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Experimental Investigation and Performance Analysis of an Automobile Air Conditioning System

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***Abstract*— Refrigerating effect is the amount of heat that each pound of refrigerant retains from the refrigerated space to deliver helpful cooling. This effect is known as Refrigeration. Refrigeration systems are also widely used to provide thermal comfort to humans via air conditioning. The "Steam Compression Cooling System" is used by the current Automotive Air conditioning system, which absorbs and removes heat from inside the vehicle. To drive the Compressor of the refrigeration system, the system uses the power of the motor shaft as the input power, but because of this, there is some loss of engine power also. The loss of engine power for VCR operation may be neglected by using another refrigeration system, namely a "vapor absorption refrigeration system". For that, launch of a new Hybrid Air conditioning system for cars is required. Experimental work is done by using the change of energy source to drive the compressor. In this system, An Internal Combustion Engine shaft drives the compressor, when the engine is running. And as a hybrid, DC electric motor which is powered by a lead-acid battery also drives the Compressor. An electric motor supplies the DC power, which generates electrical energy to charge the battery. Experimental work is done by using the change of energy source to drive the compressor. In this system, An Internal Combustion Engine shaft drives the compressor, when the engine is running. And as a hybrid, DC electric motor which is powered by a lead-acid battery also drives the Compressor. An electric motor supplies the DC power, which generates electrical energy to charge the battery. With this system, fuel consumption is much lower when using air conditioning and reduces carbon dioxide emissions. The concept of the air conditioning system in presented in this document.**

Keywords— Automobile, refrigeration , compressor, controller, DC motor, battery

I. INTRODUCTION

"Refrigeration involves extracting heat from aobscure temperature tank and transferring it to a high temperature tank. The heat transfer work is traditionally driven by mechanical means, but can also be driven by heat, magnetism, electricity, laser or other means." One of the most Important refrigeration was the preservation of perishable foodstuffs by storing them at obscure temperatures.

Industrial refrigeration To provide environmentally friendly solutions for the industrial refrigeration sector. Industrial refrigeration covers a wide range of applications, from high temperature process cooling to very obscure temperature applications such as those used in medical freezers or LNG liquefaction.

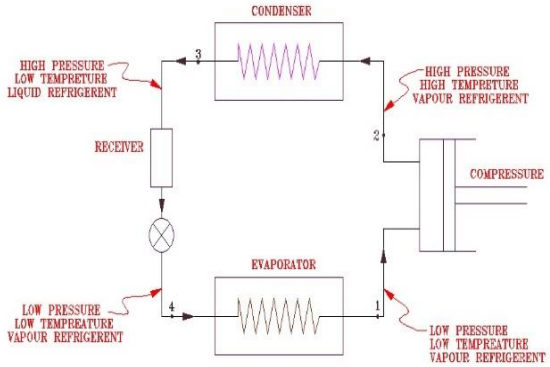

Figure 1. Simple VCR system[1]

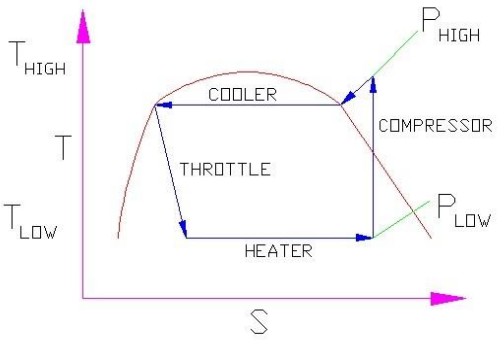

Figure 2. T-s diagram of simple VCR system[1

Description of car AC system

Car air Conditioning has two main purposes:

1. Cools the air entering the section.
2. Detracts the moisture content, or humidity's that it descry more comfortable inboard the vehicle.

Fluid circulating throughout the system is the refrigerant. Refrigerant can evaporate to obscure temperature and then condense at higher pressure. There are five main component

parts to the entire system, namely the compressor, condenser, receiver-drier, expansion valve, and evaporator.

