

DESIGN AND FABRICATION OF EXHAUST GAS ASSISTED AIR COOLING SYSTEM

Solaman Chakravarthy¹ | Tom Joseph² | Vishnu Vijayan³

¹(Mechanical Engineering, UG Scholar, Christ The King Engineering College, Solamanchakravarthy5858@gmail.com)

²(Mechanical Engineering, UG Scholar, Christ The King Engineering College, tomjoseph030@gmail.com)

³(Mechanical Engineering, UG Scholar, Christ The King Engineering College, vishnudevijayan7418@gmail.com)

Abstract— Minimizing the input energy in any process will increase the efficiency of any system. Here we are introducing an alternative system in the air conditioning function in vehicles. Currently we are using the vapour compression system for air cooling system in vehicles. Our project is trying to use the vapour absorption cooling system in which the generator section will utilize the heat from the exhaust gas to separate the refrigerant and absorbent mixture. This design couples the vapour absorption cycle with auto motive air conditioning system instead of vapour compression cycle. On other hand in this design we use ammonia as refrigerant. It can reduce the impact on environment. However an economical heat generator should be introduced for proper functioning of the system. In this process we reduce the fuel consumption by using the exhaust gas waste heat. This system uses the exhaust waste heat of an internal combustion engine as energy source.

Keywords— exhaust gas, vapour absorption system, refrigerant, absorbent and generator.

1. INTRODUCTION

The number of components in the air conditioning system gets reduced due to the usage of vapour absorption system. The generator should be fabricated by considering the heat available at exhaust gas passage of the engine and properties of the chemicals used in the air conditioning system. Air conditioning system of conventional automobile powered by the internal combustion engine utilizes power generated from the engine. This may take around 15 to 20% of engine power to drive the piston or rotary compressor. Approximately it consumes of 20% total fuel consumption on the other hand the R12 used as refrigerant (Or R134a) and it is affected to ozone layer depletion. However many passenger vehicle engine utilizes only about 35% of total energy and rests are lost to various form of energy losses. If one model is adding conventional air conditioning system to automobile, it further utilizes about 15% to 20% of the total energy. Therefore most of existing automobile becomes uneconomical and less efficient. In addition conventional air conditioner is causes to decreases the life time of engine also. Hence considering of the above factors in this research introduce an alternative solution for automobiles AC system as based on ammonia absorption refrigeration cycle using exhaust waste heat of the engine. The advantages of this system over conventional air-conditioning system are that it does not affect original design. Surely the maintenance cost for the air conditioning system can be greatly reduced since the components in the vapour absorption system is less complex than vapour compression system.

2. PROCESS INVOLVED

The vapour absorption system we are using here is having four main sections.

1. Evaporator
2. Absorber

3. Generator

4. Condenser

In our project we are mainly making design modifications at the generator section. Normally in a vapour absorption system in the generator section the refrigerant and the absorbent is separated by supplying the heat. The heat supplied here is produced by means of a heating coil. For this usually we have to find another power source. But in our project we can use the waste exhaust energy available at the exhaust section of the vehicle. Hence, the heat exchanger is designed to install in between the exhaust manifold and flexible joint of exhaust system.

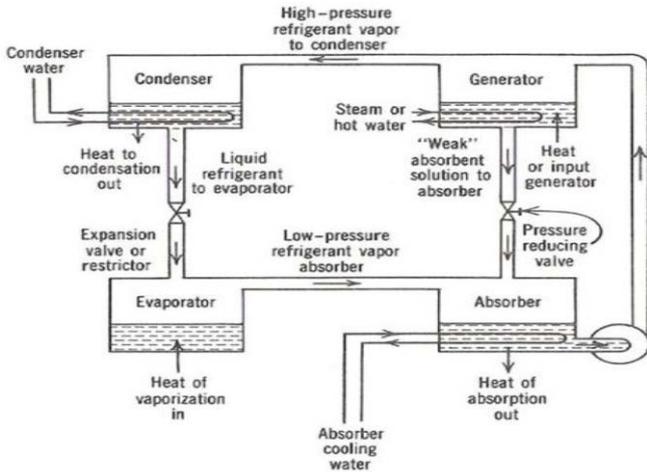
Ammonia vapor is extracted from the NH₃ strong solution at high pressure in the generator by an external heat source. In the receiver the water vapor which carried with ammonia is removed and dried ammonia gas enters into the condenser and it is condensed. The pressure and temperature of cooled NH₃ is then reducing by throttle valve below the temperature of the evaporator. Then NH₃ at low temperature enters to the evaporator and absorbed the required heat from passenger compartment and leaves as saturated vapor out from the evaporator. The low pressure NH₃ vapor is then passed to the absorber, where it absorbs by the NH₃ weak solution.

