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Alternate System for Car Cabin Comfort Cooling- Solar Powered

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Abstract

Nowadays, a car is one the most important transportation for individual compared to public transport. Parking spaces are constricting day by day and people are forced to park their car in open spaces under the scorching sun. High solar global insolation in India causes typically very high ambient temperature. During summer if the cars are parked directly under the sun, then the exposed cabin inside the car will produce greenhouse effect. This will lead to higher cabin temperatures and cause problems like Fire burst, emission of harmful poisonous gases, colour fading, wear and tear of cabin elements etc. In this paper we are trying evaluate a simple cooling and ventilation system powered by solar energy to purge the hot air trapped inside the cabin.

Key words: Car, Cabin, Cooling, Solar.

Introduction

India is developing at a faster rate than ever and its direct impact is visible on the roads of India, nowadays, a car has become the most important mode of transportation for individual compared to public transport. As per the Delhi government transport department data, there has been a significant growth in number of vehicles in Delhi *(Table 1)* from the period of 2007 to 2012.[2] In the year 2015, till march alone[1], there were almost 84.75 lacs registered private vehicles in Delhi *(Table 2)*. The high demand of the private transportation has lead to an acute shortage of covered parking area. More and more people are thus being forced to park in open spaces under the scorching sun.

High solar global insolation in India causes typically very high ambient temperature. During summer if the cars are parked directly under the sun, cabin inside the car will experience a kind of greenhouse effect. This will lead to higher cabin temperatures

and cause problems inside the car Fire burst, emission of harmful poisonous gases, colour fading, wear and tear of cabin elements etc. The high temperature prevailing inside the vehicle is definitely unreceptive to the occupants when they arrive to take a drive. In this paper we are trying evaluate a simple cooling and ventilation system powered by solar energy to purge the hot air trapped inside the cabin.

Genesis

Delhi is one of the most rapidly spreading and developing cities in the world. It is assumed that thousands of migrants move into Delhi every day, while hundreds of them return. It has resulted in acute scarcity of land for the dwelling population and even more severe shortage of space for the shaded parking lots for vehicles.

Everyday hundreds of new vehicles join the congested traffic of Delhi and add on to the already trembling situation of the city. This scorching heat results in fire outbreak incidences, emission of harmful gases inside the cabin, carcinogenic emissions, wear & tear etc.

Table 1: Private Vehicles Registered in Delhi from 2007 to 2012. (Source: Delhi Government)[2]

Private Vehicles Regd. during 01 April 2007 to 30 Sept 2012 (Incl. NOC taken/Replacement/Converted vehicles)							
Class Description	2007-08	2008-09	2009-10	2010-11	2011-12	UPTO SEPT 2012	TOTAL
INVALID CARRIAGE	7	15	31	32	39	24	148
LMV (CAR)	133204	133428	154326	161456	172727	75573	830714
LMV (IMP)	181	178	126	157	307	65	1014
LMV (JEEP)	869	473	534	70	178	12	2136
LMV (VAN)	26	23	21	9	3	1	83
MOPED	535	589	4135	5811	6433	2633	20136
MOTOR CYCLE	204249	198140	215786	230562	228609	93519	1170865
MOTOR CYCLE (IMP.)	8	8	21	78	111	104	330
MOTOR CYCLE WITH SIDE CAR	0	1	3	0	0	0	4
OMNI BUS (PVT USE)	0	0	0	1	2	0	3
SCOOTER	33776	31581	416311	455478	481141	216591	280709
SCOOTER WITH SIDE CAR	6	16	465	97	74	17	675
THREE WHEELER PRIVATE	1	2	3	4	8	2	20
TOTAL	372862	364454	416311	455478	481141	216591	2306837

Table 2: Private Vehicle registered in Delhi this year till March 2015 (Source: Delhi Government)[1]

Private Vehicles Regd. Upto 31 March 2015-11-30 (Excl. NOC taken/Replacement/Converted vehicles)	
Class Description	**Total**
LMV (VAN)	74191
THREE WHEELER PRIVATE	37
DELIVERY VAN	1
TRACTOR (AGRICULTURE)	100
SCOOTER	2715297
UNKNOWN	1
LMV (JEEP)	67464
MOTOR CYCLE (IMP.)	972
INVALID CARRIAGE	452
SCOOTER WITH SIDE CAR	748
MOTOR CYCLE	2861595
LMV(CAR)	2640809
MOPED	105114
OMNI BUS (PVT USE)	5
LMV (IMP)	6572
MOTOR CYCLE WITH SIDE CAR	10
THREE WHEELER (PASSENGER)	2
TOTAL	**8475371**

Hussain, Firdaus and Sidik [3] in their experiments for car cabin comfort, recorded the variation in temperature inside the car cabin in 12 different measurement locations *(Table 3)*. The transient variation of the temperature was covered for measurement period from 9.00 am to 4.00 pm. They were surprised to find out how high temperatures can soar within the interior of a car during a hot, sunny day. During the measurement, where all windows were closed, the dashboard temperature, DBT was raised up to 75°C. The DBT exceeded the 70°C for the period between 12.30 and 2.30 pm. It is important to note that the outside temperature does not have to be hot in order for a car to become an oven-like death trap. Even temperatures considered mild can lead to dangerously high temperatures during an extended period of time.