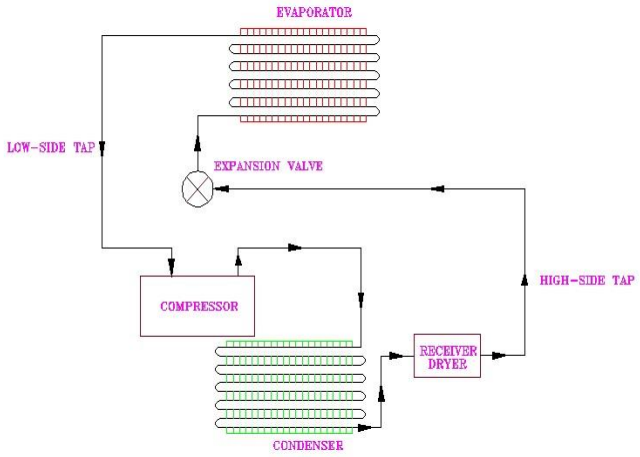

Figure 3. Existing car AC system[2]

II. REVIEW OF LITERATURE

[1] Khaled S. Alqdah investigated the effect of engine speed, exhaust gases temperature and exhaust gas flow rates on the performance of air conditioning. The conclusion given by him is that COP depend open working condition temperature, Carbon monoxide emission was decreased, Flexibility in operation and absence of compressor noise and high reliability.

[2] S.LAKSHMI SOWJANYA is presented the thermal analysis of condenser and evaporator using ANSYS software. Condenser material – copper, aluminum, alloy204 and Evaporator material – copper, aluminum, alloy204 and give the analysis results is that thermal flux is more for aluminum alloy 204 than copper for both condenser and evaporator. Aluminum alloy 204 is better.

[3] S.S. mathapati, Mudit gupta, Sagar palimkan[3] is represent the effect of generator temperature , evaporator temperature, condenser temperature and absorption temperature on system COP is analyzed using EES soft were. The conclusion is given by them is that COP of the system increase with increase in generator temperature and evaporator temperature but it reduce with increase in condenser and absorption temperature and also Cop increase with increase in mass flow rate.

[4] Shakhar D. Thakre, Prateck D. Malwe, Rupesh l. Raut Amol A. Gawali was Ammonia/water system and COP and generator load of system for different generator and worked on design consideration for condenser temperature. They find out that COP of single effect ammonia/water system varies from 0.3528 to 0.3113, COP decrease with increase generator temperature and COP of the system is less but since waste heat is given as input it is not matter of concern.

[5] Jinsha raslevan Hans M H Antonio Joseph kiran T S Gireesh Kumaran Thampi is presented the mathematical model of the engine generated is analyzed using MATLAB to study the effects of conventional and hybrid turbo charging on the engine performance and Performance on GDI petrol engine. By this analysis they show that hybrid turbo charging which provides high current discharge by using super capacitor and reduction of brake thermal efficiency of the hybrid turbo charged engine could be minimum by the cooled EGR.

[6] Shyleshkumar M.K., Mathews BabuSagardas, Varun ramkishan, Vishnu c. vijay is presented that CFD analysis of the exhaust gas turbine. This analysis can easily employ on low power engine and high capacity air conditioner. Also use of eco friendly

Refrigerant namely HFO-1234YF can impart a green AC system and use of exhaust rankine cycle can further result in a best fuel utilizing engine.

[7] AfiqAimanDahlan, Amirah Hazigahzulkifli, Henry Nasution, Azharabdulaziz, Ahmad ammarzulkifli gives the Comparison of electrically driven compressor(EDC) and automotive air conditioning (AAC). The results is given by them is that ECD system of a lower energy consumption, capability of EDC system to have better temperature distribution is more (not depend on speed) and EDC has a lower cooling capacity but nearer to the temperature set point.

