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Research Paper

Automobile A/C System Using Waste Heat from the I.C Engine- A Conceptual Approach

Engineering

KEYWORDS : I.C Engine, waste heat, exhaust gases, absorption cycle, global warming

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ABSTRACT

The increasingly worldwide problem regarding rapid economy development and a relative shortage of energy, the internal combustion engine exhaust waste heat and environmental pollution has been more emphasized heavily recently. 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 refrigerating units currently used in road transport vehicle are of Vapour Compression Refrigeration system (VCRS). This system utilizes power from the engine shaft as the input power to drive the compressor of the refrigeration system, hence the engine has to produce extra work to run the compressor of the refrigerating unit utilizing extra amount of fuel. This loss of power of the vehicle for refrigeration can be neglected by utilizing another refrigeration system i,e. a Vapour Absorption Refrigeration System (VARS).In a Vapour Absorption Refrigeration System, a physicochemical process replaces the mechanical process of the Vapour Compression Refrigeration System by using energy in the form of heat rather than mechanical work. IN this paper we have dealt with a concept of the heat required for running the Vapour Absorption Refrigeration System can be obtained from that which is wasted into the atmosphere from an IC engine.

Introduction

Recent trend about the best ways of using the deployable sources of energy in to useful work in order to reduce the rate of consumption of fossil fuel as well as pollution. Out of all the available sources, the internal combustion engines are the major consumer of fossil fuel around the globe. Carbon dioxide coming out of every car's tailpipe is a greenhouse gas[1]. The ultimate effects are unknown, but it is a strong possibility that, eventually, there will be dramatic climate changes that affect everyone on the planet – global warming to be exact. For this reason, there are growing efforts to reduce the greenhouse gases. Automobile air conditioning currently is performed by vapour compression refrigeration systems, but the refrigerants in vapour compression refrigeration systems are mainly HCFCs and HFCs, which are not environmentally friendly, and the compressor uses a significant portion of the engine power.

According to the statistic information, 65-70% of the combustion energy of the fuel consumed is taken away by the radiators and exhaust gases. If the waste heat can be recovered, it is enough to satisfy the input power need for air-conditioning. The waste heat from exhaust gases constitutes a large percentage of the total waste heat. Much of an internal combustion engine's heat from combustion is discarded out of the exhaust or carried away via the engine cooling water. All this wasted energy could be useful. The common automobile, truck or bus air conditioner uses shaft work of the engine to turn a mechanical compressor. Operating the mechanical compressor increases the load on the engine and therefore increases fuel consumption, emissions and engine operating temperature. Nowadays all the scientists and car manufacturers in the world search to solve two main problems in vehicles [2]. The first problem is fuel economy and reduces the losses and the second problem is environment pollution. This paper gives a comprehensive review of the "AUTOMOBILE A/C SYSTEM USING WASTE HEAT FROM THE I.C ENGINE".

CONVENTIONAL A/C SYSTEM USED IN VEHICLES:

2.1 Vapour compression refrigeration system:

The air conditioning system used usually in a vehicle is a vapour compression refrigeration system. It consists of a compressor, condenser, expansion valve, an evaporator blower set and a refrigerant which is circulated through the system. This system works by compressing the refrigerant. using a compressor, which increases the pressure and temperature of the refrigerant and it vaporizes[8]. The refrigerant is then passed through the condenser where the latent heat of the refrigerant is removed and is liquefied. This refrigerant is then passed through the expansion valve where its pressure is reduced reducing the temperature. This chilled refrigerant is then passed through the evaporator to produce the cooling effect. The blower blows the air through the evaporator to produce the required cooling inside the cabin of the vehicle. The refrigerant absorbs the heat of the air and vaporizes, which is then passed through the compressor. Hence cooling effect is produced inside the vehicle. The main disadvantage of such a system is that the required power to run the compressor is taken from the engine main shaft, hence to maintain the same power the engine has to produce more work consuming more fuel thereby reducing the mileage of the vehicle.

