A Solar Ventilation System for Parked Car

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Abstract— This paper shows the review of the existing solar car ventilation system by observing its effectiveness in reducing the temperature inside the car which is parked unroofed under the sun. The commercially available ventilator is only working as the exhaust fan and it was not cool down the temperature inside the car as we required. But the new ventilation system can reduce more than 17 0C inside the car cabin so that it is very useful in summer days and also it is work with the help of the solar power that's why fuel consumption become low and load on the car engine will reduced. So This paper gives the idea about the how much existing ventilation work and reduce the temperature.

Key words: Solar Power, Car Ventilation, Temperature

I. INTRODUCTION

In India most of the people drive car. While using their vehicles, sometimes the car has to be parked directly under the sun due to limited roofed parking area. So that because of the unroofed parking conditions the temperature inside the can is increased very much. Rise in temperature levels inside the car can be attributed to convection (volume of air inside), conduction (various metals and heat absorbing materials inside) and radiation (from the glass and body of the car), of which the most influencing factor in such heating is radiation [4, 5]. Because of the temperature increases inside the car it causes discomforted of passenger inside the car and also reduces the quality of plastic, rubber, seat cover, etc which is used in interior of the car [2]. Sometimes due to high temperature inside the car the glass of the car also brakes and also causes human health problem. As to reduce the heat inside the car, some drivers open a small gap of the car windows to provide some ventilation. However, study from [2] shows that the practice had minimal effect and it does not really improve the situation. That practice will also lead to safety and security issue due to theft and robbery [3,2].

Thus, there is a need to have a proper ventilation system inside a parked car. There are several tools that have been developed to assist the ventilation problem inside a parked car either via battery powered system or solar based system [3]. The use of solar based ventilation system sounds promising to be employed in India due to our present weather and sun radiation condition. In spite of the commercially available solar [5,6].

In this paper shows the analysis of the existing solar ventilation with different conditions and then compared with the developed car ventilation system. The setup for data collection for the purpose of analysis and observation will be also highlighted. Later the result and analysis from the finding are discussed. Finally the paper ends with conclusion supporting with recommendation for further research development [4].

II. CAR AIR CONDITIONING SYSTEM

As we all know that the main working of air conditioning is to blow the cold and fresh air at desired temperature. So that in vehicle or in car the installed air conditioning system is done same thing. Air conditioning's main principles are Evaporation and Condensation, then Compression and Expansion.

Hard tubing and flexible hoses connect all the actual components of the air conditioning in your car. Evaporation and condensation, expansion and compression are the physics of why it works. There are five main components to the whole system, namely the Compressor, Condenser, Receiver-dryer, Expansion valve, and the Evaporator. The fluid that passes around the whole system is the refrigerant. The refrigerant can evaporate at a low temperature, and then condense again at a higher pressure. In the bad old days, R-12 was the refrigerant used in almost all cars. It was widely available, however it was found to be a contributor to the hole in the earth's ozone layer as it was a chlorofluorocarbon (CFC). These refrigerants were discontinued, and all cars after 1996 use a non-CFC fluid called R-134A which is kinder to the environment

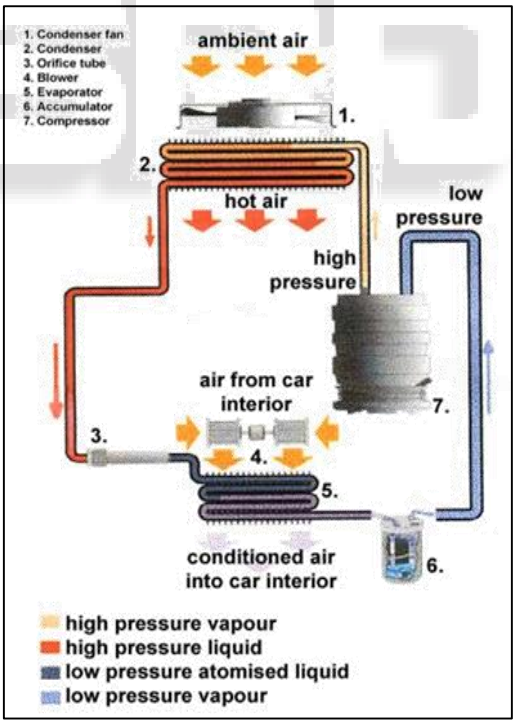

Fig. 1: Car Air Conditioning System

A. Fuel Consumption While Car is Parked at Direct Sunligh

When we parked car in direct sunlight the temperature increases rapidly so some experiment shows here in which car is parked in direct sunlight and the inside temperature of the car is measured 68 oC at 3:30 P.M. the table 1 shows that the temperature measurement inside the car when ac is running.

