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EFFECIENCY OF DIESEL OXIDATION CATALYST ON A NONROAD DIESEL ENGINE EMISSION

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Abstract: This technical paper presents the effect of diesel engine oxidation catalyst on exhaust emission by a non-road diesel engine. The diesel oxidation catalyst oxidises the carbon mono-oxide (CO), un-burnt hydro-carbon (HC) and the particulate matter from the exhaust of diesel engine. The performance and the efficiency of the diesel oxidation catalyst depend on the soot which is being generated by the engine. The soot constituents and its properties depend on the combustion, sulphur content in diesel and also on the engine lubricating oil.

Key Word: Diesel oxidation catalyst (DOC), Diesel engine emission

I. INTRODUCTION

Diesel Oxidation Catalysts (DOC) helps reduce particulate matter mass from exhaust gasses, turning hydrocarbons and carbon monoxide into carbon dioxide and water. DOCs also aid the overall performance of after-treatment systems comprising DPF/Selective Catalytic Reduction. The diesel oxidation catalyst (DOC) has been part of diesel exhaust systems since regulations were introduced to limit the amount of harmful emissions released to the environment from diesel engines. The DOC primary functions are oxidation of CO, unburned hydrocarbons, and NO, while active hydrocarbon oxidation can also be used to generate isotherms required for downstream components. This review will describe work that has attempted to understand the reactions, both desired and undesired, that occur over the catalyst. First, the history, configuration, and components of the DOC will be discussed, followed by in-depth coverage of the fundamental reactions that occur over a DOC, including reaction mechanisms, reaction inhibition, and other reactivity effects. Finally, DOC deactivation mechanisms and their effects on the DOC are described. While there is a lot of research literature regarding Pt- and Pd-based catalysts for many different reaction schemes, this review tries to highlight work most relevant to DOC applications.

II. LITERATURE REVIEW

The catalytic converter was invented by Eugene Houdry, a French mechanical engineer and expert in catalytic oil refining, who moved to the United States in 1930. When the results of early studies of smog in Los Angeles were published, Houdry became concerned about the role of smoke stack exhaust and automobile exhaust in air pollution and founded a company called Oxy-Catalyst. Houdry first developed catalytic converters for smoke stacks called "cats" for short, and later developed catalytic converters for warehouse forklifts that used low grade, unleaded gasoline. In the mid-1950s, he began research to develop catalytic converters for gasoline engines used on cars. He was awarded United States Patent 2,742,437 for his work. Widespread adoption of catalytic converters did not occur until more stringent emission control regulations forced the removal of the anti-knock agent tetraethyl lead from most types of gasoline. Lead is a "catalyst poison" and would effectively disable a catalytic converter by forming a coating on the catalyst's surface. Catalytic converters were further developed by a series of engineers including John J. Mooney, Carl D. Keith, Antonio Eleazar at the Engelhard Corporation, creating the first production catalytic converter in 1973. William C. Pfefferle developed a catalytic combustor for gas turbines in the early 1970s, allowing combustion without significant formation of nitrogen oxides and carbon monoxide.

III. EXPERIMENT

Engine Specifications:

Diesel engine the engine used in this study was 75HP 3.12 litre turbocharged diesel engine (featuring high-pressure common rail fuel injection). It is representative of modern diesel engine design practice, and features. Below mentioned the table for specification of the engine which we did the DOC exercise

Rated Power(HP)	75HP@2000 rpm
Max Torque(Nm)	350Nm@1400rpm
No of Cylinder	4
Bore X Stroke	95 X 110
Swept Volume	3.12
Aspiration	Turbo charged Inter cooler
High Idle	2200rpm
Low Idle	750rpm

The particle sample of above engine taken without DOC and sample sent to the laboratory for detailed analysis of lube Oil, Fuel, results are tabulated below

Filter Number	Particle Total loading Front(mg)	Particle Analysis							
		VOF		NVF+OTHERS		LUBE OIL		FUEL OIL	
		mg	% of Total	mg	% of Total	mg	% of Total	mg	% of Total
Primary Filter	0.423	0.311	73.5	0.112	26.47	0.223	74.3	0.0454	15.0

Engine Test Bench Details:

The engine trials were performed using an engine emission test-bed within the Escorts Engine test laboratory which is certified by VCA (Vehicle Certification Agency, U.K) and equipped with AVL instruments and devices. The configuration of the engine test cell is illustrated in Figure. The engine was mounted on a test bed and coupled to an APA120 kW transient dynamometer.

Instruments Details:

S.No.	Device Name	Model	Make
1	Dynamometer	APA 120 KW	AVL
2	Fuel Meter	AVL 735	AVL
3	Air Flow Meter	Sensy Flow	AVL
4	Smoke Meter	AVL 415S	AVL
5	Opacity Meter	AVL 439	AVL
6	Air Conditioning System	CONSYAIR 800	AVL
7	Fuel Module Unit	AVL Fuel Module	AVL
8	Fuel conditioning Unit	AVL 753C	AVL
9	Coolant Conditioning Unit	YS40346	Yantra Shilpa
10	Intercooler Unit	IACS001	G_Vision
11	Throttle Actuator	THA 100	AVL
12	Exhaust Back Pressure Valve	OAP	AVL
13	AVL Blow-By Meter	AVL 442	AVL
14	AVL Pre filter	AMA-i60	AVL
15	SPC Filter Cabinet	FIL1201S836	AVL

