IOSR Journal of Engineering (IOSRJEN)
ISSN: 2250-3021 Volume 2, Issue 8 (August 2012), PP 86-90
www.iosrjen.org

Rejuvenating automotive ventilation within existing system Boundary- A most economical approach

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ABSTRACT: *- An innovative design is used for improvement in cabin ventilation of automobiles having non-AC system. Engine which is a must part of a truck is used as a suction system to create low pressure zone inside the cabin, by sucking its air for fuel combustion from cabin. High suction pressure is used as a pulling force. Closed cabin now becomes low pressure zone and atmospheric air around the cabin is pulled inside the cabin because of low pressure inside. By design, an opening is given at the front of the cabin which becomes the path of atmospheric air movement inside the cabin. Hence a cross and continuous ventilation is achieved. CFD analysis is done at different speeds considering the worst case scenario as glass windows rolled up. Result of the analysis shows significant level of ventilation is achieved without using any external energy with minimum cost involved.*

Keywords: *- Ventilation, Automobiles, Engine, Cabin, Snorkel.*

I. INTRODUCTION

Indian trucking industry is based on value return concept. The better value proposition is most desirable. The profit margin is directly related with the number of hours vehicle is running. Till now industry is not bothered about the driver comfort as their mindset is that driver comfort is not related with the vehicle performance. A truck in India runs anything between 300kms and 400kms a day as compared to 600kms-1000kms abroad.

The reasons for this low mileage are Poor road conditions, Overloading, Long waits at multiple checkpoints and Driver fatigue. Road conditions have improved a lot and continuous efforts are in place to improve further. Also governments have begun improving the efficiency of checkpoints. For stopping overloading, some states have modified existing law and increased the fine many fold.

As bottlenecks are removed, driver fatigue becomes the weakest link in all the system. Human comfort for the driver and co-driver is very important for their safety as well as road side traveler's safety. Human comfort can be defined in a number of ways with different parameter to consider. Air conditioned cabins and ergonomically better designed cabin of vehicle become important to reduce driver fatigue. As driver tiredness and stress is reduced, the necessity for stops is reduced enabling longer distances to be covered. More importantly, it improves safety.

Ventilation system can be of natural and forced type. In case of forced ventilation we need to put energy to do the ventilation. This may be done by using a fan or on a larger scale air conditioning system. Air conditioning system and similar systems are not in the scope of this project because of its high cost impact on the vehicle. In Indian Trucking industry more than 95% of trucks are non-air conditioned. Only reason for this is its high cost hence scope of the work is to provide low budget ventilation system Fan can push air inside the compartment or cabin as well as suck from it. In both the cases a draft is obtained for air to flow along the pressure difference. Current set of truck cabins are using natural ventilation to improve air quality inside the cabin. In Most of the case, rammed air energy is used to ventilate the cabin of a truck or a car passenger compartment. Ramming effect of air is due to vehicle speed. The more the velocity of vehicle the more ramming will happen and hence more air will come inside the cabin either through opening at the front or through the window. This leads to a big drawback which is that this system will not work when vehicle will be stationary or moving at slow speed. There is no scope of air flow through the cabin when vehicle is at stationary. Similarly when vehicle is running, rolled down window is major contributor of natural ventilation but as the window is rolled up all air passes through the window seizes.

The scope of this project is to improve the ventilation of truck cabin eliminating all the basic concern in existing set of vehicles. In this case we need some external medium to move the air. One such medium will be a use of fan to create a draft. Fan use external energy to run which is again an unwanted situation. Hence an innovative design is used in which engine suction power is used as an agent to create draft inside the cabin. Engine suction power sucks the air from the cabin from the slit at its back wall. This suction creates a low pressure inside the cabin. All air surrounding the cabin tries to fill inside the cabin but there is only opening at

the front. Hence air will come inside from the front. Hence a close circuit is obtained which continuously circulate the cabin air and a significant level of ventilation is achieved in all conditions.

II. WORKING PRINCIPLE

As per below shown image, engine is used as a suction pump which sucks the atmospheric air inside the cabin, creating low pressure inside it. This low pressure drives the surrounding air inside the cabin and hence a flow of air is maintained inside the cabin and ventilation is achieved.

