EXHAUST GAS POWERED AUTOMOBILE AIR-CONDITIONING BY VAPOUR ABSORPTION REFRIGERATION SYSTEM

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ABSTRACT

The conventional automobile air conditioning system draws power from the engine. Whereas the Heat generator gets the exhaust gas directly from the engine and the heat from that exhaust gas is transfer to the heat generator of the vapour absorptions refrigeration system. So through the air conditioning effect is obtained without any loss of crankshaft power. Applying this principle there is no drop in mileage and also additionally the fuel can be used more efficiently and economically. Thus the crankshaft power which is used for normal refrigeration phenomenon has been saved.

Key Words: Refrigeration System, Vapor Absorption, Auto-mobile Air conditioning, Exhaust system.

1. Introduction

In recent trend many of the projects are carried out based on the conversion of waste energy into the useful work. Out of all the available sources, the IC engines are the major consumer of fossil fuel around the globe. For the IC engine the total heat supplied in the form fuel in that approximately 30 to 40% is converted into useful mechanical work. The remaining energy is expelled to the environment in the form of heat through exhaust gases and cooling systems. Which results in serious environmental pollution, so it is required to utilized waste heat into useful work. Most of the air-conditioner takes power form the crank shaft and gives output. But here the another way to give a input to the air-conditioner by the form of heat, it works on vapour absorption system. Where in vapour absorption system the input, and in engine the output are same. So the vapour absorption system is used to save the energy. In vapour absorption system the refrigerant is absorbed from the evaporator, the absorbing medium being a solid or liquid. In order that the sequence of events should be continuous it is necessary for the refrigerant to be separated from the absorbent and subsequently condensed before being returned to the evaporator. The separation is accomplished by the application of direct heat in a heat generator.

The exhaust gas of the engine after the combustion in the cylinder has high temperature . which is passes inside the heat generator to transfer the heat from the exhaust gas to the refrigerant and the absorbing medium mixer to separate them for a cyclic process of cooling in the system. Where there is no back pressure on the engine to decrease the efficiency of the engine and to decrease the mileage of the engine.

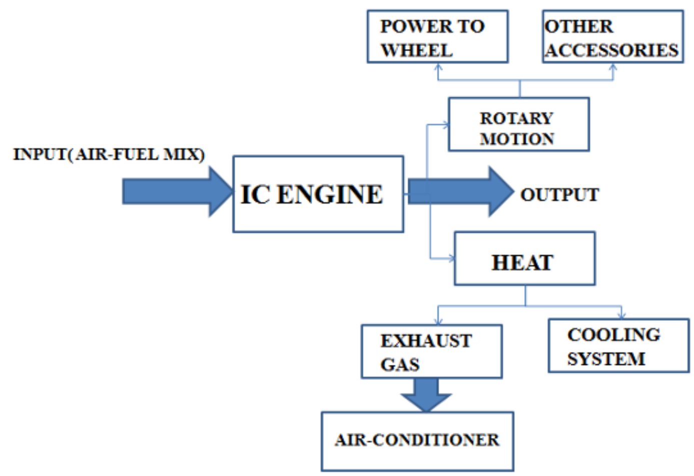

Fig.1

2. Simple vapour absorption system

Refer to Fig. 2 the simple vapour absorption system explains. The solubility of ammonia in water at low temperature and pressure is higher than it is at higher temperature and pressure.

The ammonia vapour exit the evaporator at absorber is readily absorbed in the low temperature strong solution in the absorber. This process is accompanied by the elimination of heat. The ammonia in a water solution is pumped to the higher pressure and is heated in the heat generator. Due to reduced solubility of ammonia in water at the higher pressure and temperature, the vapour is aloof from the solution. The vapour then passes to the condenser and the weakened ammonia in water solution is reverted to the absorber.

