

Design, development and performance evaluation of cyclonic type air cleaning system for automobile cabin

G. R. Jodh¹, S. S. Giri²

¹Assistant Professor, Department of Mechanical Engineering, Priyadarshini Indira Gandhi College of Engineering, Nagpur, Maharashtra, India

²Assistant Professor, Department of Mechanical Engineering, Priyadarshini Institute of Engineering and Technology, Nagpur, Maharashtra, India

Abstract- Automobile cabin air filters are devices used to remove the unwanted components of air outside the automobile cabin and deliver the air of highest possible purity inside the automobile cabin. The unwanted components of air may include particulates such as dust, dirt, pollen, industrial pollutants or pollutants from other cars. These components of air may cause severe health hazards to the occupants of the automobile cabin. Though the automotive cabins are already fitted with air cleaners, these lack a great deal of efficiency. The automobile air cleaners which are generally used are unable to filter out all of these pollutants. This paper addresses this problem and comes up with a low cost, easy to use and relatively simple solution to tackle this issue. It aims at using a cyclonic air filter in conjunction with the existing pleated paper air cleaner system to modify it to suit the present requirement.

Index Terms- Air cleaning, air quality, automobile cabin, filter, pleated paper.

1. INTRODUCTION

The amount of air pollution is increasing day by day. It has now reached a point where the air pollution stands as one of the greatest risks of the modern world. It may lead to severe health hazards. The cases may be more severe if the occupants are already suffering from health issues like lung disorders, asthma or allergies. The effects of inhaling this polluted air may lead to conditions ranging from simple cough and cold to more severe conditions like bronchitis, asthma or even cancer. To curb this menace certain steps are being undertaken by authorities. Meanwhile it is of utmost importance that we keep our self safe. At home and offices the amount of air pollution is less and we are at liberty to

use devices like room air purifiers to improve the quality of air. However we are still at risk during commute. The amount of time spent by us during travelling is considerable. During travel we are exposed to a significantly higher level of air pollution. This air pollution is also more dangerous as it contains not only the dust, dirt and particulates but also the more dangerous toxic fumes from automobiles and factories which contain dangerous components like hydrocarbons, sulfides, nitrites, carbon dioxide and carbon monoxide. Those involved in operation of heavy construction equipment are at much higher risk as the amount of particulates like those of construction, ash is very high. This risk to commuters and equipment operators may be reduced by purifying the air present in automobile cabins.

II. MATERIALS AND METHODS

Many systems are already available for purifying the automobile cabin air. The systems generally used are pleated paper, oil dipped foam, oil dipped cotton, stainless steel mesh, oil bath or water bath. Among all these systems The pleated paper is most widely used for its convenience and low cost. The pleated paper system consists of a filter paper assembly at the air intake. It is very simple in nature, does not contain any moving parts and is easy to fit in congested spaces and hence widely used. In spite of its many advantages, the system lacks when it comes to quality of air delivered. They suffer a great disadvantage of getting clogged rapidly and thus require periodic maintenance. As the air quality diminishes, the rate of clogging also increases and hence the maintenance required also increases. Once the filter paper starts clogging, the rate of air introduction inside the cabin

starts to decrease. When the filter is clogged to certain level the paper should be cleaned. The paper air filters, even if cleaned retains large amounts of particulates which reduce the maintenance intervals. Also, as the paper filters are cleaned, the paper itself gets slowly degraded due to wear and tear and hence needs to be replaced by new ones. Hence, the filter paper are usually replaced instead of cleaning. This again represents a big problem as the replacement of the filter is not easy. Mostly the filter is located in intricate locations owing to the lack of space in modern automobile. a skilled person is often employed to do this part. This results in higher maintenance cost not only for purchasing a new filter paper but also the cost for employing a professional to do the necessarily work. hence it is necessary to design a system which utilizes the advantages of pleated paper filter but does not suffer from its disadvantages. The assembly of cyclonic air filter along with pleated paper is radical solution to this problem. The system is explained next.

III. WORKING

The first component of the system is an air intake port through which the air enters. It is covered by a metal mesh to prevent foreign material of larger size from entering into the air filtering system. The air then enters into the cyclonic air purifier. The vortex of air in the cyclonic chamber forces the particulates to the circumference of the chamber and then eventually into the system exhaust. The air, free of the particulates, from the cyclonic separator enters into the pleated paper mesh. The paper filter mesh removes the remaining pollutants such as pollen, dirt and dust. The air from the paper filter is clean and is then sent to the passenger cabin.