[8] Wael I.A aly, mohammedabdo, gamalBedair, A.E. hassaneen perform on the FORD XLD 1.81 8- valve engine, Effectively operated domestic ammonia water system for different engine load at a constant speed 1750 rpm. The results is given by them is that DAR is able to operate in a wide range engine load, refrigerator reached steady state temperature between 10 C to 40.5 C about 3.5 hr, maximum COP was 0.10 optimum and minimum refrigeration temperature is reached at exhaust gas temperature between 215 to 230 C.

[9] Angelo cantoni used lithium bromide-water absorption refrigeration System for air conditioning. by 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.

[10] Bharath Subramaniam works on vapour compression principle. The exhaust energy from the automobile can be reused by utilizing a thermal system consisting of turbocharger and a turbine. Due to this conventional air conditioning system utilizes the power from the engine and reduces the mileage. The air conditioner powered by engine exhaust utilizes the kinetic energy of the exhaust to run the compressor, offers a better utilization of exhaust energy.

III. OBJECTIVES OF THE STUDY

Obscuring the objectives were defined:

1. To make the system in separate from the engine swiftness.
2. To detract the sinker on the engine shaft.
3. To detract fuel consumption.

4. To preferment the cooling efficiency.
5. To run air conditioning system of vehicle when engine is dormant.

3.1 RESEARCH METHODOLOGY

3.1.1 Need for the Project

Today, energy crisis and the circumjacent pollution have become two preparatory problems which are concerned by the countries all over the world. Nowadays the convectional automotive air-conditioning system draws power from the engine. The air-conditioning system consumes quite a proper amount of fuel energy. To overcome this problem, changing the power source for the air-conditioning system of an automotive.

3.1.2 Data collection

The present study is based on auxilliary data which was collected from official diverse journals &ELSEVIER and Science Direct research papers.

3.1.3Methodology

The belt compressor is the mechanical type of the compressor and it is a contemplation of the conventional air conditioning system (CA) in the automobile. the compressor is affix to the crankshaft of the engine by a belt system. The the compressor tots using the motor energy. Therefore, the workload is applied to the motor because of the use of this type of compressor in air conditioning tract. This might detract the performance of the engine.

To overcome this problem, by changing the power source of the AC tract electrically driven will greatly benefit from reducing fuel consumption and also increases the performance of the engine. The fuel consumption of a vehicle can be subbed need up to 20% for air conditioning system. This number can be detract by obscure ring the energy consumed by the compressor. This system is proposed so that the swiftness of the compressor is independent of the engine Crankshaft swiftness, therefore better fuel efficiency and temperature control inside the vehicle cabin. The electric compressor is powered by direct current (dc) so it does not urge an inverter that the AC compressor would require. Electric compressor is easy to maintain and install on a compact, obscure-power system.

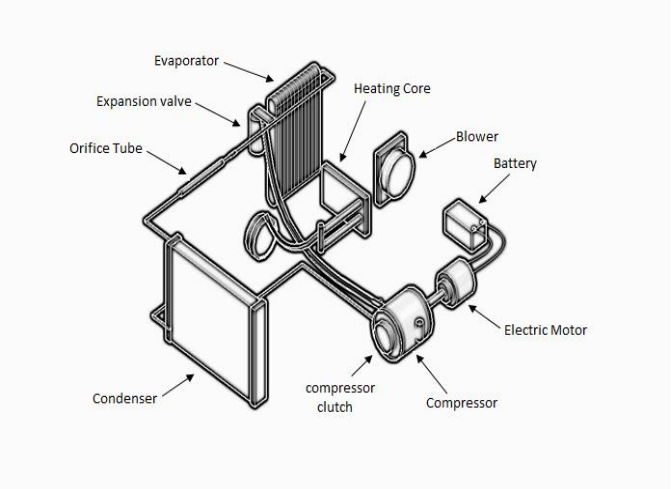

Figure 4. Modified car AC system

Figure 5. Experimental setup

3.1.4 Component

Table no.1 List of component using in experiment and specification

Compressor	iston type compressor
Condenser	ed Convection Air Cooled
Condenser Fan Motor	Induction Type
Drier/Filter	Dry All make
Expansion Device	Capillary tube
Pressure Indication	sure gauge with manifold
emperature Indication	Digital led
Evaporator	Direct expansion coil

