Copper Oxide Coated Diesel Particulate Filters

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Abstract--- Automotive emission standards have become stringent worldwide, because of the growing vehicle population and persistent air quality problems.
vehicle population increasing rapidly, if all the worlds motor vehicles are lined up bumper to bumper, the line of traffic would circle the globe 120 times, according to world motor vehicle market. Attainment of emission standards will require advance exhaust after treatment systems. Diesel particulate filter (DPF) is recognized as visible solution to reduce the particulate matter emission from diesel engines.
This paper mainly focused on the use of CuO coated particulate filters in a single cylinder naturally aspirated four stroke DI Diesel engine. Experimental study was made to find the performance and emission characteristics of the engine. The investigation shows that the DPF was effective for reducing the PM by 60-70%.Further, the investigation shown that there is a moderate increase in power output compared to bare filter and specific fuel consumption also reduces appreciably.

I. INTRODUCTION

Diesel particulate filters are devices that physically capture diesel particulates to prevent their releases to the atmosphere.

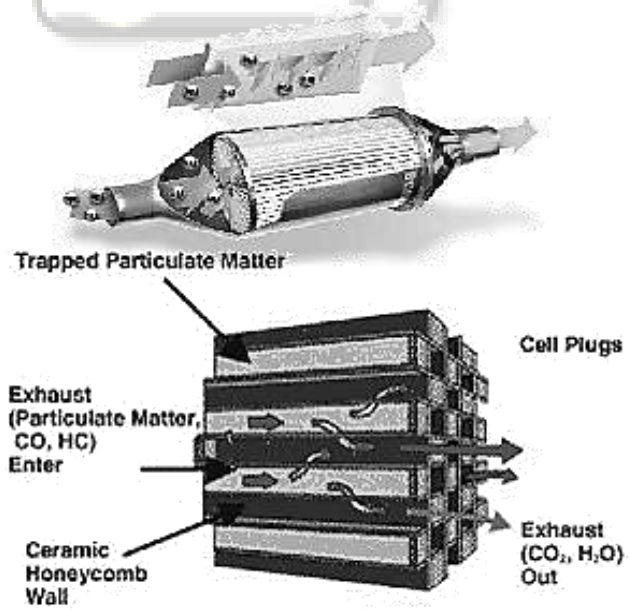

Fig. 1: construction details of DPF

Diesel particulate filter (DPF) is the most effective way to control diesel PM emissions [1]. The filter is an extruded ceramic honeycomb in which the channels are blocked at alternative ends. Exhaust gas flowing through the filter must pass across the porous walls between the channels. The PM is deposited on and within the filter walls [2]. Internal combustion engines generate undesirable emissions during the combustion process. In this both SI and CI engines are equally responsible for the same. Engine emissions can be classified into two categories:[3,4]

1) Exhaust emissions
2) Non-exhaust emissions
3) Exhaust emissions From CI Engines
   a. Unburned Hydrocarbons
   b. Carbon Monoxide
   c. Nitrogen Oxides
   d. Sulfur Dioxide
   e. Particulate Matter

Diesel Particulate matter (PM) is formed by the incomplete combustion of diesel fuel in an engine. It consists of Solid fraction (SOL), soluble organic fraction (SOF) and Sulfate particulates.
Particulate matter leads to, reduced atmospheric visibility, Human health impact and black carbon particulates contribute to global warming. Emission control through Engine Design and after treatment is the ways to control the Emissions from engine. In our investigation we concentrate on after treatment method. Different processes are currently under development to remove the major components NOx and PM from the exhaust. The most common design for a diesel particulate filter is the wall-flow monolith. This is an extruded, usually cylindrical ceramic structure with many small, parallel channels running in the axial direction. The filter materials are designed to hold a certain quantity of soot. If the filter becomes overloaded, the particulates create an obstruction on the gas flow, which manifests itself in increased pressure drop and may lead to clogging of the filter. Therefore the filter system has to provide reliable regeneration mechanisms to ensure problem- free operation. Some DPF systems regenerate continuously. Others, which regenerate periodically, must perform this operation fairly frequently, usually at least once per day.

II. EXPERIMENTAL INVESTIGATION

The objectives of the present investigation are to test the performance of CuO coated ceramic foam filter.
The important criteria for the selection of catalyst material depends on availability and cost, the catalysts are classified as noble metal catalysts and transition metal catalyst. The metals such as tin, copper, iron are called as transition metal catalyst. The properties of catalyst are listed below

1) High conversion efficiency
2) Withstand thermal shock
3) Cheap and readily available

Ceramic foam filter was used as catalyst substrate. The coated ceramic foam filter was used to trap relatively bigger

particulates. The smaller particulates are trapped with the help of Bare Alumina Pellets. These ceramic form filter and Alumina pallets were possessing following significant properties.