Sr. No.	Time	Inside Temp. of the Car	Ambient Temperature
1	3:30 PM	68ºC	43ºC
2	3:35 PM	58ºC	41ºC
3	3:40 PM	50ºC	41ºC
4	3:45 PM	42ºC	40ºC
5	3:50 PM	34ºC	39ºC

Table 1: Temperatures inside the car when AC is ON

This table 1 shows that the temperature at the mid of the day inside the car is maximum which is around 68 oC so to reduce the temperature inside the when we turn on the AC it takes 20 minutes to get ambient temperature. So without running condition the car consumes fuel around 20 minutes which is the wastage of the fuel.

Here gives some calculation for the fuel consumption report that when car AC is turned on at high speed it consumed 1 litter per hour so that if car is on for 20 minutes then the fuel consumption for that particular period is

20*1/60 = 0.33 litter consumption of fuel.

If the fuel is petrol then price of the fuel is 0.33*69 = 22.77 Rs.

This calculation gives indication that it takes too much fuel for running Air Conditioning system. and it is also shown that while driving the car when AC is turned on then the load on the engine is increases and it also required high fuel consumption and it reduces the engine efficiency.

III. CAR GEOMETRY AND SPECIFICATION OF COMPONENT FOR THE NEW VENTILATION SYSTEM

To find the what size of cooling and exhaust fan is required firs of all we have to find he internal area and volume of the car cabin but it is very difficult to find internal area so all equipment are taken as rectangular shape.

Place	Length	Width	Height	Volume
Volume of Free Space Available in car.				
Volume between front glass and dash board	1.15 m	0.25 m	0.30 m	0.08625m^3
Net cabin Volume of the car	1.67 m	1.25 m	1.22 m	2.54675m^3
Back side volume of the car	1.25 m	0.31 m	0.84 m	0.3255 m^3
Total				**2.9585 m^3**
Volume of Different Components which Consume Free Space of Car.				
Volume of the passenger seat at back side of the car (lower portion)	1.15 m	0.48 m	0.32 m	0.1766 m^3
Volume of the passenger seat at back side of the car (upper portion)	1.15 m	1.52 m	0.80 m	0.888 m^3
Volume of the dash board	1.20 m	0.20 m	0.60 m	0.1453 m^3
Volume of driving seat (upper portion*2)	0.85 m	0.13 m	0.45 m	0.09956 m^3
Volume of driving seat (lower portion*2)	0.40 m	0.49 m	0.20 m	0.0784 m^3
Volume between steering roof and front glass	1.15 m	0.30 m	0.12 m	0.0414 m^3
Volume of the middle portion of the car where hand brake is placed	1.48 m	0.25 m	0.20 m	0.0748 m^3
Total				**1.09406 m^3**
Total Free Space Volume	2.9585 m^3 – 1.09406 m^3			**1.8644 m^3**

Table 2: Car Cabin Volume Maruti 800

This table shows the free volume of the car cabin where air flow ratio is determined. So if we want to create ventilation in car cabin we have calculate air flow ratio or CFM of fan with free space volume.

A. Fan Design

To know how big fan is required for ventilation in car cabin first of all we have to find the free space in car cabin which is shown in table 3. So here give the calculation of what type of exhaust and cooling fan required in placed car when all window is closed. Here we have to calculate car volume in cubic fit so

$$1 \text{ cubic meter } = 35.3147 \text{ cubic feet}$$

$$\text{So } 1.8644 \text{ cubic meter} = 35.3147 \times 1.8644 = 65.8406637 \text{ cubic feet}$$

$$\text{CFM of exhaust fan} = \text{volume of the car} \times \text{air change rate} \div 60$$

$$= 65.8406637 \times 2 \div 60$$

$$= 2.19468878 \text{ CFM}$$

Temperature difference in car is around 30 ºC

$$\text{Actual CFM required} = \text{CFM} \times \text{temprature difference} = 2.194688 \times 30$$

$$= 65.840\ CFM.$$

So we required a exhaust and cooling fan which capacity is 65.840 CFM which is also known as minimum ventilation requirement. Now we have to calculate the dimensions and type of the exhaust and cooling fan. Requirement.

An air moving device in which the air flow is parallel or axial to the shaft on which the propeller is mounted. These fans have good efficiency near free air delivery and are required primarily in low static pressure, high volume applications. As SP is increased, HP increases and CFM decreases. Usually mounted in a venture, ring, or other housing featuring simple construction and low cost. figure 2 shows the all specification of the fan wit capacity of 100 CFM.

