AUTOMOBILE A/C BY UTILIZING WASTE HEAT AND GASES

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Abstract
The use of chlorofluorocarbon and hydrochlorofluorocarbon refrigerants in traditional cooling systems and in automobile air conditioning has been widespread for many decades. As part of the Montreal Protocol, a major commercial refrigerant, Chloro-fluorocarbons (CFCs), will be phased out soon because they contributed to the greenhouse effect and the loss of the ozone layer. The compressor in an automobile's air conditioning system consumes about 10% of the energy available at the crankshaft while running on gasoline or diesel. Because most gasoline and diesel-powered vehicles' thermal efficiency ranges from 20 to 30 percent in excellent condition, this loss is enormous. The simple line is that air conditioning uses a lot of petroleum.
Keyword: A/C , Air Conditioner , CFC , Automobile, Waste Heat, Gases, Environment.

Introduction

Because of the continuously changing weather and atmospheric effects, auto air conditioning has become a requirement. As a result of rising gasoline prices, component costs, and vehicle maintenance costs, people are finding it increasingly difficult to afford a car. Several innovative manufacturing improvement theories have been created and implemented in recent years in a variety of industries. An investigation has been made to see if waste heat can be recovered and used to cool a vehicle's air conditioning system without increasing the cost, weight, or number of components, and making the vehicle more luxury. [1] Automobile air conditioning is the process of cooling and cleaning the air, as well as lowering the humidity level, and circulating the air. Controls are also in place to regulate the amount and quality of air. These are all things that an air conditioner should be able to do in a perfect world. Ideally, the interior of a vehicle should be kept at a temperature of 20Â°C to 22Â°C. The "comfort range" of climatic load is the equivalent of this. When a car is driven in 40Â°C sunshine, the interior temperature rises by more than 15Â°C, and it may even approach 60Â°C to 70Â°C due to the addition of heat from the ambient air, sunlight, the engine, the road, and the exhaust system. [2]Compared to alternative heating techniques, heat pumps reduce energy usage, improve heating performance, and reduce environmental impact. The exhaust heat from a vehicle can be used to power the Vapour compression Refrigeration System (VCRS), minimising the amount of work the engine has to do to drive the compressor. Mechanical vapour compression Cycle is used in the refrigeration process to cool products for both household and commercial applications. [3] Vapour compression refrigeration is used in the majority of residential refrigerators nowadays. The compressor, evaporator, throttling device, and condenser are all part of the vapour compression refrigeration system, which has four major components in total.

Automobiles' air conditioning systems use a vapour compression refrigeration system, which uses adiabatic work relations for open systems W = - V. dP to manage the refrigerant under adiabatic conditions (where V is volume in m3, dP pressure rise, W is work required to attain dP) If the fluid pressure rises, vapour will absorb more work than liquid since its volume V is so much greater. [4] As a result, the ideal alternative is a vapour absorption system, which works with liquid rather than vapour, but it requires a high-temperature heat source for separation at high pressure; fortunately, high-temperature exhaust gas is readily available and can meet this need without costing anything. To save energy, this acts as a waste heat recovery system.

Refrigeration system components for vapour absorption. The Vapour Absorption Refrigeration System uses only two components. Those are.

- Refrigerant
- Absorbent

a. Refrigerant

Substances or mixtures used in a heat pump and refrigeration cycle are known as refrigerants. Most of the time, it moves back and forth between the liquid and gas phases. Many different types of working fluids have been employed in the past for this purpose. All of the vapour compression refrigeration system's processes, such as compression, condensation, expansion, and evaporation, are included in the vapour absorption refrigeration system. Ammonia, water, or lithium bromide are common refrigerants in vapour absorption systems. The condenser and evaporator are where the refrigerant is condensed and then evaporated. In the evaporator, the refrigerant generates a cooling effect, and in the condenser, the heat is released to the atmosphere. [5]

b. Absorbent

An absorber is a substance that has the ability to take in and hold onto a substance. This technique relies on water as an absorbent. When heated, the ammonia is absorbed by the cold water and released.

