International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-7 Issue-4, September 2018

Effect of Cabin Partitioning on the Fuel Consumption in Automobiles

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Abstract*: This paper deals with the effect of cabin separation on load on compressor in turn the fuel consumption in automobiles. It is a study to check reduction in working time of compressor in turn the fuel consumption when the cabin space is reduced to 45% by providing cabin partition. In present scenario people are using automobiles (cars) to reach their destinations irrespective of number of passengers. So, at minimum load conditions that is when only one or two persons travelling then there is no need to cool the entire space in the cabin so, the cabin space is reduced by providing a partition between Rear seats and front seats, the work done by compressor reduces which in turn increases the fuel economy, the load on the engine, compared to the non-partition of the cabin. Due to fuel economy, a micro level reduction in pollution and as a whole macro level.

Keywords: Due to Fuel Economy, The Load On The Engine,

I. INTRODUCTION

At present people are using automobile to travel fro home to workspace and vice versa. During their travel, it is noticed that most of times only one or two persons are travelling by car to reach their destinations. Cooling system is required only to the front end of the cabin, instead of the whole. This results in more workload on compressor and unwanted fuel consumption because cabin is designed to accommodate at least 4-members. So, air conditioning system cools entire cabin which is not necessary. This in turn increases the compressor work done which results in load on engine. Thereby increase in fuel consumption. If a partition is allowed between rear seats and front seats then load on refrigeration system decreases. By which the work done by compressor reduces and the load on the engine, when compared to the non-partition of the cabin. This in turn increases the fuel economy.

II. THEME OF THE PAPER

The theme of the project is to reduce compressor work. In general, the air conditioner in a car takes around 600 seconds that is 10 minutes to cool the entire cabin space. When this cabin space is reduced by 45% the cabin is cooled around in 6 minutes. The compressor work for 4 minutes is reduced and the required temperature in cabin is achieved in less time. If compressor work is reduced, the load on engine reduces which in turn reduces the fuel consumption and minor air pollution.

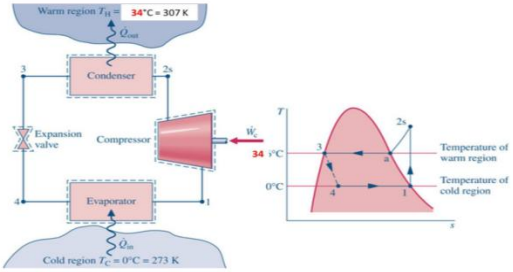

Fig. 1. Refrigeration Cycle.

III. MAJOR COMPONENTS AND THEIR DESCRIPTION

Components Used:

- Cabin separator - PVC sheet
- Automobile - Car
- Joints for assembly of sheets - Ropes, Adhesives, strap, nails

Specifications of Car:

- Car - SUZUKI SWIFT
- Engine - 1197 cc
- Mileage - 22 kmpl
- Transmission - Manual
- Refrigerant - R134a

Fig. 2. Car Cabin before Partitioning

Revised Manuscript Received on 30 September 2018.
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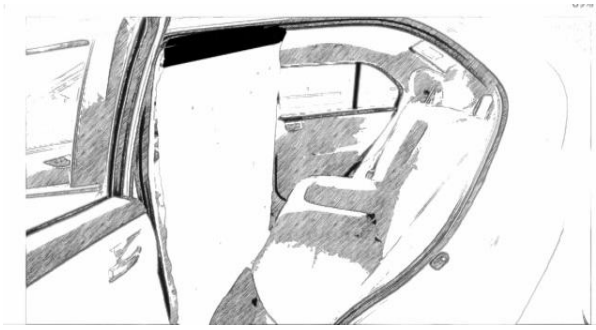
Specifications of PVC sheet:

- Length - 275 cm
- Width - 137 cm
- Material - Poly Vinyl Chloride
- Pattern - plain

Cabin separator:

Polyvinyl chloride sheet is used to separate the cabin. It acts as good cabin separating medium as it is bad conductor of heat. It is 2 meters wide and 1.5 meters long enough to separate cabin by means of adhesives and holders. It can be easily folded whenever, the full cabin space is required (more than 2 persons are travelling). It is of low cost, easily operated, and maintenance cost is low



Car cabin after partitioning

IV. DESIGN AND WORKING OF THE SYSTEM

Causes for temperature rise in car cabin

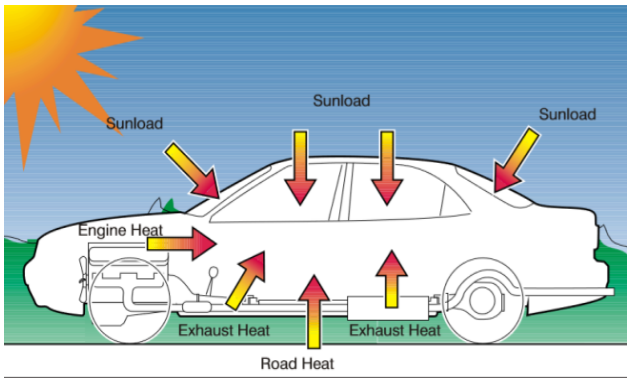


Fig. 2. Causes for Heating of Car Cabin Space

1. Heat present in cabin:

The average volume of air space in passenger compartment is = 5 m^3

Initially, for human comfort first of all we have to reduce the heat present in cabin at 35°C to 21°C.