B. Specification of the Fan

Power required in fan	1.5 Watt
Dimensions of the fan in cm	$12cm \times 12\ cm$
Diameter of the fan in cm	10 cm
Voltage of fan required (V)	12 V
Current required in fan (A)	0.35 A
Speed of fan in RPM	2500 RPM
Blade in fan	7
Length of fan (cm)	3.2 cm

Table 3: Specification of the fan

C. Specification of the Solar Panel

Power (watt)	20 watt
Type	Poly crystalline
Voltage (V)	17.9 V

Current (A)	1.16 A
Maximum system voltage (V)	1000 V
Open circuit voltage (V)	21.65 V

Table 4: Specification of the solar panel

D. Design of the Casing

The most important components which is used in new ventilation system is the casing. All the other equipment like rotating motors, rotating shaft, rotating cloth cooling fan are mounted in this casing the casing material is steel so that strength of the casing is very high. The table 4 shows the volume and the area of the casing. In this casing also used for the reservoir the water so that base of this casing is filled with the water and when power is supplied the cloth is rotate and become wet.

Sr. No	Area or Volume	Dimensions Inches	Total Inches
1	Total volume of casing	6.5*6.5*8	338
2	Area of the front and back side window	4*4	16
3	Distance between two rotating shaft	5	5
4	Area of the air passing from the wet cloth	5*3	15

Table 5: Design of casing used in new ventilation system

This table shows that the all dimensions of the casing and the area of the rotating cloths.

E. Costing of the New Ventilation System

Sr. no.	Components	Units	Price(Rs)
1	Solar panel	**1**	3000
2	battery	**1**	1000
3	Cooling fan	**1**	500
4	Exhaust fan	**1**	500
5	Wiring system	**1**	300
6	thermometer	**4**	1000
7	Casing with cloth rotating mechanism	**1**	2000
9	Rotating cloths	**1**	200
10	Installation charge		1500
		Total	Rs. 10000

Table 6: Costing of the ventilation system

IV. WORKING OF THE NEW VENTILATION SYSTEM

In Figure 2 shows the installation of the new ventilation system when car is parked under the direct sun light. This ventilation is mounted on the wooden stand placed at front side of the car. Which has one cooling fan and one exhaust fan and one cloth rotating mechanism with motor of 30 rpm and one 12 V battery behind the wooden stand. All this cooling fan and water rotating mechanism placed inside the casing.

The cooling fan and cloth rotating mechanism connected with 12 V battery one end of the cloth connected with motor with the help of the shaft and the other end of the cloth is submerged in water. When we switch on the battery the cooling fan is start rotating with the speed of 1500 rpm and also motor at 30 rpm. When motor is started to rotate the shaft is connected with the motor is also rotate and with the help of shaft rotation cloth is also start rotation at the speed of 12 rpm. The second shaft is submerged in water and upper and lower shaft is connected with cloth. So when upper shaft is rotate, the lower shaft also starts to rotate with the same speed. By rotating lower shaft cloth also start to rotate. In this rotation some part of the cloth is submerged in water and it become wet after some time. So that air comes from the fan pass through the wet cloth and temperature of the air will decreases.

A. Circuit Diagram of the Ventilation System

In this portion gives the idea about the circuit diagram of the new ventilation system that how it will be installed. The fig 3 shows that the only solar panel placed at the outside of the car cabin or at the top of the car and all other components are placed at inside the car cabin.

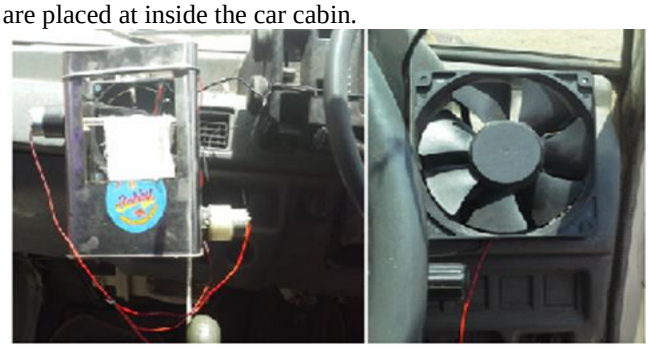

Fig. 2: Location of the cooling and exhaust fan with wet cloth rotating mechanism.

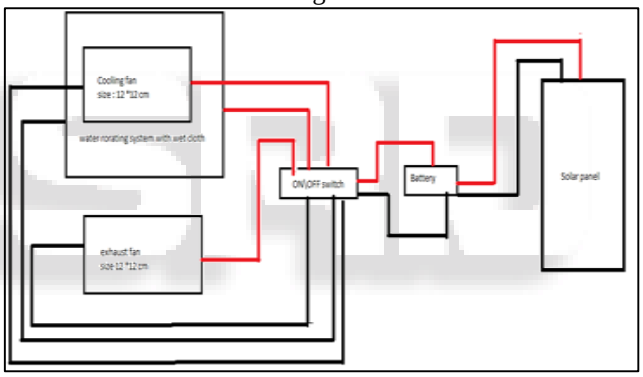

Fig. 3: Circuit diagram of the new ventilation system.