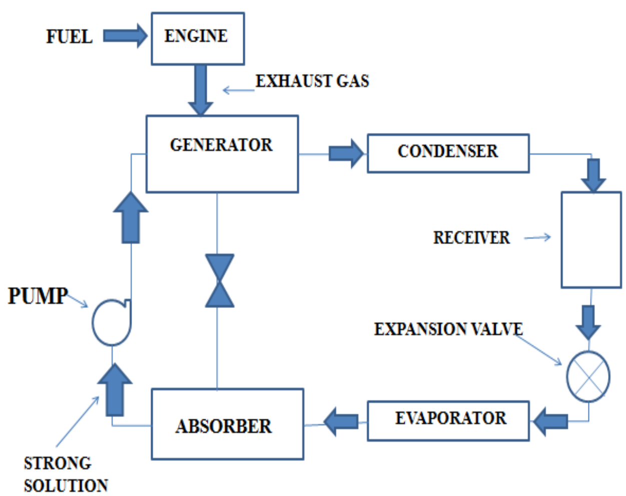

Fig. 1

In condenser the heat transfer surface through which heat passes from the hot refrigerant vapour to the condensing medium. Which the hot refrigerant is converted into normal refrigerant at same pressure(high pressure). Then it passes to the expansion valve where the pressure drops occurs on the refrigerant which makes very cold and low pressure on it . In the evaporator the heat transfer surface through which heat passes from the cold refrigerant liquid to the evaporating medium, and absorb the heat from the evaporating medium it become hot refrigerant. In the simple vapour absorption refrigeration system the performance of the process is low

3. Practical system

Refer the fig. 2 the simple vapour absorption system can provide refrigeration yet its operating efficiency is low. The following accessories are fixed to make the system more practical and improve the performance and working of the system.

1. Heat exchanger
2. Analyser
3. Rectifier

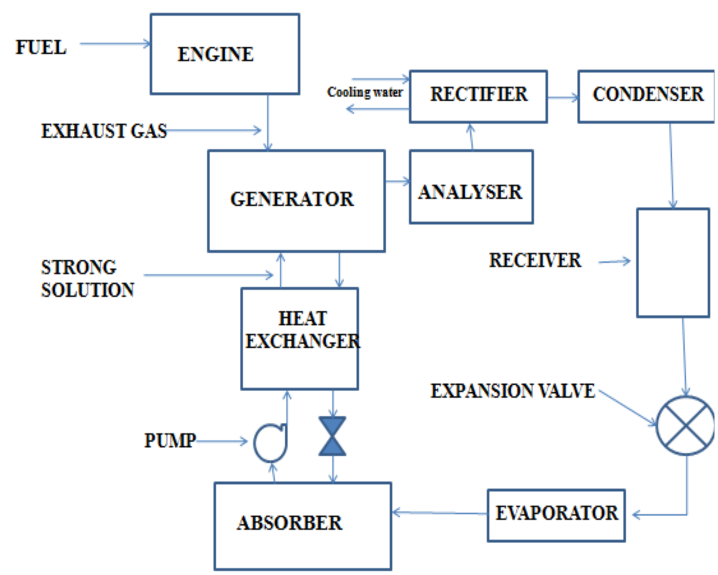

Fig. 3

3.1. Heat exchanger

A heat exchanger is to be found between the generator and the absorber. The strong solution which is pumped from the absorber to the generator has be heated and the weak solution from the generator to the absorber has be cooled. This is consummate by heat exchanger and consequently cost of heating the generator and the cooling the absorber are reduced.

3.2. Analvser

. If these water vapours are permitted to enter condenser they may enter the expansion valve and frezze as a result the pipe line may get choked.

3.3. Rectifier

A rectifier is a water –cooled heat exchanger which condenses water vapour and some ammonia and sends back to the generator. Thus final reduction or elimination of the percentage of water vapour takes place in a rectifier.

