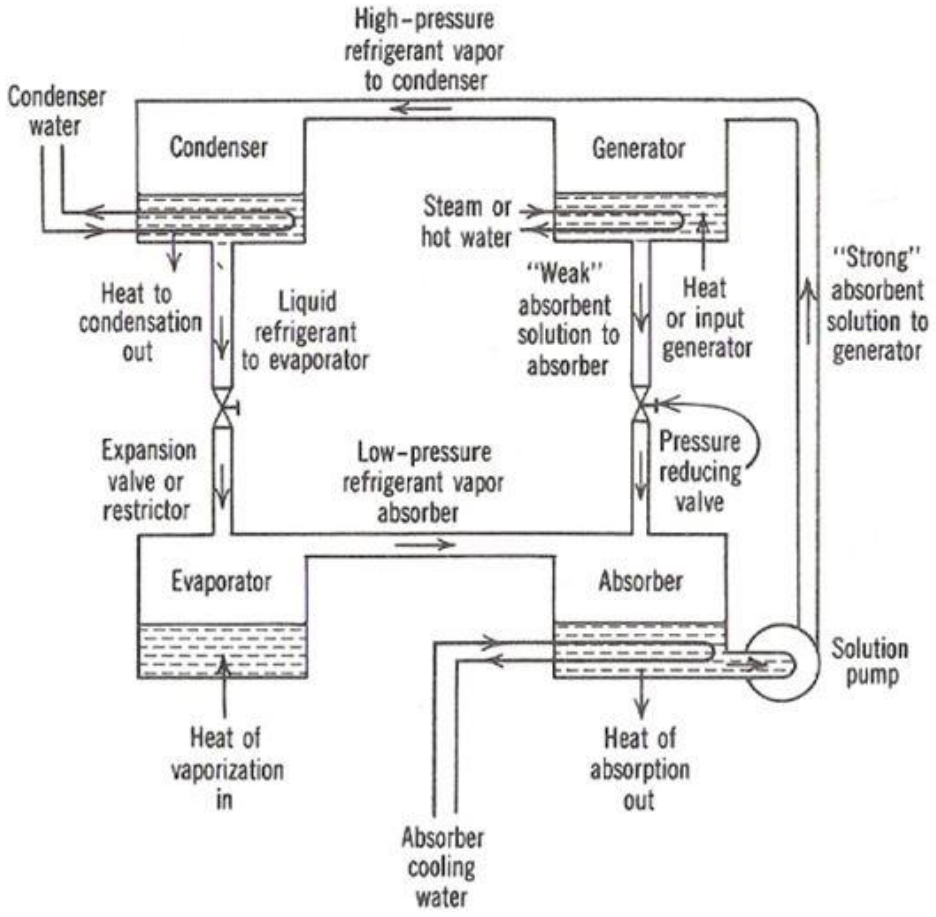

Figure 2. -Vapour Absorption Refrigeration System

The evaporator and absorber are situated at low-pressure side while the condenser and generator are located on the high pressure side of the system. In this system high pressure refrigerant vapour from the generator gets condensed into low pressure liquid refrigerant in the condenser and passed into the evaporator through the expansion valve. The liquid refrigerant gets vaporized in the evaporator into low pressure vapour refrigerant and enters into the absorber. The existence of absorbent in the absorber, it changes into a strong hot solution. This strong solution of low pressure is again pumped into the generator which is at high pressure. The strong solution in the generator is heated up separating solution and vapour. This weak absorbent solution left in the generator is returned to the absorber and the high pressure vapour refrigerant is passed into the condenser thus completing the cycle.

The power required for pumping is almost negligible and hence refrigerating effect is obtained from a vapour absorption system without any mechanical power being done on it. But the refrigerating effect produced from a vapour compression refrigeration system is comparatively higher than that produced from a vapour absorption refrigeration system of same capacity. The advantages of vapour absorption system over vapour compression system are many as there is no moving part in the entire system, the operation is quiet , and subjected to a very little wear, so that the maintenance cost is very low. The pump motor is comparatively small as compared to the motor required for a compression system of same capacity. The common method used in air conditioning of automobiles is vapour compression refrigeration system.

Here for our work we used vapour absorption refrigeration system as a refrigerant we used water (H2O) and Lithium Bromide as absorbent is used for producing refrigerating effect in automobiles. As an IC engine has an efficiency of about 35-40%, converts only one-third of the energy in the fuel into useful work and about 60-65% is wasted to environment. In which about 28-30% is lost by cooling water and lubrication losses, around 30-32% is lost in the form of exhaust gases and remainder by radiation, etc. For the purpose of study this experiment we uses the electrical heating coil equivalent to exhaust temperature.