After absorbing NH₃ vapor by weak NH₃ solution (aqua-ammonia), the weak NH₃ solution becomes strong solution and then it to pump to generator through heat exchanger. Heat is supplied to the generator from the exhaust system, which generates ammonia gas from a liquid water ammonia mixture. Ammonia gas flows to the condenser allows the ammonia gas to dissipate its thermal energy and condenses into liquid. The liquid ammonia flows to evaporator via the expansion valve, it is vaporized and cooling load generated by absorbing the heat from the vehicle's passenger compartment.

The cooling effect can be feel at the evaporator section since the heat is absorbed by the refrigerant at this section

.We are using ammonia as the refrigerant and water as the absorbent. These two compounds are easily available and there won't be much problem in collecting and filling in our exhaust gas assisted air cooling system. In case of leakage of any compounds in the apparatus get, it can be easily detected by adding some colour giving ingredients in the compounds.

3. GENERAL DIAGRAM



4. CONCERNED PARAMETERS

COEFFICIENT OF PERFORMANCE (COP)

In the engine we are judging its work by its efficiency. But in the refrigeration and cooling system the COP of the system is taken into account. The coefficient of performance, of a refrigeration system is the ratio of the heat removed from the cold reservoir to input work.

$$COP_{cooling} = \Delta Q_{COLD} / \Delta W$$

ΔQ_{COLD} is the heat moved from the cold reservoir (to the hot reservoir).

ΔW = is the work consumed by the heat pump.

UNIT OF REFRIGERATION

The refrigeration capacity of our exhaust gas assisted air cooling system can be evaluated by the unit of refrigeration. For implementing our system in the automobiles the ton of refrigeration is calculated and compared. Refrigerators are rated in kJ/s, or Btu/h of cooling. One ton of refrigeration Capacity can freeze one ton of water at 0 °C (32 °F) in 24 hours.

Based on that:

$$1 \text{ ton of refrigeration} = 200 \text{ Btu/min} = 3.517 \text{ kJ/s}$$

5. COMPARISON OF VAPOUR ABSORPTION AIR CONDITIONING WITH VAPOUR COMPRESSION AIR CONDITIONING:

WAY OF COMPRESSION OF THE REFRIGERANT COMPOUND:

The compression of refrigerant in the vapour absorption and vapour compression systems are carried out on different principles. One of the most important parts of any air conditioning cycle is the compression of the refrigerant since all the further operations depend on it. In the vapour compression air conditioning system the compression of the refrigerant is done by compressor which can be of reciprocating, rotating or centrifugal type. In the vapour absorption air conditioning system, the compression of the refrigerant is done by absorption of the refrigerant by the absorbent. As the refrigerant is absorbed, it gets converted from the vapour state to liquid state so its volume reduces. Any way in the compression process the volume get decreased.

6. POWER CONSUMING DEVICES:

To run a system the power have to be supplied to the system. In the vapour compression cycle the compressor is the major power consuming device while in the vapour absorption cycle the pump used for pumping refrigerant-absorbent solution is the major power consuming device. The efficiency of the system increases when the input power get reduced.

7. MAGNITUDE OF POWER NEEDED:

While considering the power consumption the required quantity of the power should be calculated. The compressor of the vapour compression cycle requires large quantities of power for its operation and it increases as the size of the system increases. In case of the vapour absorption system, the pump requires very small amount of power and it remains almost the same (or may increase slightly) even for higher capacities of air conditioning. Thus the power consumed by the vapour absorption system is less than that required by the vapour compression system. So it will be surely economical when we select the vapour absorption system.

8. TYPE OF ENERGY REQUIRED:

The energy will be available in different forms and the suitable energy according to our system have to be selected. The vapour absorption system runs mainly on the waste or the extra heat in the plant. Thus one can utilize the extra steam from the boiler, or generate extra steam for the purpose and also use the hot available water. Similarly the waste heat from the diesel engine, hot water from the solar water heater, etc. can also be utilized. In case of the vapour compression system, the compressor can be run by electric power supply only; no other types of energy can be utilized in these systems. The way to control the power transmission also taken into account at this section.