Their results indicate that the dashboard functioning as a sink of solar radiation and source of convection heat transfer to the adjacent air particles. Large air circulation cavity above the dashboard and small air circulation cavity near the rear upper part with stagnant portion between the two cavities were observed. The sun shade installation underneath the front windshield reduced the thermal accumulation considerably. Generally speaking, it reduced the temperature by about 27% inside the car cabin. Accordingly, its use has been highly recommended. The drop down of the front side windows by 20 mm caused reduction in the front air gap by 20%.

Table 3: Locations for car cabin temperature measurement. [3]

Location Of The Measuring Points	Type
Dashboard	Surface
Space for leg-near firewall (passenger side)	Air
Under roof	Surface
On left passenger seat	Surface
Front windshield	Surface
Back windshield	Surface
On back seat	Surface
Front side (hanging between driver and passenger)	Air
Head support of seat (front passenger)	Surface
Side window (left back passenger)	Surface
Back side (hanging at centre)	Air
Side window (driver side)	Surface

Alternative approach for car cabin comfort

The remarkable outcomes of the car cabin comfort experiment resulted in many design reconsiderations by the automobile manufacturers, but it still left us unanswered with a major challenge, i.e. cooling, the green house effect and harmful emission inside car cabin.

The most promising method to handle the challenge of the green house effect, harmful emission inside car cabin and to quickly cool the car cabin is to provide for a system of air conditioning and ventilation in the car, but not the conventional system provided along by the manufacturer, but rather an alternate system which works without consuming the Fuel or running the engine while the car is parked in the sun.

Currently we all use car air conditioning system for cooling the cabin of the car. But when car is parked it is not economical to use the system provided by the manufacturers to start the air conditioner as it requires the engine to remain ON so as to match the power required. This is not economical at all. So we thought and propose to make the use of solar energy to give power to the air conditioner as it is more economical than the conventional systems.

But the following theoretical limitations stood forward. [13] A normal car conventional air conditioners requires a input power of around 360 Watts. A solar panel of 200 Watts costs somewhere around Rs 12,000, so it requires a lot of initial investment to run a conventional car air conditioning unit by solar power which is not feasible. [12][8] Thus the idea of using the car inbuilt air conditioner to cool the car while its parked is dropped and we decided to build a new ventilation system so as to cool the cabin and being economical at the same time which runs on solar power.

After close study and comparison of the distinctive features and respective advantages of the conventional and alternate cooling technologies available today, we are of the opinion that the Thermionic, Thermo acoustic & Magnetic cooling systems are still in their early stages of research and development, and their lower COP do not allow to use them commercially. [4][6][8]

Hence, we have focussed on the application of the major systems which are currently being used, to our cause. We have narrowed down to: [9][12][13][14]

1. Vapour Compression
2. Vapour Absorption
3. Thermoelectric Cooling systems

Based on various parametric comparison of these technologies, we have come to a following conclusion: [4][5][6][7][8][10][12][13][14]

1. Weight: thermoelectric units weigh 1/3 to 1/2 as much as the other units because of the lightweight cooling system and lack of heavy compressor unit.
2. Compactness: thermoelectric are the most compact systems because of the small size of the cooling components.
3. Price: thermoelectric coolers cost 20%-40% less than the equivalent sized compressor or absorption units available for recreational use.
4. Portability: thermoelectric are the most portable because they are light enough to carry with one hand and are not affected by motion or tilting. Compressor models are quite heavy and the absorption models must be kept level within 2-3 degrees.
5. Safety: thermoelectric systems are completely safe because they use no gases or open flames and run on just 12 volts. Compressor systems can leak Freon which can be extremely dangerous especially if heated. Absorption systems may use propane which can be extremely dangerous in the event of a leak.
6. Battery drain: thermoelectric coolers have a maximum current drain on 12 volts of 4.5 amps. Compressor portables draw slightly more current when running but may average slightly less depending on thermostatic control settings. Absorption portables draw 6.5 to 7.5 amps when running and may average about 5 amps draw.
7. Ease of servicing and maintenance: thermoelectric units have only one moving part, a small fan (and 12 volt motor) which can easily be replaced with only a screw driver. Most parts are easily replaced by the end-user. Compressor and absorption units both require trained (expensive) mechanics and special service equipment to service them.
8. Cooling performance: compressor systems are potentially the most efficient in hot weather. Some models will perform as a portable freezer and will refrigerate in ambient temperatures of up to 110 degrees f. Thermoelectric units will refrigerate in sustained ambient temperatures of up to 95 degrees f.
9. Reliability: thermoelectric thermoelectric modules do not wear out or deteriorate with use. They have been used for military and aerospace applications for years because of their reliability and other unique features. Compressors and their motors are both subject to wear and Freon-filled coils are subject to leakage and costly repairs. Absorption units are somewhat temperamental and may require expert servicing from time to time, especially if jarred when travelling.

Conclusion

Even though the COP and cooling capacities of Vapour Compression and Absorption/Adsorption systems are higher than thermoelectric systems, the compactness, reliability and absence of any moving parts make the thermoelectric systems as the best

choice for a portable car cabin cooling system. Further design considerations, load calculations and experimental analysis will give us more conclusive results and effectiveness of this proposed model. This system will not only provide for an alternate cooling mechanism for the car but will also substantively remove the harmful emissions from the car cabin space, thereby reducing the adverse effects on the passengers.

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