II. FABRICATION OF PARTS

2.1 Generator

Generator is the component in which the heat is applied so that the vapour can be generated. In generator, the heater is applied for evaporation of the refrigerant from the solution. For this purpose we take the heater at the capacity of 3kw. This heater is clamped outer side of the generator.

Figure 3.- Generator

Figure 4.- Generator with Heater

When the steam is generated, it has the passage for the supply in the condenser through the steam control valve. It also maintains the flows of the vapor according to the load apply.

2.2 Absorber and Pump

In order to keep evaporating, the refrigerant vapor must be discharged from the evaporator and refrigerant (water) must be supplied. The refrigerant vapor is absorbed into lithium bromide solution, which is convenient to absorb the refrigerant vapor in the absorber. The heat generated in the absorption process is continuously removed from the system by cooling water. The absorption also maintains the vacuum inside the evaporator.

Pump is required to pressurize the liquid and control the flow of the liquid. To continue the process the liquid is continuously supply to the generator. So the pump is required. The selection of the pump depends upon the amount of the solution to be pumped for producing the required effect from absorber to generator. When the steam is generated then the amount of solution is reduced in the generator and it becomes the weak solution. So continue supply of solution is required. It can be achieved by supplying the solution from the absorber with the help of the pump. So we have used submersible pump in the absorber vessel which supplies the required amount of solution to the generator. When the amount of solution is increase in generator then it can be easily controlled by removing from the generator with the help of the discharge pipe. The discharge pipe is connected with the too-way valve so the amount of flow can be controlled in the discharge pipe

Figure 5.- Pump

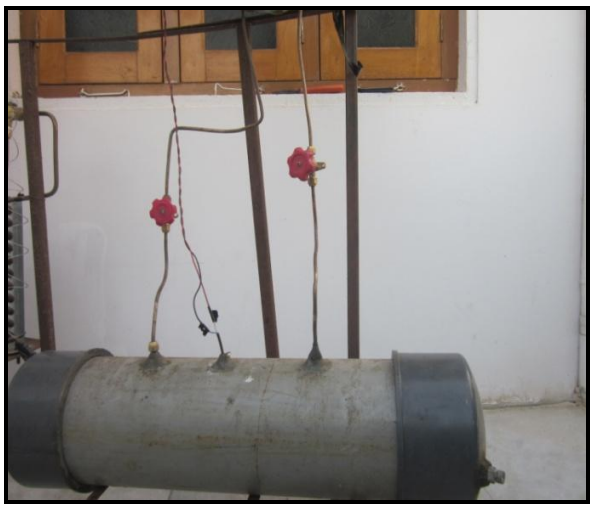

Figure 6.- Absorber

In the absorber the storage of the solution of refrigerant and absorber is done. For the continuous cooling effect it is accentual that the supply of solution is take place at the continuously from the absorber to the generator. In the absorber, the salutation which is come from the generator is hot. And for the proper absorption of the water with the libr the temperature should be low. So for the cooling of the solution the cooling coil is used. It is made from the copper coil. The cooling water is applied to flow in the coil to cool down the solution.

2.3 Condenser

The steam coming out from the generator passes through the copper tubing and enters into inlet of the condenser. The condenser used is a copper coil of ¼" dia. and the length of the condenser is 330cm. Condenser extracts the heat of the steam and the vapor is converted into liquid form. Cooling system is provided for the efficient cooling of the condenser coils.

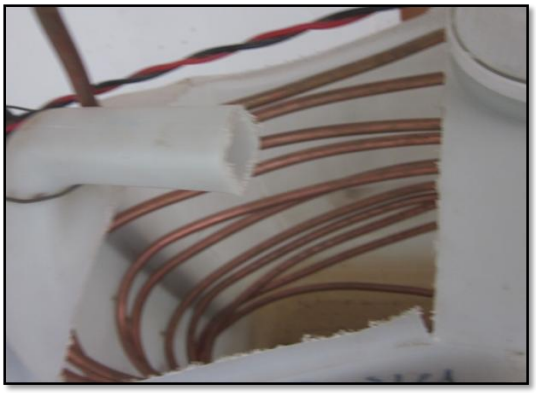

Figure 7.- Condenser

2.4 Thermostatic expansion valve

The high pressure liquid from the condenser outlet is passed through the thermostatic expansion valve and the pressure is decreased by iso-enthalpy process.

Figure 8.- Expansion Valve

2.5 Evaporator

Steam's pressure is reduced in the pressure reducing value upto evaporator pressure. This chilled water is sprayed by an evaporator pump where it absorbs its latent heat of vaporization from hot water circulated from air-conditioned space in chilled water tubes. During the process, the hot water gives away heat and is converted into chilled water, thereby, it produces the required refrigeration load for air-conditioning purposes and the sprayed cool water is converted into water vapour.