Drawbacks of vapour compression refrigeration system:

This approach, despite being the most efficient, nonetheless has a few disadvantages:

- More wear and noise is generated by the compressor in a vapour compression system.
- The amount of effort it takes to compress the gas in the compressor is enormous.
- It can only be used in places where electricity or mechanical power is readily available.
- When the evaporator pressure is reduced, the vapour compression system's capacity rapidly decreases.
- At low loads, a vapour compression system's performance is sluggish.
- The vapour refrigerant exiting the evaporator in a vapour compression system must be superheated so that no liquid may enter the compressor. [6]

Advantages of using vapour absorption system in automobiles

When used in road transport trucks, the Vapour Absorption Refrigeration System offers the following benefits:

- The refrigerating unit does not require a separate IC engine for operation.
- No refrigeration compressor is necessary.
- The refrigerating unit requires no additional effort to operate.
- Reduction in the cost of capital.
- Fuel costs will be reduced.
- Reduced pollution in the atmosphere.
- Maintenance is reduced.
- Noise pollution has been reduced in this area. [7]

Review of Literature

An examination of compression and spark ignition engines employing single-entry turbochargers and modified twin-entry turbochargers was undertaken by Kusztelan et al (2012) [8]. Twin-entry turbochargers outperform single-entry turbochargers in terms of torque, according to an engine performance comparison study. According to Rakopoulos et. al., (2004)[9], intercoolers play an important role in managing the temperature of the combustion chambers of turbocharged engines. There has been a lot of research done on turbocharging internal combustion engines for higher torque and performance characteristics [10] by Ghodke et al. (2012) For diesel engine performance, Pundlik R. Ghodke and J. G. Suryawanshi [11] investigated new turbocharger technologies. Turbo lag and engine volumetric efficiency were studied by S. Shaaban and J. Seume [12]. Simulated a turbocharged gasoline engine by Vishal Seeburrun and Ramzy Gouda Abdel Gayed [13]. The performance of supercharged two-wheelers was studied by Yashvir Singh, Nishant Kr. Singh, Rakesh Prasad, and Hemant Kr. Nayak [14]. In an internal combustion engine, J Panting, K R Pullen, and R F Martinez-Botas developed a transitory performance improvement [15].

Recent work by Sami et al. [16] has presented an improved dynamic model for analysing single- and/or dual-absorber heat recovery systems. The evaporator and condenser were both air cooled in the systems they evaluated. Heating fluids for absorbers could be hot oil, steam, or exhaust gas. Similar to the car waste heat cooling system proposed by us, in these ways. It also provided information on the thermodynamics of a few of the system's parts. However, their research assumed an equilibrium adsorption condition because the cycle duration was so long.

According to Kruse [17], an indirect refrigeration system with secondary fluid loops consumes less energy than a direct refrigerant system (DX). In a theoretical comparison of indirect, distributed cascade and two-stage refrigeration systems, Kauffeld [18] examined supermarket refrigeration trends and perspectives.

Installing and testing the SL refrigeration system in U.S. supermarkets was done by Faramarzi and Walker [19]. As described by Nyvad and Lund [20 and 21], a grocery store in Denmark made the switch from a (H) CFC plant to an indirect SL system. One supermarket in Sweden, according to Rolfsman [22], has gone completely paperless. A mixture of NH_3 and CO_2 was employed as the principal refrigerant for freezing. There was a store in the

United Kingdom that had SL refrigeration installed, according to Thomas [23]. The primary refrigerant in this system was NH3, while the secondary refrigerant was propylene glycol.

Objectives

- To investigate how the engine's RPM affects the exhaust heat.
- Experimenting with engine RPM and exhaust gas temperature
- Analyze the temperature values taken at various intervals of time
- Studying the Compressor Cycle of Vapour

Research Methodology

A research technique is a method for resolving a research issue in a methodical manner. It can be viewed as a science that studies how scientific research is carried out. The logic behind the numerous procedures taken by a researcher to investigate his research problem is examined in this article. The researcher must understand both the research methods and the methodology.