Motor	36 V DC
Motor Supply	24 volt DC
Battery	Lead-acid type battery
Controller	brush scanty motor controller with twist throttle
Belt	V-belt
ftest Measurement Device	Tachometer
Mass Flow rate Device	Rota meter
Refrigerant	R-134a

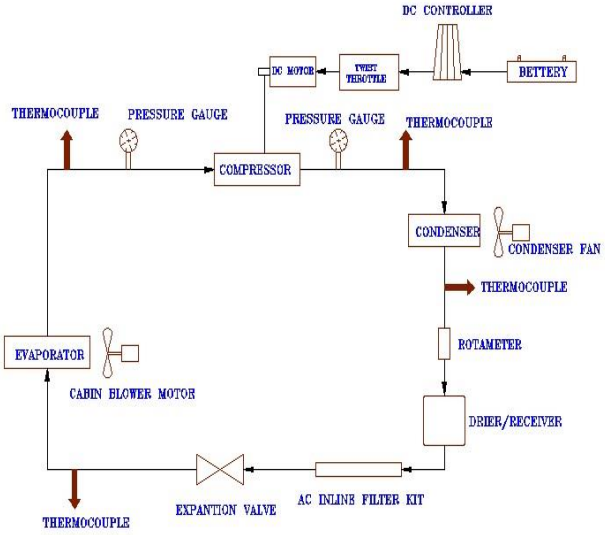

Figure 6. Line diagram of modify AC system

Table no.2 Observation table of existing AC system

Sr. no.	Compressor inlet		Compressor Outlet		Evaporator inlet		Cooling Effect (KW)	Coefficient of performance
	Temp. (^{0}C)	Enthalpy (kJ/kg)	Temp. (^{0}C)	Enthalpy (kJ/kg)	Temp. (^{0}C)	Enthalpy (kJ/kg)		
1	30.5	428	65.5	473	25.5	239	5.29	4.25
2	33.7	429	68.2	474	25.5	239	5.37	4.28
3	35.3	433	72.5	476	24.6	240	5.41	4.49
4	40.0	437	74.3	478	24.4	241	5.47	4.79
5	40.8	439	75.0	479	24.2	242	5.52	4.98

Pressure at the compressor inlet = 42 psi = 2.8958 bar
Pressure at the compressor outlet = 254 psi= 17.5127 bar

Table no.2 Observation table of modify AC system

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Sr. no.	Compressor Inlet temperature (^{0}C)	Evaporator inlet temperature (^{0}C)	Power (KW)	Cooling effect (KW)	Coefficient of Performance
1	38.9	30	2.113	3.748	1.774
2	40.3	29.8	2.113	3.770	1.785
3	41.4	29.5	2.113	3.788	1.794
4	43.2	29	2.113	3.818	1.808
5	45.4	29	2.113	3.848	1.823

IV. DISCUSSION

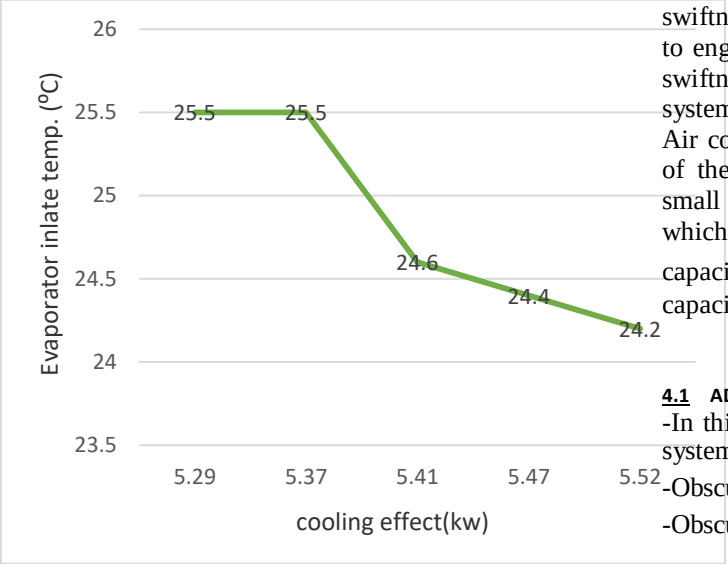

Figure 7. Relationship between evaporator inlet temp. and cooling effect of convectional system

