International Journal of Engineering and Management Research e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-13, Issue-1 (February 2023)
https://ijemr.vandanapublications.com https://doi.org/10.31033/ijemr.13.1.12

Device Compartment with Non-Woven Secondary Filter Medium for Diesel Engine Exhaust Vent

Dr. M Saravanan[1], Pradeep D N[2], Sindhoora R P[3], Vikneshver V[4] and Chidambara Meena K[5]
[1]Assistant Professor II, Department of Textile Technology, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, INDIA
[2]Final Year B.Tech Textile Technology, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, INDIA
[3]Final Year B.Tech Textile Technology, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, INDIA
[4]Final Year B.Tech Textile Technology, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, INDIA
[5]Final Year B.Tech Textile Technology, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, INDIA

[3]Corresponding Author: sindhoora.19tt@kct.ac.in

ABSTRACT

Transportation is a significant contributor to air pollution in many nations across the world, because of the large number of vehicles that are present on the roads. To reduce pollution from diesel engine vehicles, the Indian auto sector made its hard transition from BS4 to BS6 norms in April 2020. Selective Catalytic Reduction (SCR) and Diesel Particulate Filter (DPF) were included to the BSVI norms to evaluate the emission levels of the BS6 motor vehicle, but the BS4 norms do not include such an in-built filtration capability. However, it is mandatory to reduce the emission level in vehicles running on BS4 engine. This paper deals with the development of device compartment for filter fabric to be fitted as an attachment for various diesel engine vehicles and fabrication of non-woven filter fabric as a secondary medium. Through this additional fitting along the exhaust vent of BS4 diesel engine vehicles, soot particles can be arrested and reuse of BS4 engine is made possible.

Keywords-- Device Compartment, Non-Woven Filter Fabric, BS4 Diesel Engine

I. INTRODUCTION

India currently ranks third among countries with the worst air quality in the world and 13 of its North Indian cities are among 15 of the world's most polluted. The various types of pollutants released into the environment by automobile engines significantly exacerbate air pollution. When petroleum-based fuels, such as gasoline or diesel, are burned in an engine, the main toxic substances present in the exhaust gases are incomplete combustion oxides of hydrocarbons, which contain CO, NOx, HC, and particulates. To control pollution from automobiles, the Indian government has enacted regulations known as Bharat Stage Emission Standards (BSES).

II. BHARAT EMISSION STAGE

To be marketed and operated in India, all automobiles must meet the government's Bharat Stage or BS Emission Standards. The first BS rules were developed in 2000, and they are based on European Emission Standards (Euro norms). The first version, which was the Euro-1 equivalent, was called "India 2000," not "BS-IN." The emission standards were designated as BS-II, BS-III, and BS-IV. At the moment, all new cars sold and registered in India must meet the BS-VI iteration of emission requirements.

2.1 BS4 Norms

In April 2017, the Bharat Stage IV norms were implemented throughout the country. That means that form April 2017 onwards, all vehicles manufactured and sold must meet the BS IV standards. Sulphur content is limited to 50 parts per million under BS IV standards, compared to 350 parts per million under BS III standards. Under the BS IV standards, the volume of nitrogen oxide, hydrocarbons, and particulate matter emissions has been significantly reduced. Despite BSIV norms, the Indian government decided to jump directly from BS-4 to BS-6 emission standards to control vehicular pollution, despite the country's constantly rising air pollution.

2.2 BS6 Norms

After the deadline of April 1st, 2020, the entire automobile industry has been asked to phase out all BS-4 vehicles and sell only BS-6 cars and two-wheelers. The pollution limit has been drastically reduced under the BS6 standard. While the BS4 emission standard for NOx from diesel vehicles is 250mg/km, it is reduced to 80mg/km in BS6 emission standards. The HC level in the BS4 has been reduced from 300mg/km to 170mg/km, while the PM level has been reduced from 25mg/km to 4.5mg/km.

2.2.1 Diesel Particulate Filters (DPF)

Diesel particulate filters (DPFs) are an important emission control technology for reducing diesel engine particulate matter (PM) emissions. DPFs work by capturing and retaining PM emissions, which are mostly solid particles like soot and ash. These filters trap particles and prevent them from being released into the atmosphere using a combination of filtration mechanisms. The collected particles are then removed from the filter via a process known as thermal

regeneration, which involves heating the filter to a high temperature in order to burn off the accumulated PM.

A DPF typically employs a ceramic substrate formed into a honeycomb structure with parallel channels spanning the entire length of the object. The structure's main component is a porous cordierite (2MgO - 2AL - 5S O2), which has the necessary mechanical strength, chemical resistance, thermal fracture resistance, and melt resistance. The exhaust gas enters the cells through the open end upstream. Because the downstream end of the cell is blocked by a ceramic plug, the exhaust gas is forced through the porous wall of the adjacent cell, where it is filtered by the porous wall. A diesel engine typically emits one gallon of particulate matter per thousand miles driven. It is understood that accumulated particulate matter must be eliminated on a regular basis, most likely through thermal oxidation. To accomplish this, the temperature of the exhaust (450 °C or higher) as it exits the engine and enters the filter must be raised sufficiently to ignite the soot. The ceramic body serves as the thermally stable foundation for this procedure.