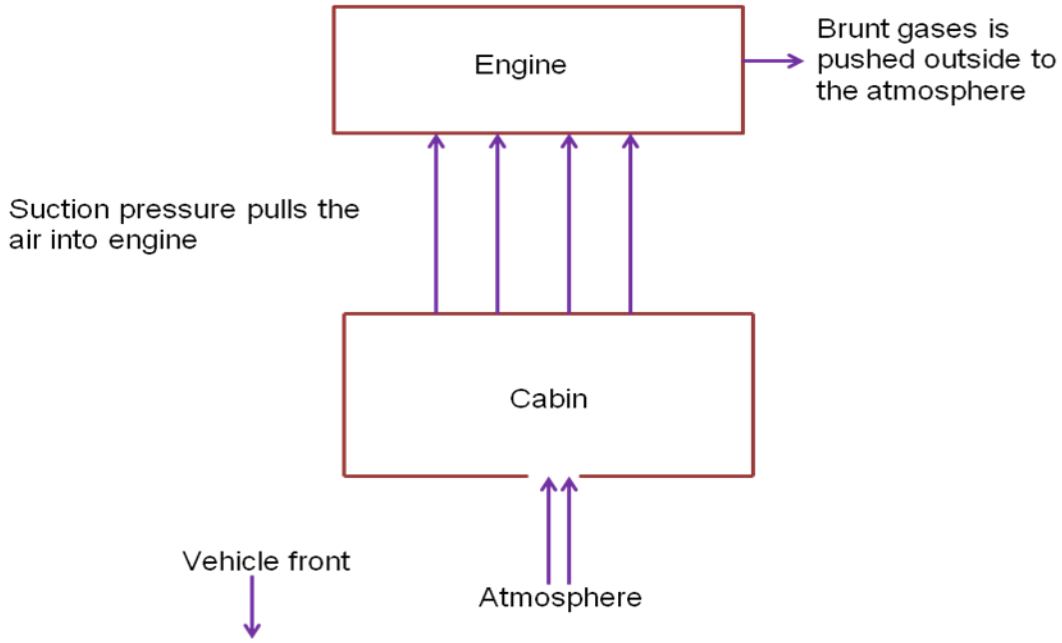

Figure1: Line diagram of working of cabin ventilation

Below image shows the line diagram of cabin. In front side of the cabin air ducts are made through which air is sucked inside the cabin. These vents are taking air from the atmosphere and distributing air inside the cabin through the instrument Panel. Instrument panel is designed with ducts which in case of AC system will distribute the cold air and in Non-AC system we will use same duct for air transportation. Snorkel duct is connected with cabin and snorkel. Snorkel sucks the air from the atmosphere as well as from the cabin. Depending upon the level of ventilation required its opening is decided. Air is sucked through the snorkel duct from the cabin.

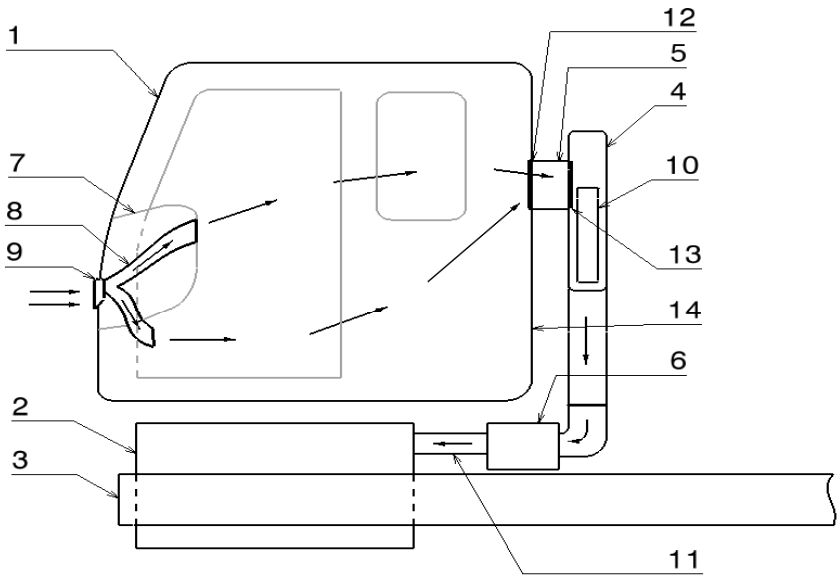

Fig 2: Line diagram showing different structure and air flow movement

Table 1: Truck Parts and their description

1	Truck cabin
2	Engine
3	Frame
4	Snorkel
5	Duct connector
8	Ducts
9	Air vents
10	Snorkel inlet
6	Air Filter
7	Instrument Panel
11	Air Intake tube
12	Cabin closer
13	Snorkel Closer
14	Cabin

III. CFD ANALYSIS

With the help of ANSA and T-grid, CFD analysis is done taking the working fluid as air at atmospheric pressure and room temperature. Three different set of analysis is done considering the vehicle moving at10, 30 and 60 Km/Hr. At these set of velocity of vehicle velocity contour is obtained at different cross-section of the cabin. Below is the sets of results are shown. Results show that as the velocity increases the air flow rate inside the cabin also increases. At a speed of 10 Km/Hr velocity is very low which is clearly indicated by blue color in maximum zone of the section. At vehicle velocity of 30 Km/Hr inside air velocity obtained is close to 0.5m/sec and in the rear side where suction is taking place it is of 0.7 m/s where as in case of 60Km/hr the inside air flow rate is close to 1.2 m/sec. this value shows a significant improvement in ventilation in cabin. Stagnation zone inside the cabin continuously decreases as the vehicle speed increases. Hence the hot pocket of air will also go from the cabin and will improve the level of human comfort.