1) Inexpensive starting materials
2) High melting temperature
3) High heat capacity
4) Thermal shock resistant
5) Thermal expansion coefficient controllable
6) Light weight and mechanically strong

In the present investigation, the metal oxide CuO was coated on the ceramic substrate. These coated filters were placed upstream of the particulate trap. Alumina pallets were placed in the downstream of the particulate trap.

III. EXPERIMENTAL SETUP

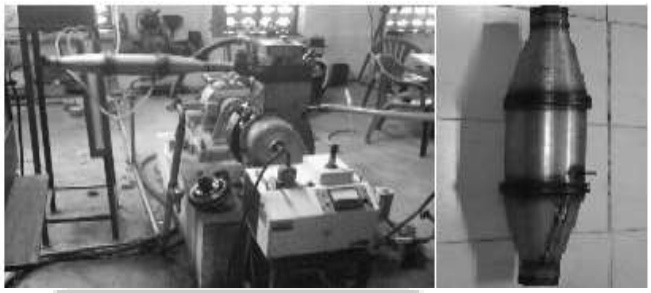

Fig. 2: Photographic view of Experimental setup and DPF

The experimental investigation was carried on a typical 5.5 kW, single cylinder D.I Diesel engine. Fig 2 shows the photographic view of the experimental setup and DPF

IV. RESULT AND DISCUSSION

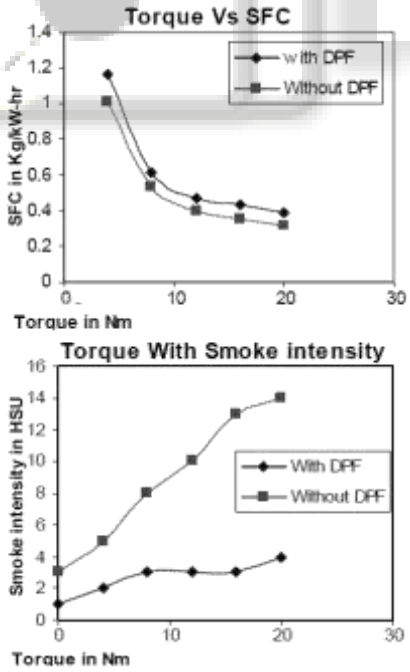

Fig 3: [a] Torque Vs. SFC, [b] Torque Vs. smoke intensity

Fig 3[a] shows the variation of brake specific fuel consumption with torque. It is observed that there is a general marginal rise in the specific fuel consumption. This increase in the brake specific fuel consumption may be attributed due to the marginal back pressure build up because of DPF.

The variation of smoke intensity with Torque is found that there is a general reduction with the particulate trap. The smoke intensity in Hart ridge Smoke Units (HSU) for with and without DPF is varied between 1 to 4%, 3 to 14% respectively over the power range. (Fig 3[b])

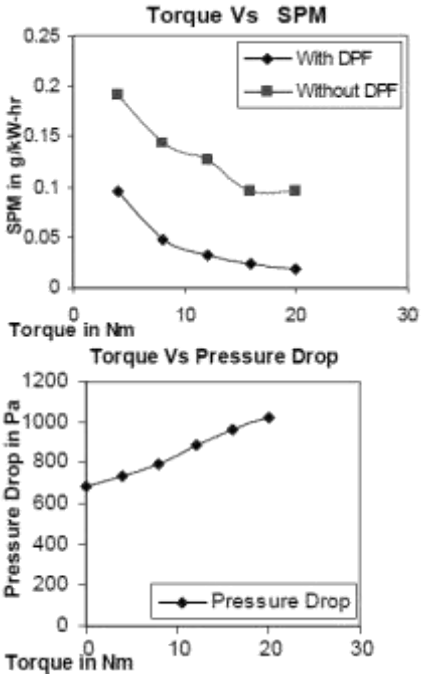

Fig. 4: [a] Torque Vs. Specific particulate matter, [b] Torque Vs. pressure drop

The variation of specific particulate emission is observed that there is a general reduction of the specific particulate emissions with DPF. (Fig 4[a])

Fig. 4 [b] shows the variation of pressure drop with Torque. It is found that there is an increase in back pressure due to DPF. It is because of the flow resistance along the path of exhaust getting out to the atmosphere.

V. CONCLUSIONS

With the use of DPF, there is a marginal reduction (70%) in smoke intensity and SPM. There was a general marginal rise (12%) in the Brake specific fuel consumption. This increase in the brake specific fuel consumption may be attributed due to the marginal back pressure build up because of DPF. The maximum pressure drop developed was found to be 1024 Pa. There was marginal reduction (12-16%) in Brake Thermal efficiency.

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