IV. ADVANTAGES

The use of a cyclonic type air filter along with the widely used paper air filter will help overcome the many disadvantages of using only pleated paper air cleaner. A cyclonic air filter will provide a much cleaner air to the paper filter thereby reducing the amount of particulates that are to be trapped by the paper filter. This in turn will increase the interval between each maintenance and prolong the life of the paper filter. The cyclonic air filter along with paper

filter will provide an air of much better quality and that too for a longer period of time.

V. DISADVANTAGES

Though the paper has demonstrated the higher performance of paper filter when used in conjunction with cyclonic air filter, some inherent disadvantages cannot be overlooked, for example, the use of this type of filter will require higher initial cost, thereby increasing the cost of the automobile. The overall weight of the automobile will increase thus reducing fuel efficiency. The cyclonic filter draws its power from the engine and hence additional load is to be taken up by the engine. The cyclonic air filter requires significant amount of space and that near the front end of the automobile where the space available is quite low.

VI. RESULTS AND DISCUSSIONS

The air quality obtained while using paper filter and paper filter along with cyclonic air filter is studied and compared. It is found that the quality of air while using the above mentioned system is higher. The life of paper filter in both cases is studied and it is found that the life of paper filter in the later case is more. Hence, it is concluded that the use of the combined system not only increases the quality of air but also enhances the life of the paper filter thus overcoming the initial cost of installation of the separator.

VII. CONCLUSION

The combined system is advised for installation in all passenger vehicles. The use is more advisable for installation in vehicles that work in harsh environment such as that of mining, construction and digging. The use of the system will lead to better health quality and lower maintenance costs.

REFERENCES

- [1] Müller, D.; Klingelhöfer, D.; Uibel, S.; Groneberg, D.A. Car indoor air pollution-analysis of potential sources. *J. Occup. Med. Toxicol.* 2011, 6, 33.
- [2] Lawryk, N.J.; Weisel, C.P. Concentrations of volatile organic compounds in the passenger compartments of automobiles. *Environ. Sci. Technol.* 1996, 30, 810–816.

- [3] R.K. Shah, “Automotive air-conditioning systems – historical developments, the state of technology and future trends”, Proceedings of the 3rd BSME-ASME International Conference on Thermal Engineering, 20-22 December 2006, Dhaka, Bangladesh
- [4] S.Y. YOO and D.W. LEE, “Experimental Study On Performance Of Automotive Air Conditioning System Using R-152a Refrigerant”, International Journal of Automotive Technology, Vol. 10, No. 3, pp. 313–320 (2009).
- [5] G.H. Lee a, J.Y. Yoo, “Performance analysis and simulation of automobile air conditioning system” ,International Journal of Refrigeration 23 (2000) 243-254
- [6] Hudda, N.; Kostenidou, E.; Sioutas, C.; Delfino, R.J.; Fruin, S.A. Vehicle and driving characteristics that influence in-cabin particle number concentrations. Environ. Sci. Technol. 2011, 45, 8691–8697.
- [7] You, K.W.; Ge, Y.S.; Bin, H.U.; Ning, Z.W.; Zhao, S.T.; Zhang, Y.N.; Peng, X.I.E. Measurement of in-vehicle volatile organic compounds under static conditions. J. Environ. Sci. 2007, 19, 1208–1213
- [8] Chan, A.T., Chung, M.W., 2003. Indoor-outdoor air quality relationship in vehicle: effect of driving environment and ventilation modes. Atmospheric Environment 37, 3795e3808
- [9] Esber, L.A., Fadel, M.L., Nuwayhid, I., Saliba, N., 2007. The effect of different ventilation modes on in-vehicle carbon monoxide exposure. Atmospheric Environment 41, 3644e3657
- [10] Knibbs, L.D., DeDear, R.J., Morawska, L., 2010. Effect of cabin ventilation rate on ultrafine particles exposure inside automobile. Environmental Science and Technology 44 (9), 3546e3551.
- [11] Pui, D.Y.H., Qi, C., Stanley, N., Oberdorster, G., Maynard, A., 2008. Recirculating air filtration significantly reduces exposure to airborne nanoparticles. Environmental Health Perspectives 116 (7), 863e866.
- [12] Qi, C.; Stanley, N.; Pui, D. Y. H. and Kuehn, T. H. Laboratory and on-road evaluations of cabin air filters using number and surface area concentration monitors. Environ. Sci. Technol. 2008, 42, 4128-4132.
- [13] Xu, B. and Zhu, Y. Quantitative analysis of the parameters affecting in-cabin to on-roadway (I/O) ultrafine particle concentration ratios. Aerosol Sci. Technol. 2009, 43, 400-410.