2.3 Difference Between BS4 and BS6 Diesel Engine

- Diesel Particulate Filter (DPF) and Selective Catalytic Reduction (SCR) are being introduced with the roll-out of Bharat Stage VI norms, which were not a part of Bharat Stage IV.
- The major upgrade brought about by the implementation of Bharat Stage VI emission norms is a change in the fuel used in vehicles. A vehicle with a BS6 engine will require BS6 fuel. If a BS6 vehicle runs on BS4 fuel, it will fail to meet the BS6 emission standards. Similarly, if a BS4 vehicle uses BS6-grade fuel, the engine suffers and emissions rise.
- The most significant difference between BS6 and BS4 fuel is the content of Sulphur and Nitrogen Oxide. Sulphur traces in BS6 fuel are five times lower (10 ppm) than sulphur traces in BS4 fuel (50 ppm). Furthermore, nitrogen oxide levels in BS6-grade diesel and petrol engines will be reduced by 70% and 25%, respectively.

III. PARAMETERS CONSIDERED FOR FILTRATION IN DIESEL ENGINE EXHAUST SYSTEM

3.1 Exhaust Particle Size

Diesel particulate matter is the solid material found in diesel exhaust (DPM). More than 90% of DPM is less than 1 m in diameter (roughly 1/70th the diameter of a human hair), making it a subset of particulate matter smaller than 2.5 microns in diameter (PM2. 5).

3.2 Temperature

Normal car exhaust pipe temperatures range from 400 to 500 degrees Fahrenheit. Several high-performance exhaust pipes, on the other hand, can reach temperatures of 1,000 degrees Fahrenheit or higher. When the gases exit the engine and enter the exhaust system, they are at their hottest.

3.3 Pressure

Engine Size (kW)	**Back Pressure Limit (**kPa)
Less than 50	40
50-500	20
500 and above	10

Table 1: Diesel Engine Exhaust Pressure Limit

3.4 Speed

The pressure waves travel through the exhaust manifold at the local speed of sound which can be over 500m/s in that environment, while the gases themselves move at an average speed of about 100 - 125m/s.

3.5 Exhaust Pipe Size

ENGINE CID	SINGLE SYSTEM	DUAL EXHAUST SYSTEM
150-200	2” (51mm) 2.25” (57mm) 2.5″ (64mm)	2″ (51mm) 2″ (51mm) 2″ (51mm)
200-250	2.25” (57mm) 2.5” (64mm) 2.5″ (64mm)	2″ (51mm) 2″ (51mm) 2.25″ (57mm)
250-300	2.25” (57mm) 2.5” (64mm) 3” (76mm)	2” (51mm) 2.25” (57mm) 2.5” (64mm)
300-350	3” (76mm) 3” (76mm) 3.5” (90mm)	2.25” (57mm) 2.5” (64mm) 2.5” (64mm)

350-400	3” (76mm) 3.5″ (90mm)3.5″ (90mm)	2.5″ (64mm) 2.5″ (64mm) 2.5″ (64mm)
400-450	3.5” (90mm) 4″ (101mm)4″ (101mm)	2.5″ (64mm) 3″ (76mm) 3″ (76mm)
450-500	4.5″ (115mm) 4.5″ (115mm) 4.5″ (115mm)	3.5″ (90mm) 3.5″ (90mm) 3.5″ (90mm)

Table 2: Diesel Engine Exhaust Pipe Size

IV. DEVICE COMPARTMENT

4.1 Material: Stainless Steel

There are only a few materials that are commonly used in exhausts, which are steel, stainless steel, nickel alloys, and titanium. Steel and stainless steels are the most commonly used materials in the automotive industry outside of motorsports because of Its moderate ductility, excellent corrosion resistance and relatively low cost.

V. NON-WOVEN FILTER FABRIC (SECONDARY MEDIUM)

Nonwoven filters are designed to remove ultrafine dust, aerosols, and viable organisms from the air in a variety of applications, including clean rooms, hospital operating rooms, microelectronics, optical and precision industries, and the pharmaceutical and food industries. among various non-woven techniques Melt-blown nonwoven fabric is an excellent fiber filter media for air filtration because of its high specific surface area, small pore size, high porosity, superfine fiber, low pressure drop, and high filtration efficiency.

5.1 Material: Polycotton with Activated Charcoal Coating

Carbon monoxide, hydrocarbons, and nitrogen oxides are all absorbed by activated charcoal filters. this contributes to lower emissions and better air quality.