Figure 9.- Evaporator

III. EXPERIMENTAL SETUP

The basic working of this system is explained in this section, generator and condenser are located in high pressure vessel and the evaporator and absorber are located in low pressure vessel. Weak Li Br solution from absorber is circulated by the solution pump to generator. Weak Li Br solution is heated by the heater which is enclosed around the generator tank. As a result, the water refrigerant from weak solution of LiBr is converted into water vapor leaving behind the strong solution of LiBr in generator. The water vapor passes through the copper tubing which can be visualized in a glass tube placed after the generator outlet. Refrigerant is condensed by the water circulated from cooling pond which condenses the water vapour formed.

Figure 10.- Experimental Setup

The condensed water vapour refrigerant from condenser at high pressure flows down from condenser. It's pressure is

reduced in the pressure reducing value upto evaporator pressure. The cooled water is sprayed in the evaporator as shown. This cooled water is sprayed by an evaporator pump where it absorbs its latent heat of vaporization from hot water circulated from air-conditioned space in chilled water tubes. During the process, the hot water gives away heat and is converted into chilled water, thereby, produces the required refrigeration load for air-conditioning purposes and the sprayed cool water is converted into water vapour. This water vapour is absorbed by the strong Li Br solution sprayed in the absorber and it is converted into weak Li Br solution.

IV. RESULT

4.1 Comparison of COP and Temperature

COP can be obtained by this equation : $COP = \left(\frac{T_E}{T_C - T_E}\right)\left(\frac{T_G - T_C}{T_G}\right)$

Here we can get both parameters cop and temperature as given below.

Table 1 Temperature and COP of the System

Reading	T_A(K)	T_G(K)	T_C(K)	T_E(K)	COP
1st	309 (36°C)	393 (120°C)	318 (45°C)	288 (15°C)	1.83
2nd	310 (37°C)	390 (117°C)	319.5 (46°C)	289 (16°C)	1.7128
3rd	308 (35°C)	393 (120°C)	320 (47°C)	288.5 (15.5°C)	1.7143
4th	312 (36°C)	391 (118°C)	321 (48°C)	289 (16°C)	1.61

V. CONCLUSION

Based on the result and discussion and observation the following conclusions are drawn:

- The system can be easily adopted for heavy vehicles as more exhaust heat from the engine will be available. This is new technique to be used in automobile air conditioning, industrial refrigeration and air conditioning system especially in food preservation.
- The heat required in Generator can be save up to 30% by using hot exhaust gases as an energy source. The part load on engine will be reduced as there is no work required to run the compressor, so thermal efficiency of engine increases.
- Either the decrease in the temperature of evaporator or the increase in temperature of Generator, the COP of the system decrease respectively. The minimum condenser temperature to increase the refrigerating effect of the automobile air conditioning system.

REFERENCES

[1] Performance Improvement in Automotives Engines using Vapour Absorption Refrigeration System for Air Conditioning (document no. 2005-01-3466, published at date September 2005) by Jayaraman Venkatesam, Bhargav V.K., V M Praveen, Bharat B Moorthy (all from Sri Venkateswara college of engineering).

[2] Ananthanarayanan P N (2005) 'Refrigeration and Air Conditioning', Tata McGraw-Hill, 3rd edition, pp 398-424.

[3] Arora : domkundwar, (2008) ' A course in Refrigeration and Air Conditioning', Dhanpat Rai & co, 7th edition, pp 6.1-6.23

[4] Absorption refrigeration and air conditioning system (US document no. 3661200) by Thomas J.McNamara, 317 Harding Ave Des Plaines, III, 60016.

[5] Andre Aleixo Manzela, Sergio Morais Hanriot, Luben Cabezas-Gomez, Jose Ricardo Sodre a PETROBRAS, exploration and production, Av. Rui Barbosa, 1940- 3_andar, 27915-012Macae-RJ,Brazil.

[6] Satha Aphornratana, Thanarath Sriveerakul. Experimental studies of a single effect absorption refrigerator using aqueous lithium- bromide: Effect of operating condition to system performance, Science Direct, 30Aug(2007), 658-669.

[7] K.K.DattaGupta, D.N.Basu and S.Chakravati. Optimization study of a solar-operated lithium bromide-water cooling system with flat 7.Mohammad Ali FAyazbakhsh and Majid Bahrami. Comprehensive Modeling of vehicle air conditioning loads using heat balance method, SAE international,04/08/2013,2013-01-1507

[8] Florides, G.A., Kalogirou, S.A., Tassou, S.A., Wrobel, L.C. Design and construction of a LiBr–water absorption machine, Energy Conversion and Management 44 (2003) 2483–2508.

