Ventilation of the Parked Automobile under Blazing Sun

1. Introduction
Temperature rises above the tolerable range in the parked automobiles in the open place during summer. This is very uncomfortable for the passengers and also has bad impact on electronic equipment. At the same time, when passengers return from job or shopping, air-condition systems need more power to cope with the heated cabin. There are different ways, thinking by the engineers to overcome this problem. The objective of this research is to invent a ventilation system which will be cheaper and should be sound in engineering point of view. To fulfill this objective, this research is divided into two parts. In the first part, we have to find out the temperature distribution of the car cabin, suitable locations of the inlet and outlet of the air flow and finally the optimum flow rate for comfortable temperature mitigation. Second part will be devoted to design the ventilations system and performance test for the newly invented system. This paper will report the results of the first part of this research.

2. Experiment
Outline of the experimental set-up for temperature measurement was shown in figure 1. This figure shows the top view of the experimental set-up. Temperatures were measured in the different locations of the car cabin and shown by the black and white circle. T-type thermocouple was used for this purpose. Five analog modules were used for data acquisition. Sampling rate of the data acquisition was 1 samples/min. Accuracy of the modules was ±0.1%. This analog data was converted into digital data by analog/digital converter. Digitized data was analyzed by the computer. To suppress the heated atmosphere in the car cabin, air was passed through the cabin. For this purpose, two different locations for air inlets were used one was on the top of the front panel and other one was used on the bottom of the front panel. At the same time the location of the vent for air outlet was also shown in figure 1. Before entering into the car cabin, air flow rate was measured by the combination of the orifice and manometer. Different rate of air flow were passed into the car cabin e.g. 50, 100, 150, 200$m^3$/h. For this purpose, orifice was calibrated before experiment.
3. Experimental results

3.1 Effect of Solar radiation without ventilation

Figure 2 shows the temperature of the top of the front panel and the air temperature near the drivers head without ventilation. Ambient temperature was 28.6°C and solar radiation was 21.2 MJ/m². Maximum temperature of the car cabin was found on the front panel and it was 71°C. Air space temperature near the head of the driver was 62°C. Lowest temperature of the cabin was found near the
foot step of the rear seat and it was 45\degree.

3.2 Comparison of different location of air inlet on ventilation

The influence of the location of the air inlet was shown in figure 3. Temperature distribution on the front panel was shown in this figure. Air inlet from the top of the front panel shows the better temperature mitigation than the air inlet at the bottom of the front panel. When the air inlet was on the top of the front panel temperature reaches below 55\degree C within 30 minutes but it took more 60 minutes when air inlet was located below the front panel. Temperature difference between the constant

![Graph showing temperature distribution with time at different location of the air inlets for cooling for flow rate 200m³/h](image1)

![Graph showing temperature distribution with time at different flow rate (m³/h)](image2)
temperatures of these two locations was 10°C after three hours.

3.3 Comparison of effect of different air flow rate on temperature mitigation
Figure 4 shows the comparison between the different flow rates of the cooling air on the front panel. The cooling effect of the car cabin was observed at different flow rate e.g. 50, 100, 150 and 200m³/h. Temperature reaches below 55°C within 20 minutes when the flow rate was 200 but it took more than 40 minutes for 100 and 150m³/h. However, temperature reaches almost same level after 60 minutes for the different flow rates except for 100m³/h. For flow rate 50m³/h, temperature never decreases below 55°C. From this figure it was clearly showed that air flow rate 50m³/h was not sufficient to mitigate the temperature within comfortable range. However, for rest of the air flow rate showed the almost same temperature mitigation after 100 minutes. From this result it can be concluded that for ventilation system 100m³/h will be sufficient to limit the temperature inside the car cabin within comfortable range.

4. Concluding remarks
Temperature mapping inside the car cabin was performed by experimentally. Suitable location of the air inlet for maximum cooling affect was investigated. The optimum flow rate was investigated for which the temperature mitigation was in the range of comfortable level for the passenger. Necessary temperature mitigation was possible with air flow rate 100m³/h and the location for the air inlet should be on the top of the front panel.

5. Future plan
For the suitable locations for air inlets and ventilation, more experimental data is necessary. Last year, two locations for air inlets and one location for ventilation were used due to the limitation of the available days for experiment. This year, location of air inlet should be increased with four and the ventilation location will be increased with two. At the same time, for ventilation a fan should be used and this will be run by a solar powered engine. For this purpose, power of the designed engine will be calculated according to the optimum air flow rate for temperature mitigation within the comfortable range for the passenger.

Reference
(1) Frank K., Principles of Heat Transfer, Third ed. 1976