The amount of heat to be removed from the cabin is

= mass of air x specific heat of air x temperature difference.

= (density x volume) x 1 x 14

= (1.225 x 5) x 14

= 85.75 KJ

2. Heat added to cabin by sun through Glasses:

Strong sunlight can increase the interior temperature by more than 15°C above the ambient temperature, particularly through glasses. This is when the driving time is 1 hour and ambient temperature is 35°C.

The rate of heat added to cabin by the sunlight

= (mass x specific heat x temperature difference) KJ

= (density x volume) x 1 x 15

= 1.225 x 5 x 15

= 91.875 KJ/hr

= 1.53125 KJ/sec

3. Heat added to cabin by human radiation:

Average temperature of a human body is - 37°C

The surface area of an adult human body is - 1.9 m2

Heat added to cabin from human radiation according to Stephen Boltzmann's law is given by

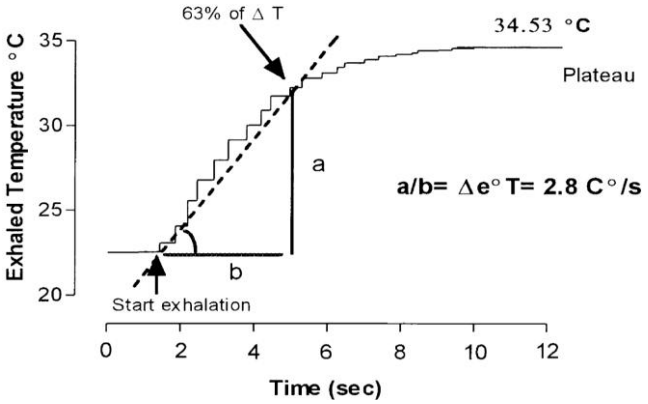
= Stephen Boltzmann's constant x surface area x (absolute temperature of body)4

= 5.67 x 10(-8) x 1.9 x 300

= 0.000032319 Watts

= 0.01163484 J/hr (which can be neglected)

4. Heat added to cabin by respiration of human:



Graph showing temperature of exhalation air as 34.5°C

Let, the cabin temperature be

= T cabin = 25°C (after conditioning)

The inhalation temperature of by humans is

= T cabin = T inhalation = 21°C

The exhalation temperature of a healthy human is

= T exhalation = 35.4°C

The capacity of human lungs (in terms of volume)

V air = 0.5 l = 0.0005 m^3

Specific heat of air = 1 KJ / kg-K

The amount of heat added to the air in lungs

= mass of air x specific heat x temperature difference

= (density x volume) x 1 x (35.4-25)

= 1.225 x 0.0005 x 10.43

= 0.00735 x 10.43

= 0.006388375 KJ / Respiration

A healthy adult breadth (18-20) times per minute.

By taking into this as consideration we respire approximately 1 Time per 3 seconds.

Therefore,

The heat transferred into cabin by respiration

= 0.006388375 KJ / Respiration

= 20 x 0.006388375 KJ / min

= 20 x 60 x 0.006388375 KJ / hour

= 7.6605 KJ/hour

5. Minor cause for heat entering into cabin:

Heat conducted into cabin by

1. Engine heat (By conduction)
2. Exhaust heat,
3. Road heat (By radiation).

Heat to be removed without cabin partitioning

Total heat that must be removed by the refrigeration system in an hour = 185.29 KJ

With cabin partitioning

By providing cabin partitioning we can approximately reduce the volume to 45%

Therefore,

Total heat that must be removed by the refrigeration system in an hour

= 45% of (185.2913484) KJ

= 83.3KJ

Hence for removing of 100KJ of heat from Cabin, for the compressor assumed 6min of time is more than sufficient.

V.EXPERIMENTAL SETUP

The following components are required for the successful completion of experiment.

1. Partition arrangement for cabin.
2. Temperature measuring device T –type Thermocouple with ±0.1°C accuracy
3. Flow rate measuring device with an accuracy of ±0.2% (Max 650 Kg/hr of flow rate)
4. Stop Watch for measuring the time required for cooling.

VI. CONCLUSION

From the above analysis, it is observed that the heat that must be removed by the refrigeration system of car from the cabin per hour is reduced by 100KJ. Which will surely decrease the compressor work (which is to be supplied by the engine) to create the required cooling effect which eventually will increase the fuel economy of the automobile and air pollution is minor due to partition.

FUTURE SCOPE

1. The cabin space separator can be decorated to a great level.
2. The material used for the separator can be different which do not vary from our principle.

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