The co-efficient of performance of a systems given by:

C.O.P

$$= \frac{heat extracted from the evaporator}{heat supplied in the generator + work done by the liquid pump}$$

4.Comparison between the refrigeration cycle in automobile

4.1. Vapour compression cycle

- The type of energy supply is mechanical – high grade energy. The energy supply is low .
- The wear and tear in the cycle is more.
- The performance at part loads is poor for this cycle.
- Charging of refrigerant is simple.
- Leakage of refrigerant is more chances .
- liquid traces in suction line may damage the compressor.

4.2.Vapour absorption cycle

- The type of energy supply is mainly heat – low grade energy. The energy supply is high .
- The wear and tear in the cycle is less.
- The performance at part loads in the system not affect by variations of loads for this cycle.
- Charging of refrigerant is difficult.
- Leakage of refrigerant is no chances .

5. Problem viewed

It this the heat loss from the engine is calculated. The engine taken for the test is kirloskar oil engine of Single Cylinder. 4-Stroke, Vertical Stationary C.I. Engine. Where that has;

Bore and stroke length = 87.5mm & 110mm.
Compression ratio = 17.5.
Power = 8hp (5.9KW) at 1500 rpm
Capacity = 661cc (0.661 Ltrs)
Sp. Fuel combustion = 220 g/KW-hr
RPM = 1500 rpm
BHP at 1800 rpm = 5.9 KW

Assuming,
Volumetric efficiency = 0.8 to 0.9
Density diesel fuel = 0.84 to 0.85 gm/cc
Calorific value of diesel = 42 to 45 MJ/kg
Density air fuel = 1.167 kg/m3
Specific heat of exhaust gas = 1.1-1.25 KJ/kg°K

Exhaust heat loss through CI engine

$$\text{Compression ratio}(R_C) = \frac{V_C + V_S}{V_C}$$

$$17.5 = \frac{V_C + 0.000661}{V_C}$$

$$17.5\, V_C = V_C + 0.000661$$

$$V_C = 0.00004\ m^3$$

Total volume (V_T) = $V_C + V_S$

$$= 0.00004 + 0.000661$$

$$= 0.000701\ m^3$$

Mass flow rate of fuel (m_f)

$$S.F.C = \frac{m_f}{power}$$

$$0.22 = \frac{m_f}{5.9}$$

$$m_f = 1.298\ kg/hrs$$

Mass of air = 0.9*1.16*(1500/2)*0.000661

= 0.5175 g/min

Mass of air = 8.625 g/sec

Mass flow rate of exhaust gas = mass of fuel + Mass of air

= 8.625 + 0.3605

= 8.985 g/sec or 0.00898 kg/sec

Heat loss in exhaust gas (Q)

Q = mass of exhaust gas * C^p * ΔT

= 0.00898 * 1.1 * (450-30)

Q = 4.1487 kJ/sec

Where the 4.1487 kJ of heat is converted into mechanical work but the remaining amount of heat is rejected by the exhaust gas

Power loss = Total power – power convert to work

= 5.9 KW – 4.1487 KW

Power loss = 1.7513 KW

Percentage of loss = power loss / total power

= 0.2968

= 29.68 % of heat is waste from the engine in the form of exhaust gas

Hence the 1.7513 KW of power may used for heat generator to heat the refrigerant and water mix and process the system to done work by the use of exhaust gas

5.Properties of ammonia

s.no	properties	ammonia
1.	Boiling point	−33.3 °C (−27.94 °F)
2.	Auto-ignition temperature	651°c(1204°F)
3.	Ozone depletion level	0
4.	Solubility in water	100 ml of water can dissolve as much as 31 gm of ammonia at 25 degree Celsius
5.	Critical temperature	405.5 K (132.3 °C)
6.	Cylinder color code	Shoulder(red),body(yellow&black)
7.	Global warming potential(GWP)	0

6. Conclusion

We carried out the study on the exhaust gas powered air conditioning by vapour absorption refrigeration system. From this we conclude that by implementing this method in automobiles will enhance the performance of engine and conservation of fuel .

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