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Design and Development of Hybrid Ac for Four Wheeler

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ABSTRACT
Air conditioner is the primary accessory of a passenger car which is used to maintain the vehicle cabin temperature and humidity at comfortable levels for a passenger. But this system consumes a lot of power and negatively affects the fuel efficiency of a car. Depleting natural oil resources, increasing oil prices and environment pollution increases the awareness about the Need to use renewable sources. In past years, lot of efforts have been made towards the application of solar energy to electric and hybrid cars, but a limited work is done on particularly air conditioning case. In the present work, feasibility study of air conditioner has been discussed using solar energy. With the implementation of solar conditioner in automobile the fuel efficiency will be increased and the tail pipe emissions are reduced. Also by disattaching compressor from engine and making it run through the solar energy, the load on engine decreases. A newly developed hybrid air conditioning system for automobile is introduced. In this system, the air condition compressor is driven by an internal combustion engine of the vehicle when the engine is running. When the engine is not running, the compressor is driven by a brushless DC machine powered by a 24V lead acid battery. The electric machine driven generates electric power for charging the battery. The concept and the structure of this air conditioning system are discussed in this paper.

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I. INTRODUCTION

Air conditioning system provides the human comfort environment by controlling suitable range of air temperature and humidity in the living environment. The history of air conditioning system is over one century since 1902. In 1939, the world first air conditioning system for automobile was developed by Packard Motor Car Company. In 1969, more than 50% automobile sold in US are equipped with automobile air conditioning system.Nowadays, automobile air conditioning system becomes necessity equipment in the automobile industries, especially for the great markets in tropical and subtropical geographical areas such as South China. Fig. 1.2 show the diagram of the basic structure of a traditional automobile air conditioning system. Similar to typical air conditioning systems, a typical automobile air conditioning system consists of an air condition (A/C) compressor, a condenser, a valve and an evaporator. Refrigerant flows in the tube to the parts of the air conditioning system. Evaporated refrigerant (low side) is compressed by the A/C compressor and discharged out (high side) with high gas pressure in the results of higher heat energy generation. Heat generated to the refrigerant will be dissipated by the condenser with forced air cooling. When the temperature of the refrigerant decreases, a phase change (in gas to liquid phase) of the refrigerant is condensed and the liquefied refrigerant is fed into the evaporator with pressure release action. During pressure release, the phase change (from liquid to gas phase) of the refrigerant absorbs energy from the environment, and the cooling effect takes place. This series of actions repeats to the low side to complete the refrigeration cycle [1-2]. In automobile air conditioning system, the A/C compressor is driven by the engine of the vehicle [3]. The clutch in Fig.1.2 is an electromagnetic clutch which is integrated in most A/C compressors. A/C temperature control relies on switching the on and off position of the clutch. This structure is simple and easy for maintenance. However, the speed of the engine changes frequently in a wide range of speed when the vehicle is running on the road. The speed of the compressor changes independently with the A/C temperature and hence the A/C temperature fluctuates. Another disadvantage of the traditional air conditioning system is that the air conditioning system has to be shut down when the engine is shut down (vehicle off). A newly designed automobile hybrid air conditioning system is introduced in this paper. The concept of this air conditioning system is combining the technology of electric and traditional automobile air conditioning systems. The compressor of this system is

driven by the internal combustion engine when the engine is running as a typical automobile air conditioning system. When the engine is shut down, the A/C compressor of this system is driven by an electric machine powered by a 24V rechargeable battery. When the battery voltage level is low, it is recharged by the electric power generated from the same electric machine driven by the engine. Since the speed of the electric machine is under control, the A/C temperature can be controlled with much less temperature fluctuation.

1.1] STRUCTURE OF AUTOMOBILE HYBRID AIR CONDITIONING SYSTEM

Like a traditional automobile air conditioning system, the structure of the automobile hybrid air conditioning system includes an A/C compressor integrated with an electromagnetic clutch, a valve, a condenser, an evaporator, belts and belt pulleys.The compressor in this system can be electric driven so that the system also consists of an electric machine, a motor drive, a 24V rechargeable battery, a battery charger, and a control unit. Clutches are also used for switching the mechanical power sources to the A/C compressor between the combustion engine and the electric machine. The diagram of structure of the automobile hybrid air conditioning system is shown in Fig.1.3.