Result and Discussion

The vapour compression cycle is being utilised to cool the interior of automobiles. Apart from controls and drives, all of a car air conditioning system's core components are the same as those of a traditional air conditioning system. [24]

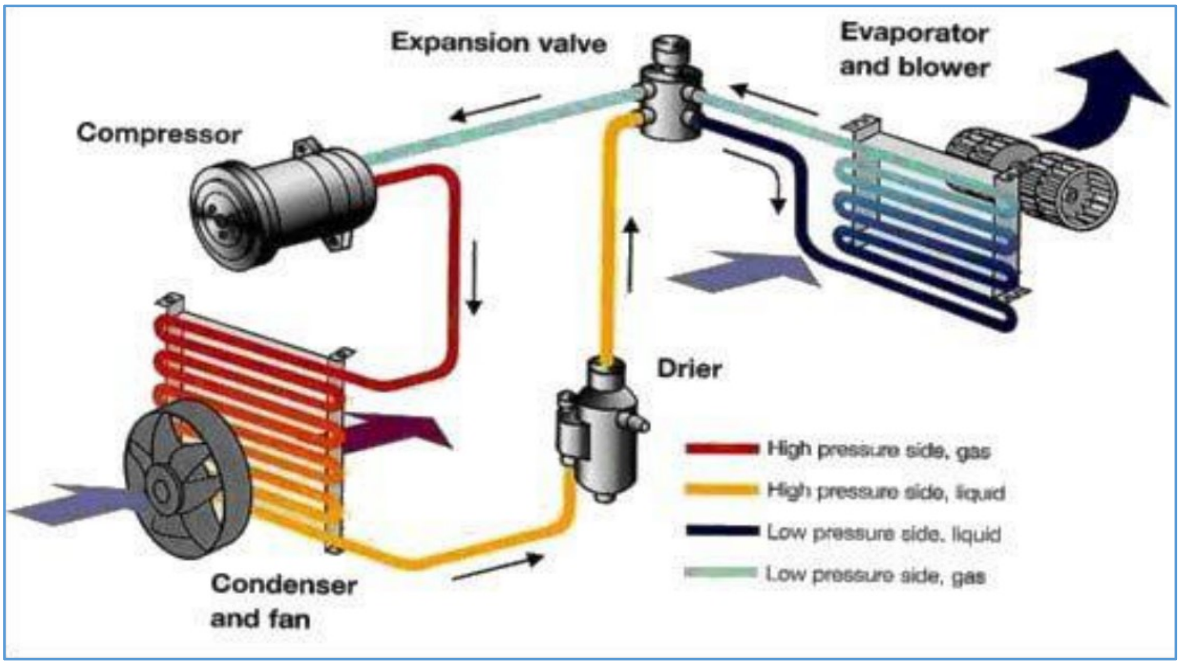

Fig. 1 Vapour compressor cycle

Compressor, Condenser, Expansion valve, and Evaporator are the four essential components of the vapour compression cycle.

Table 1Cooling Load Calculation

CONDITIONS	HEAT IN KJ/hr
SOLAR RADIATION	300
HEAT GAIN TROUGH THE GLASS	200
HEAT GAIN THROUGH THE CAR WALLS	4300
AIR LEAKAGE	1000
PASSENGER INCLUDING THE DRIVER	1200
HEAT RADIATED FROM THE ENGINE	2000

In the table above, we can see the various conditions and how much heat they generate over the course of a day.

The ammonia-water VAR system's temperature measurements at several points. It is necessary to keep track of not only the temperature of the air conditioning system itself, but also of the various components that make up the system's cooling system. Tables following indicate the temperatures that were measured and recorded with a digital thermometer.

Table 2. Temperatures noted at various time intervals

Parts	Temperature measured after.....						
	5 min.	10 min.	20 min.	30 min.	40 min.	50 min.	60 min.
Engine Exhaust	60	85	106	150	180	200	210
Generator	35	40	45	50	54	56	56
Condenser	32	32.5	33	32.5	33	33.2	33
Evaporator	31.8	31.2	30.6	27.3	26	24.9	23
Absorber	30	30.8	31.5	32	32	31.8	31.5
Air Conditioned Space	32	32	31.8	30	28.6	26.2	24

The temperature of the area to be cooled begins at 32^{0}C Fahrenheit. An increase in exhaust temperature can be seen while the engine runs constantly. Heat transfer media affects the pace at which refrigerator temperature falls as a function of exhaust temperature rise. [25] Figure 2 shows the variance in exhaust gas temperature as a function of engine RPM at various loads. When the engine speed is increased, the exhaust temperature rises, and thus raises the temperature to a point where it may drive air conditioning.