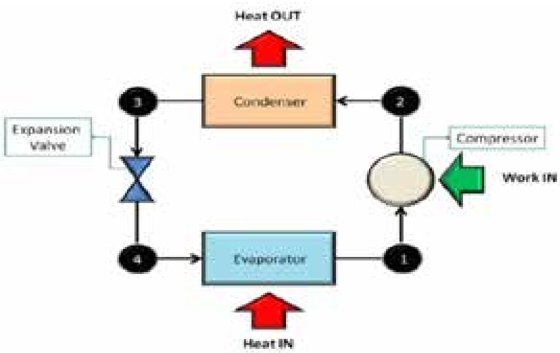

Figure 1

The process that the refrigerant undergoes in the two heat exchangers, compressor and expansion device. The most convenient diagram for such explanation and performance analysis is that of a pressure vs. enthalpy coordinate system, as shown in fig1: The compressor receives low pressure and low temperature refrigerant at state 1 and compresses it to a high pressure. This compression process is associated with an increase of refrigerant temperature. At state 2, the high pressure, high temperature vapour enters the condenser. The refrigerant passing through the condenser 3rejects heat to the high temperature reservoir and changes to a saturated liquid at state 3. Then the refrigerant flows through the expansion device undergoing a drop in pressure and temperature. Finally, the low pressure, low temperature and low quality refrigerant at state 4 enters the evaporator, where it picks up heat from the low temperature reservoir reaching a dry saturated vapour state at the evaporator exit[10].

2.2 Drawbacks of vapour compression refrigeration system[4]:

Though this system is the most efficient of all the refrigeration system still it has some disadvantages:

- ❖ A vapour compression system has more, tear and noise due to moving parts of the compressor.
- ❖ The amount of work required to compress the gas in the compressor is very high.
- ❖ It strictly depends on electric power or mechanical power and cannot be used at places where these recourses are not available.
- ❖ The capacity of vapour compression system drops rapidly with lowered evaporator pressure.
- ❖ The performance of a vapour compression system at partial loads is poor.
- ❖ In the vapour compression system, it is essential to superheat the vapour refrigerant leaving the evaporator so that no liquid may enter the compressor.

3. LITERATURE SURVEY:

3.1 Work done by Angelo Cantoni, Rome, Italy

This invention comprises a vapour generator member connected to a condenser which is itself connected, by way of a pressure reduction valve, to an evaporator connected to an absorber which receives the liquid present in the lower zone of the generator and from which liquid is fed to the upper zone of the generator, there being provided in the generator a heat exchanger through which the engine cooling liquid flows. Hence it uses heat of the cooling water as the source of heat for the generator.

3.2Work done by i horuz, bursa, Turkey[6]

The work done by I Horuz consists of using exhaust heat of the automobile as the heat source for the generator. He used two heat exchangers one with insulation and the other without insulation for transferring heat to the solution of the absorption system. He plotted the results obtained after conducting various performance tests on the engine under different running conditions.

4 .VAPOUR ABSORPTION REFRIGERATION SYSTEM IN AUTOMOBILES

4.1 Introduction

It is well known that an IC engine has an efficiency of about 35-40%, which means that only one-third of the energy in the fuel is converted 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[7]. In a Vapour Absorption Refrigeration System, a physicochemical process replaces the mechanical process of the Vapour Compression Refrigeration System by using energy in the form of heat rather than mechanical work. The heat required for running of a Vapour Absorption Refrigeration System can be obtained from the exhaust of any vehicle working with an IC engine, which would otherwise be exhausted into the atmosphere. Hence using a Vapour Absorption Refrigeration System will not only prevent the loss of power from the vehicles engine but will also produce refrigeration using the low grade energy (i,e. exhaust) from the engine. The use of a Vapour Absorption Refrigeration System will also reduce pollution by reducing the amount of fuel burned while working the conventional vapour compression refrigerating unit.