5.2 Method: Meltblown with GSM of Around 400

Nonwoven filters are designed to remove ultrafine dust, aerosols, and viable organisms from the air in a variety of applications, including clean rooms, hospital operating rooms, microelectronics, optical and precision industries, and the pharmaceutical and food industries. among various non-woven techniques Melt-blown nonwoven fabric is an excellent fiber filter media for air filtration because of its high specific surface area, small pore size, high porosity, superfine fiber, low pressure drop, and high filtration efficiency.

Under the BS6 norm, the limit of pollution has been drastically reduced over 50% less polluting than the BS4 vehicles, but it also has certain disadvantages like high cost, high maintenance and low fuel efficiency. After the implementation of BS6 emission standards on April 1, 2020, no new BS4 vehicles will be manufactured or registered by the RTO. Existing BS4 vehicles, on the other hand, will continue to operate until the end of their legal life cycle. This simply means that you can use your BS 4 vehicle for 15 years from the date of registration (10 years for diesel vehicles in Delhi). During this course time to control the pollution from BS4 engine, it is possible to develop a device compartment as an additional fitting along the exhaust vent of diesel engine vehicles with two primary and secondary filters fabric so that soot particles can be arrested and reuse of BS4 engine is made possible.

VI. CONCLUSION

Various studies have revealed that motor vehicle emissions are a combination of various pollutants that have the potential to cause adverse health effects such as carcinogenicity, mutagenicity, cardiovascular mortality, and the worsening of the health of vulnerable groups such as asthmatics, children, and the elderly. As a result, effective vehicle emission control strategies should be developed and implemented. To ensure the effectiveness of vehicle emissions-control systems, a vehicle maintenance and inspection programme should be developed. Emissions can be reduced through proper maintenance, inspection, a clean car, and the use of clean fuel.

REFERENCES

[1] Lim, H. (2002). Study of exhaust emissions from idling heavy-duty diesel trucks and commercially available idle-reducing devices. *US Environmental Protection Agency, Air and Radiation*.

[2] Likhanov, V. A., Lopatin, O. P. & Vylegzhanin, P. N. (2020, May). Passenger gas diesels to preserve the city’s ecology. In: *IOP Conference Series: Materials Science and Engineering*, *862*(6), pp. 062078.

[3] Pilusa, T. J., Mollagee, M. M. & Muzenda, E. (2012). Reduction of vehicle exhaust emissions from diesel engines using the whale concept filter. *Aerosol and Air Quality Research, 12*(5), 994-1006**.**

[4] Zhang, R., Liu, C., Hsu, P. C., Zhang, C., Liu, N., Zhang, J., ... & Cui, Y. (2016). Nanofiber air filters with high-temperature stability for

efficient PM2. 5 removal from the pollution sources. *Nano letters*, *16*(6), 3642-3649.

[5] Sakthivel, S., Ezhil, A. J. & Ramachandran, T. (2014). Development of needle-punched nonwoven fabrics from reclaimed fibers for air filtration applications. *Journal of Engineered Fibers and Fabrics*, *9*(1), 155892501400900117.

[6] Doleisch, H., Mayer, M., Gasser, M., Wanker, R. & Hauser, H. (2004, May). Case study: Visual analysis of complex, time-dependent simulation results of a diesel exhaust system. In: *VisSym.*, pp. 91-96.

[7] Wahile, G. S., Malwe, P. D. & Kolhe, A. V. (2020). Waste heat recovery from exhaust gas of an engine by using a phase change material. *Materials Today: Proceedings*, *28*, 2101-2107.

[8] Furuta, Y., Mizutani, T., Miyairi, Y., Yuki, K. & Kurachi, H. (2009). Study on next generation diesel particulate filter (No. 2009-01-0292). *SAE Technical Paper*.

[9] Masuda, S. & Moon, J. D. (1983). Electrostatic precipitation of carbon soot from diesel engine exhaust. *IEEE Transactions on Industry Applications*, *6*, 1104-1111.

[10] Kumar, D., Raju, A., Sheth, N. & Digeser, S. (2016). On road durability and performance test of diesel particulate filter with BS III and BS IV fuel for Indian market. *SAE International Journal of Engines*, *9*(3), 1651-1661.

[11] Dziubak, T. & Dziubak, S. D. (2020). Experimental study of filtration materials used in the car air intake. *Materials*, *13*(16), 3498.

[12] Patil, A. A., Joshi, R. R., Dhavale, A. J. & Balwan, K. S. (2019). Review of Bharat Stage 6 emission norms. *International Research Journal of Engineering and Technology*, *6*, 1359-1361.

[13] Ghodke, P. R. & Suryawanshi, J. G. (2014). Investigation of multicylinder diesel engine to meet future indian emission norms. Iranian *Journal of Science and Technology. Transactions of Mechanical Engineering*, *38*(M1+), 239.