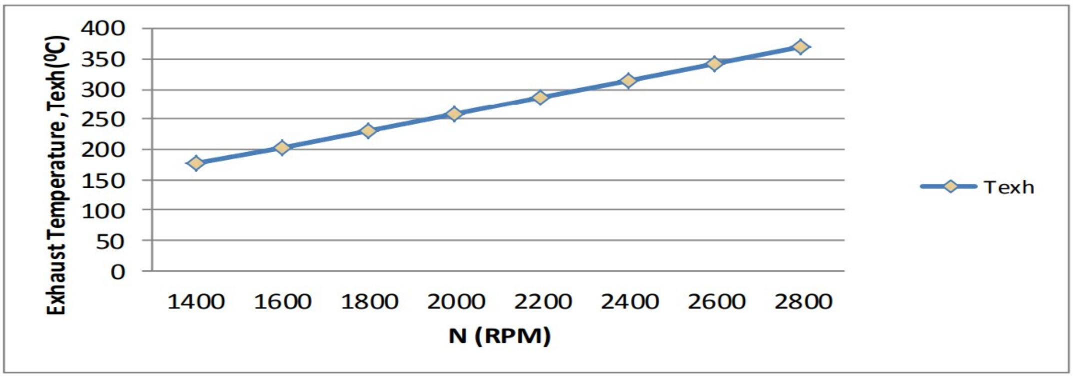

Fig. 2 Exhaust Temperature Vs RPM

In fig 3 shows the variation of exhaust heat with the engine RPM.

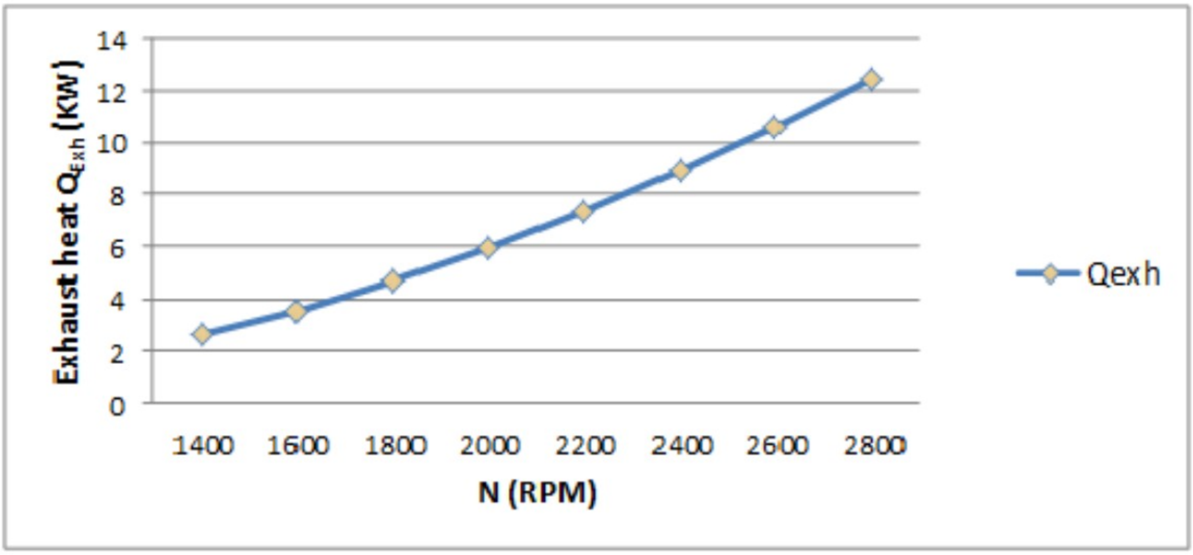

Fig. 3 Exhaust heat Vs RPM

As the engine speed increases, so does the amount of exhaust gas that can be used to evaporate the aqua ammonia solution.

Conclusion

Vapor Absorption Refrigeration System can be used to design an air conditioning unit for an automobile that uses waste heat from the engine. This system is also environmentally beneficial, as it uses Ammonia (a natural gas) as a refrigerant and does not contribute to the Green House Effect or the depletion of the OZONE layer. Thus, it can be concluded from this that about 35%-40% of heat supplied to the engine in the form of fuel combustion results in useful mechanical work, while the remaining heat is expelled from the system, increasing the amount of entropy; thus, it is necessary to convert this waste heat into useful work.

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