9. COST ANALYSIS:

Selection of an apparatus is done according to the economical status of the components used in it. The vapour compression air conditioning system can run only on electric power, and they require large amount of power. These days the electric power has become very expensive, hence the running cost of the vapour compression air conditioning system is very high. In case of the absorption

air conditioning system only small pump requires electric power and it is quite low. In most of the process industries, where the absorption refrigeration is used, there is some extra steam available from the boiler, which can be used for running the system. Thus in absorption air conditioning system no extra power in the pure electric form is required and the energy that would have otherwise gone wasted is utilized in the plant. Thus the running cost of the absorption air conditioning system is much lesser than the vapour compression system. By comparing the exhaust gas assisted air cooling system and the vapour compression system we can notice that the components used in our system is economical than the existing vapour compression air conditioning system. So in future also we can introduce the vapour absorption cooling system in the automobiles with the needed design modifications.

Type: TPB,D1
 Output: 3.7/5 kw/bhp
 Speed: 1500 rpm
 SFC: 240 g/kwh
 Governing: class B1

Load condition	Exhaust gas temperature(°c)
No load	169
On load 1	223
On load 2	251

10. LIST OF COMPONENTS OF VAPOUR ABSORPTION AIR CONDITIONING OVER VAPOUR COMPRESSION AIR CONDITIONING

VAPOUR ABSORPTION AIR CONDITIONING

- Generator
- Drier
- Condenser
- Capillary tube
- Evaporator
- Absorber
- Pump
- Connection Tubes
- Glass Cloth Tape
- Insulation Foam Tube

VAPOUR COMPRESSION AIR CONDITIONING

- Compressor
- Condenser
- Expansion valve
- Evaporator

EXPERIMENTAL OBSERVATIONS

ENGINE 1

MULTI CYLINDER DIESEL ENGINE

Model: GD1B
 Type: BB,D1
 Output: 9.56/13 kw/bhp
 Speed: 1500 rpm
 SFC: 250 g/kwh
 Governing: class B1

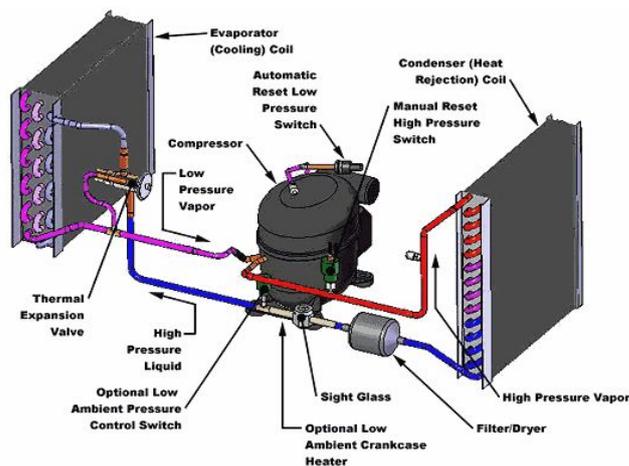
Load condition	Exhaust gas temperature(°c)
No load	156
On load	238

ENGINE 2

SINGLE CYLINDER DIESEL ENGINE

Model: GF1B

11. DIAGRAM



12. RESULT AND CONCLUSION

By the experimental values we had obtained from our observation it is noted down that the heat energy available at the exhaust port is sufficient to separate the refrigerant and the absorbent at the generator section. It is possible to design an automobile air conditioning system using engine heat based on Vapour Absorption Refrigeration System. Also from the Environmental point of view this system is Eco-friendly as it involves the use of Ammonia as a refrigerant which is a natural gas and is not responsible for OZONE layer Depletion. In this way we can concluded, technically, that Out of the total heat supplied to the engine in the form of fuel, approximately, 30 to 40% is converted into useful mechanical work; the remaining heat is expelled to the environment through exhaust gases and engine cooling systems, resulting in to entropy rise and serious environmental pollution, so it is required to utilized waste heat into useful work.

The recovery and utilization of waste heat not only conserves fuel (fossil fuel) but also reduces the amount of waste heat and greenhouse gases damped to environment. The study shows the availability and possibility of waste heat from internal combustion engine, also describe loss of exhaust gas energy of an internal combustion engine. Possible methods to recover the waste heat from internal combustion engine and performance and emissions of the internal combustion engine. Waste heat recovery system is the best way to recover waste heat and saving the fuel. By

regaining the exhaust heat energy and using it in the corresponding apparatus the input power that have to be supplied can be reduced. The successful model can be expected in the future by using this principle.

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