B. Temperature Measurement

This portion shows the temperature measurement inside the car cabin when the car placed at the direct sun light without any ventilation system and with commercial ventilation system. The figure 4 shows the comparison between without and with ventilation system inside the car cabin.

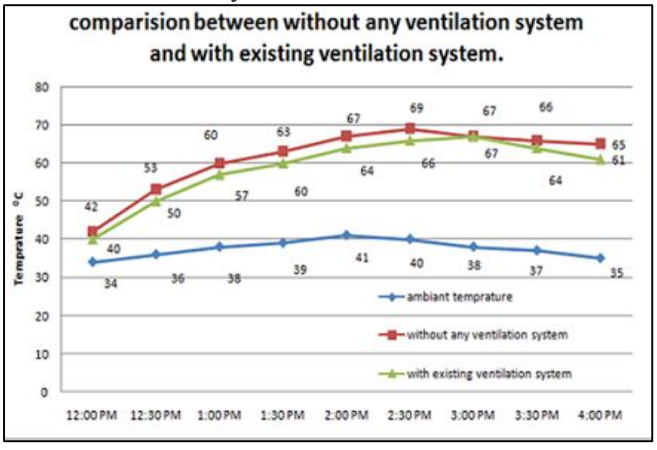

Fig. 4: Temperature comparison between without any ventilation system with existing system.

The other figure shows the temperature comparison between with new ventilation system placed at the front side of the car and without any ventilation system in figure 5.

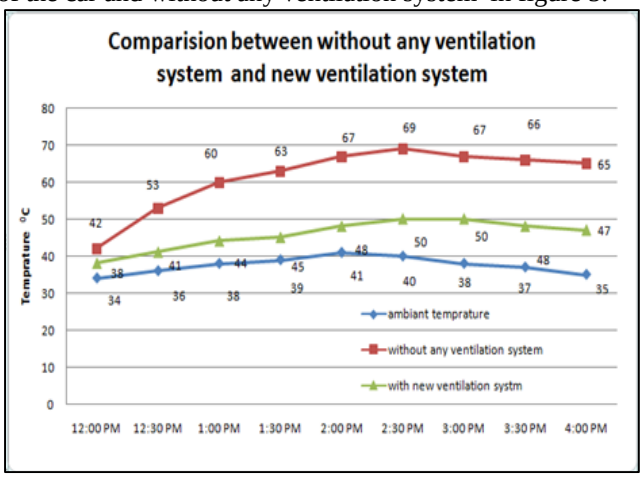

Fig. 5: Temperature comparison between without any ventilation system and with new ventilation system.

The figure 6 shows the comparison between new ventilation system and the existing ventilation system.

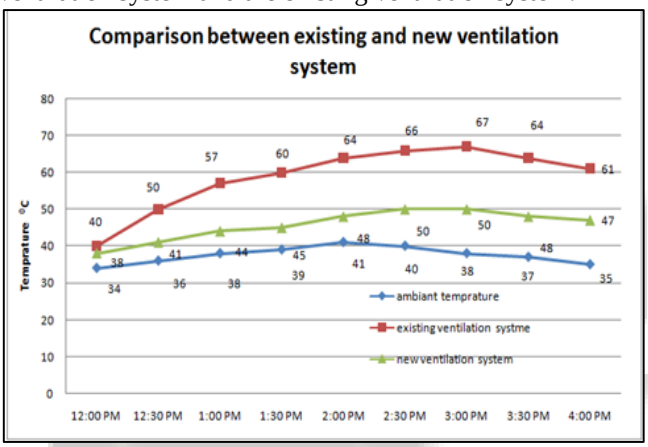

Fig. 6: Comparison between old and new ventilation

V. Conclusion

Comparison of temperature inside the car between without any ventilation system to the new developed ventilation system. From this comparison chart we can see that the difference between temperatures is very high. The new developed ventilation system decrease 16 to 19 degree Celsius inside from the car which is very appreciable we get efficiency of new ventilation system is about 25 to 27 percent. So when we entered in car it takes less time to get ambient temperature which gives us less fuel consumption and decrease load on the engine which impact on when we start the air conditioning

The usage of wet cloth rotating mechanism is found to reduce the average maximum temperature for the ambient air inside the car. It is best for temperature reduction and very economical.

VI. Future Scope

The design of the present ventilation system is not attractive in future we can improve the design of the solar ventilation system so that it will work properly and we can also suggest that design to the car manufacturer company.

If the design of this ventilation system is improved than we can also use this as portable cooler while driving the car. So by using this in car we can replace the air conditioning system.

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