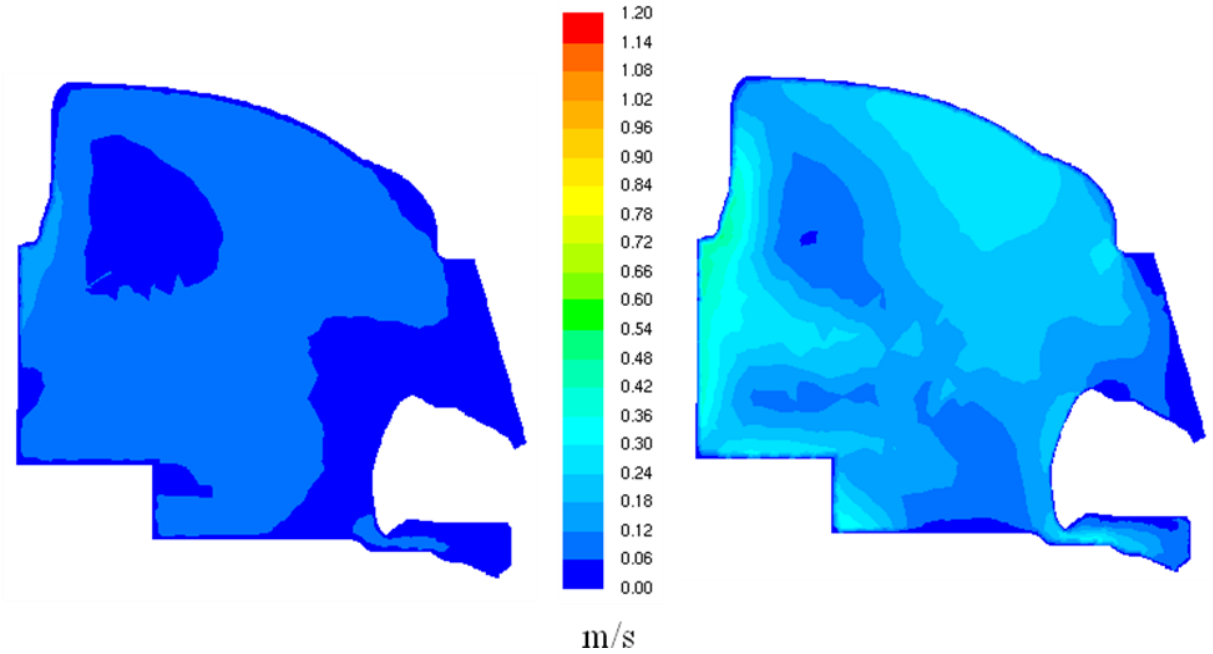

Fig. 3: Contours of velocity on mid surface of cab at 10 Km/Hr and 30 Km/Hr

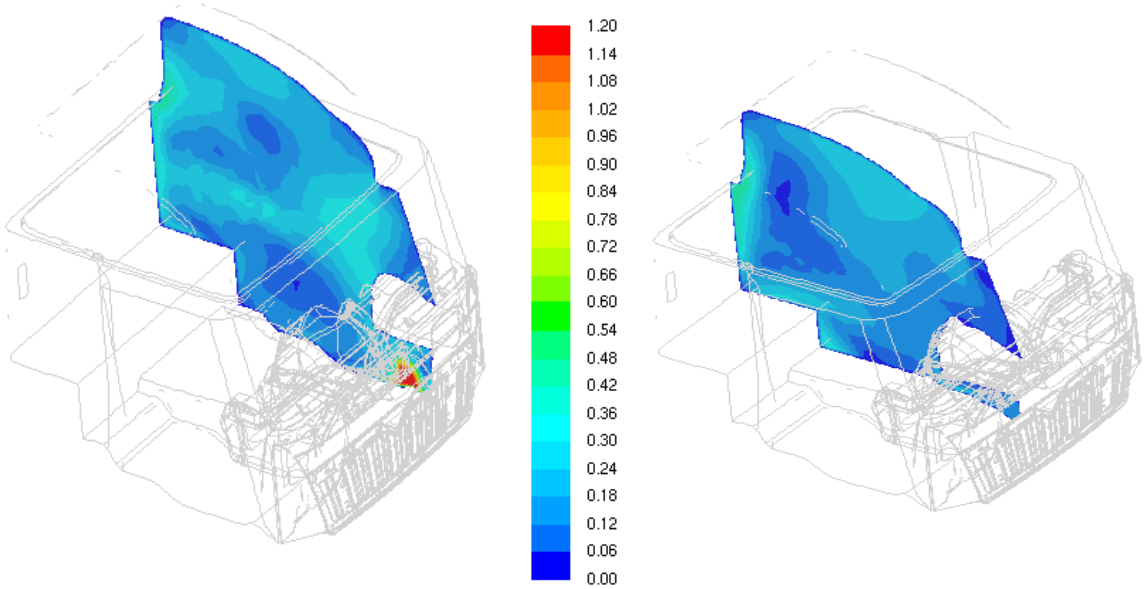

Fig 4: Velocity Contour of air at a speed of 30 Km /Hr

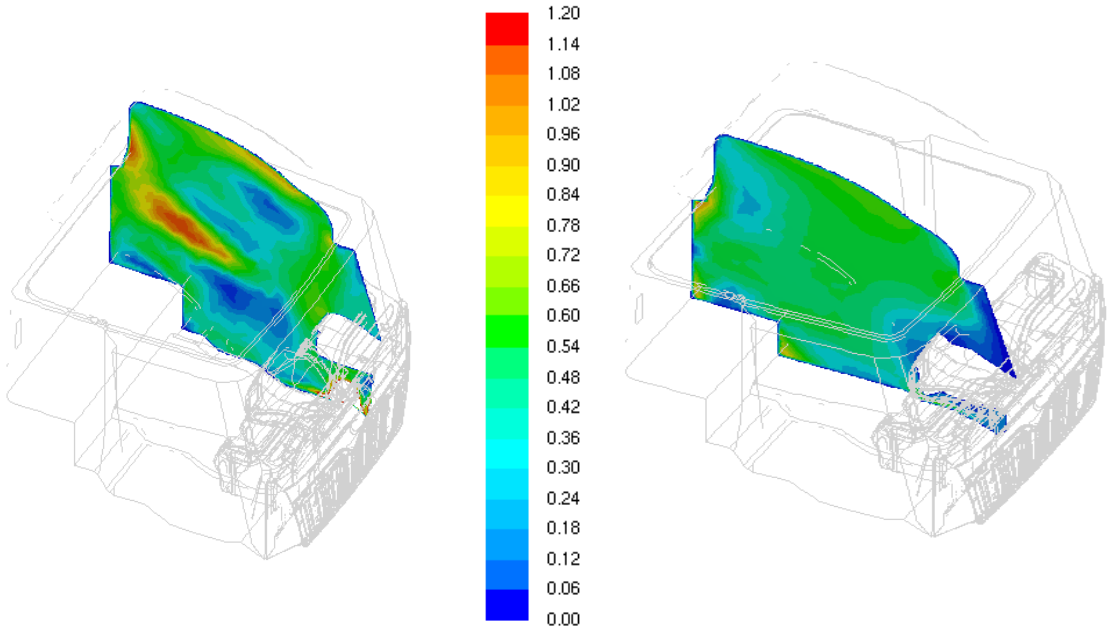

Fig 5: Velocity Contour of air at a speed of 60 Km /Hr

IV. CONCLUSION

With the above mentioned design a significant level of ventilation can be achieved without putting much cost to the system. Detail CFD analysis shows that a good level of air flow is achieved which is comparable to the air velocity of air conditioned system. Cost and investment for achieving this level of ventilation is very low. Only three ducts are new. Rest all other parts are carried from existing vehicles. Approx weight of new parts is one Kg and the material id FRP. Hence the cost involved is approx Rs. 50 only. This enhanced ventilation will increase the cabin occupant comforts and intern gives more miles to the truck buyer. The scope of this paper is not to check the impact of the proposed design on engine performance which needs to be established before implementing in any automotives vehicles. Major application will be truck cabin as well as cars of rear engine.

V. LIMITATIONS

Scope of this work is to improve the air velocity inside the cabin. Effect of temperature and moisture is not taken into account while considering the human comfort. Only parameters which contribute to the comfort, is velocity of air. Air flow achieved, is also not constant inside the cabin everywhere. It varies point to point.

VI. SCOPE OF FUTURE WORK

Pressure drop inside the ducts can be reduced further by studding the air flow for each duct. Result of CFD analysis for pressure drop is directly related with its profile and curvature. By smoothing the profile even further will help in increasing the air flow inside the cabin. Engine performance need to be established with the proposed design. Testing of 30-40k km is required for checking its performance parameter. Ventilation with the cost of engine performance cannot be done. Also maximum velocity that can be achieved at maximum RPM, need to be checked for cabin comfort.

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