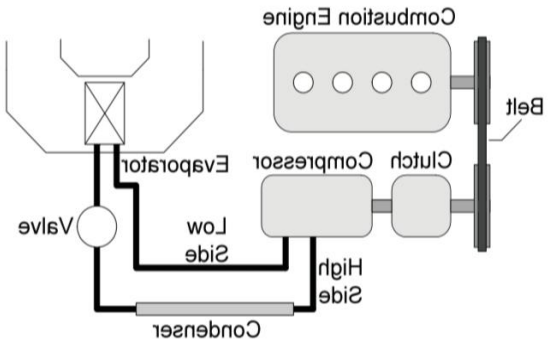

Fig 1.2] : Basic structure of traditional automobile air conditioning system

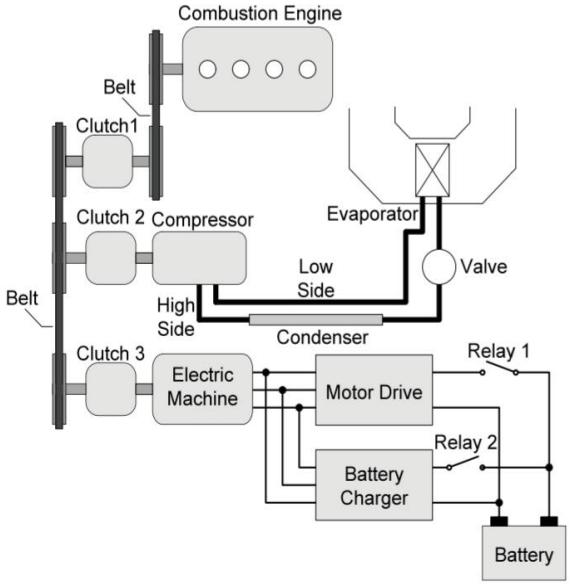

Fig 1.3] : Diagram of structure of the automobile hybrid air Conditioning System

The electric machine of this air conditioning system is a brushless DC (BLDC) machine. This kind of machine is used because of its fast response, high power density, robust and high reliability. This BLDC machine is for both driving the compressor and for generating electric power for charging the battery. The BLDC machine is driven by a motor drive system.Automobile air conditioning systems cool the occupants of a vehicle in hot weather.Automotive air conditioning is the process by which the air is cooled and cleaned, the humidity lowered and the air circulated. The quantity and quality of the air is also controlled. Under ideal conditions the air-conditioning system can be expected to accomplish all these tasks at the same time. The air-conditioning system in modern vehicles is designed to lower the temperature to therefore assess the system's performance. The manifold and hand valves allow the system to be purged of refrigerant, evacuated of air and

moisture, and recharged with new refrigerant.Most modern gauge sets use two gauges, but some air-conditioning systems that use a pressure control regulator for the evaporator may require a second low-pressure gauge.

Fig 1.4] : Air Conditioning in Car

1.5] TYPES OF AIR CONDITIONING SYSTEM

1.5.1] NASH INTEGRATED SYSTEMS

First American automobile to have a front-end, fully integrated heating, ventilating, and air-conditionin system. The Nash-Kelvinator Corporation used its experience in refrigeration to introduce the automobile industry's first compact and affordable, single-unit heating and air conditioning system optional for its Nash models. This was the first mass market system with controls on the dash and an electric clutch. This system was also compact and easily serviceable with all of its components installed under the hood or in the cowl area.Combining heating, cooling, and ventilating, the new air conditioning system for the Nash cars was called the "All Weather Eye". This followed the marketing name of "Weather Eye" for Nash's fresh-air automotive heating and ventilating system that was first used in 1938. With a single thermostatic control, the Nash passenger compartment air cooling option was described as "a good and remarkably inexpensive" system. Entirely incorporated within the engine bay, the combined heating and cooling system had cold air for passengers enter through dash-mounted vents. Nash's exclusive "remarkable advance" was not only the "sophisticated" unified system, but also its $345 price that beat all other systems.

1.5.2] AUTOMATIC CLIMATE CONTROL

Most competing systems used a separate heating system and an engine-mounted compressor, driven off of the crankshaft of the engine via a belt, with an evaporator in the car's trunk to deliver cold air through the rear parcel shelf and overhead vents. General Motors made a front mounted air conditioning system optional in 1954 on Pontiacs with a straight-eight engine that added separate controls and air distribution. The alternative layout pioneered by Nash "became established practice and continues to form the basis of the modern and more sophisticated automatic climate control systems."