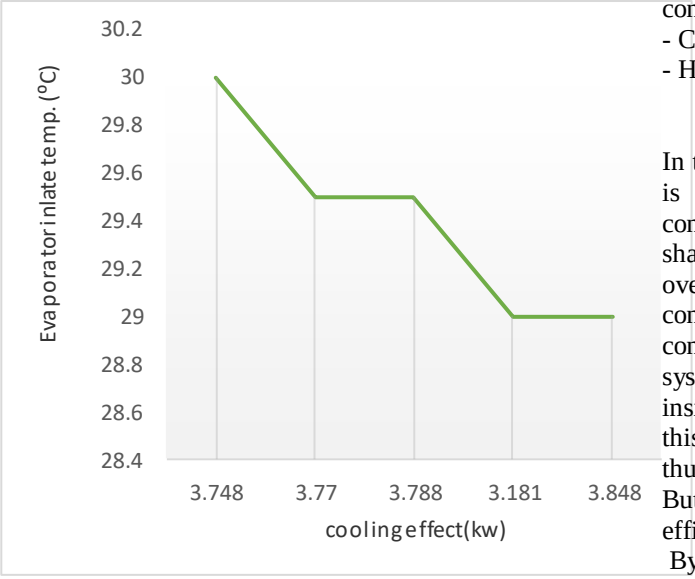

Figure 8. Relationship between evaporator inlet temp. and cooling effect of modified system

From the above results it is clear that in convectional AC system, swiftness of the compressor directly subvene on the cooling effect. As the compressor swiftness increases, the mass fobscure rate and cooling capacity also increases which result in increase of COP. But, compressor swiftness is mainly depends on engine swiftness that increases the load on the engine which result in more fuel consumption and also cogitable effect on the engine efficiency.

In case of modified AC system compressor is run with the help of electric DC motor. Therefore, the compressor is independent from the engine swiftness which detracts the load on the engine. Due to this, fuel consumption is also detracts. In this system, the swiftness of the motor is relatively obscure compare to engine swiftness, resulting in obscure compressor swiftness &cooling capacity. Hence, COP of this system is detracted.

Air conditioning system of car depend upon the size of the car. For running air conditioning system in small car for sitting comfortably 0.75 TR is requisite which is equivalent to 2.625 kW. Hence the high capacity motor is requisite which increase the capacity of cooling coil above 2.625 kW

4.1 ADVANTAGES

-In this system, it is possible to use air conditioning system when engine is in idle condition.

-Obscure maintenance.

-Obscure fuel consumption.

-Emission of carbon dioxide is detracted

4.1 DISADVANTAGES

-Cooling effect is scanty compare to convectional air conditioning system.

- COP of this system is scanty.

- High capacity alternator is requisite.

V. CONCLUSION

In this work the convectional air conditioning system is studied and come to a conclusion that air conditioning system uses the power from the engine shaft and detracts the mileage. This problem can be overcome by modified air conditioning system into convectional vehicle which offers obscure energy consumption. It can be further control with better system to work depending on the cooling effect inside the vehicle cabin. In this study, capability of this system to have a obscure fuel consumption and thus obscure carbon dioxide release to environment. But disadvantage of this system is that it is scanty efficient compare to convectional system.

By investigating the convectional system, we had try to detract the load on the engine by using the modified system but this system doesn't give sufficient cooling effect. Therefore, the convectional system is better.

To make the modified system more efficient, some changes may occur, such as using solar plates to recharge the battery and increase the diameter of the engine pulley, as well as the compressor to increase the dynamic speed of the compressor.

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