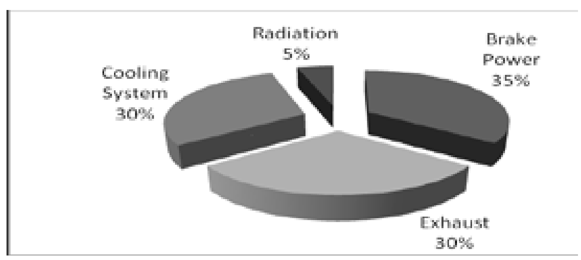

Figure 2

4.2 Components of the system:

There are basically eight components,

1. Pre-heater
2. Generator
3. Condenser
4. Expansion valve
5. Evaporator
6. Absorber
7. Pump
8. Control valve

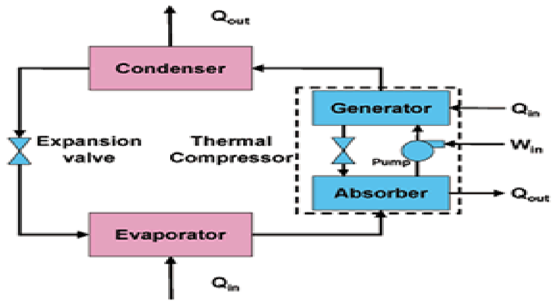

Figure 3

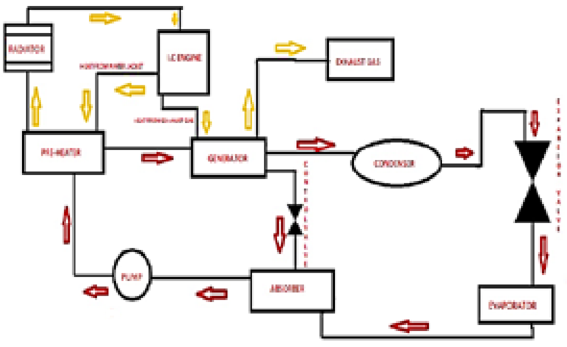

Figure 4

5. LITHIUM BROMIDE-WATER ABSORPTION REFRIGERATION SYSTEM:

The process of working of this refrigeration system is that a mixture of refrigerant (water) and an absorber (lithium bromide) (i,e. strong solution) is pumped from the absorber using a small pump to the pre-heater. Initially the mixture gets heated due to the hot water flow from the water jocket from the I.C Engine. Again the solution is passed through the generator. The generator is the main unit of the whole refrigeration system. This is the place where the heat is again supplied to the strong solution from the exhaust gas from the I.C Engine. Due to the supplied heat to the mixture in the generator the refrigerant is separated from the strong solution and forms vapour. The remaining weak solution flows back through a restrictor in to the absorber. The refrigerant is then allowed to pass through a condenser where the heat of the vapour is extracted and the refrigerant temperature is brought to the room temperature. This cooled refrigerant is then passed through an expansion device where during expansion the temperature of the refrigerant falls below the atmospheric temperature. This cold refrigerant is then passed through an evaporator from where the refrigerant absorbs heat and produces refrigerating effect. The refrigerant coming from the evaporator is hot and it is passed to the absorber. The weak solution(lithium bromide) coming from the generator mixes with the refrigerant coming from the evaporator in the absorber due to high affinity towards each other for the two fluids, hence forming a strong solution. The formed strong solution is again pumped into the generator and the cycle repeats itself.

6 ADVANTAGES OF USING VAPOUR ABSORPTION SYSTEM IN AUTOMOBILES:

The use of a Vapour Absorption Refrigeration System in road transport vehicles has the following advantages:

- ❖ No dedicated IC engine is required for the working of the refrigerating unit.
- ❖ No refrigerant compressor is required.
- ❖ No extra work is required for the working of the refrigerating unit.
- ❖ Reduction in capital cost.
- ❖ Reduction in fuel cost.
- ❖ Reduced atmospheric pollution.
- ❖ Reduced maintenance.
- ❖ Reduced noise pollution.

7.CONCLUSION:

With all the required components it is possible to install a vapour absorption refrigeration system in an automobile working using the waste heat of the vehicle engine to produce refrigerating effect inside the automobile cabin. Using a vapour absorption refrigeration system within an automobile as an air conditioner will not only reduce the fuel consumption of the vehicle while working but will also reduce the environmental pollution.

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