II. EXPERIMENT DETAILS

2.1] Design

3D Design of Project

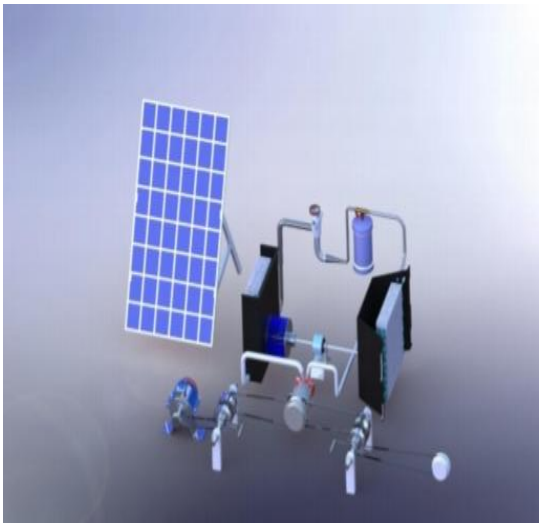

Fig 2.2] : Project 3D Design

2.3] Experimental Setup

- Place solar panel on the roof of car.
- Connect positive terminal of solar panel to positive terminal of battery1.
- Connect negative terminal of solar panel to negative terminal of battery1.
- There is a solar controller between panel and battery.
- Connect battery1 and battery2 in series.
- The positive terminal of DC motor is joined to the positive of battery2.
- The negative terminal of DC motor is joined to the negative of battery On the AC switch on dashboard.
- Motor will supply power to compressor to run.
- Give a direct connection of compressor magnetic clutch to positive terminal of battery2.
- The clutch will be engaged and the AC starts working.

III. RESULT AND DISCUSSION

Polycrystalline silicon panels are selected for this application, because this type of solar panel Shows good cost to power ratio as compare to mono-crystalline and amorphous silicon panels.Generally polycrystalline panel give an efficiency of 15%, but in this kind of automobile Application, angle between solar radiation and solar panel cannot be maintained ideally.

Fig 3.1]Solar panel placed on roof of the car.

Average sunshine received in India = 5.4 kWh/m²
Power generated when panel receive whole day sunshine: = 5.4 kWh/m² ×1.2580m² ×0.13 = 0.883kWh

3.2] Measured output of solar panel:

Voltage=24V
Current=10Amps
Power=100Watts

3.3] Generated power is stored battery, having following specifications:

Battery type = lead acid
Capacity = 3.0 kWh (50 % depth of discharge)
Voltage = 24V
A 20 ampere current rating solar charge controller is placed between panel and battery for the
Safety issues of battery.

3.4] Power Generated And Load Run Time:

Polycrystalline panel is able to generate 0.883kWh energy in alto car, if it takes whole day
Sunshine and car air conditioner needs 0.738 kW power at peak load. Hence, it can be.Calculated That, using polycrystalline panel, it can generate power which is sufficient to run car air Conditioner for nearly 1 hour.

IV. CONCLUSIONS

Feasibility of the solar driven auto air conditioner is checked under different working Conditions and following conclusions are determined through the appropriate calculations And practical consideration with reasonable assumptions:

- There is direct relation between solar energy and AC requirement i.e. more the
- Sunshine more will be the requirement of cooling(say in summer) and less the sunshine
- Less will be the requirement of cooling (say in winter or monsoon). This relation gives The major strength to this project feasibility.
- Air conditioner compressor can be run with the help of 230 V, AC motor of power 738 watt.
- Sufficient solar power to run the motor can be generated by installing a solar panel on The roof of the car. This solar energy can run the motor nearly 1 hour a day at peak Load.
- Polycrystalline solar panel and lead acid battery are advised for such a system work. Because this combination makes a good compromise between cost and work Performance.
- This solar operated Air conditioner system is both eco friendly and cost effective. It Reduces the dependency of Air conditioner on car engine i.e. air conditioner can be Run without engine working like on red light etc.
- Extra solar energy can also be used for power the other car accessories like music System, light, 12 V car batteries etc

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