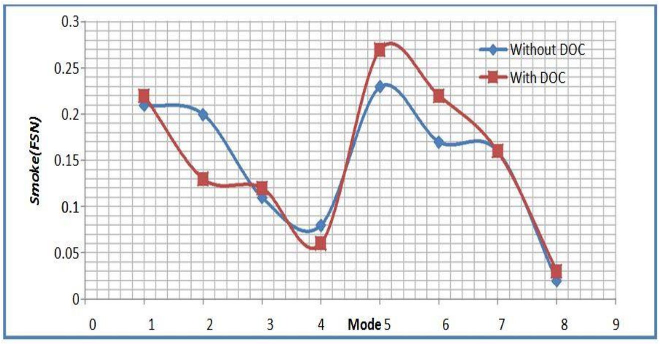
IV. ENGINE CONTROL & DATA ACQUISITION SYSTEM

The test cell was equipped with data logging facilities made by AVL.The data logging box consisted of three pressure and thirty temperature channels. The computer in the control room used Puma 2.0 software, which recorded all the temperatures, pressures, gas concentrations and engine operating conditions from the test. It allows system customization using Visual Basic and also contains Real Time multi-tasking direct digital control functions. Its interface supports input from the dynamometer, engine control unit (ECU), fuel Balancing Unit, sensors and controllers. This comprehensive system eliminated the need for laborious data synchronisation (between temperature and gas composition measurements) post testing. .

V. RESULT & CONCLUSION:

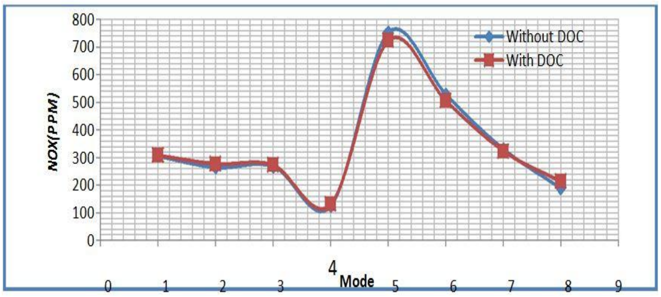
5.1 Smoke :

The smoke values without DOC at almost all 8 modes found to be at par with DOC.



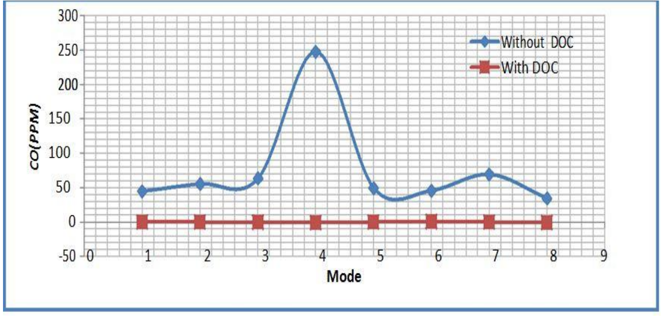
5.2 NOX:

The NOx PPM values without DOC at almost all 8 modes found to be at par with DOC.



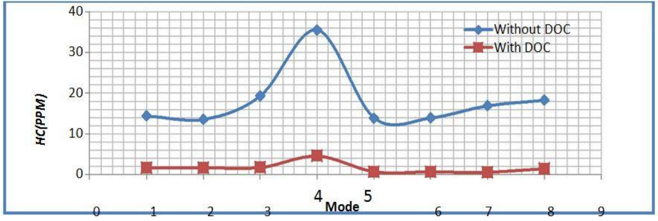
5.3 CO:

There found considerable impact of DOC on CO PPM value mainly at the 4th mode.

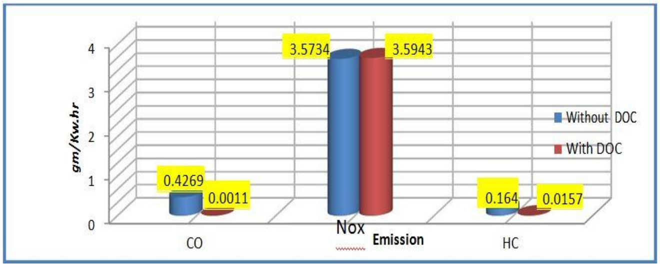


5.4 HC:

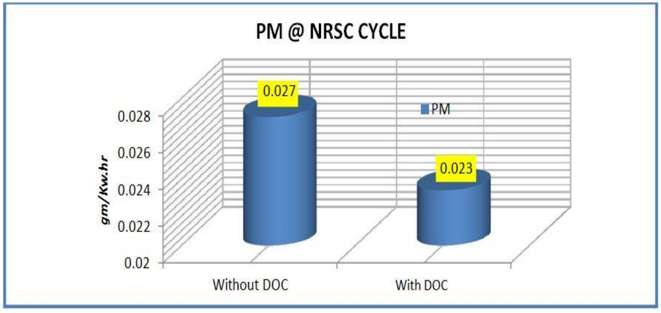
There found considerable impact of DOC on HC PPM value mainly at the 4th mode.



5.5 NRSC Cycle gaseous emissions (gm/Kw.hr):
The difference of NRSC cycle gaseous emission with and without DOC, can be seen in the below plot:



5.6 NRSC Cycle PM during:



5.7 DOC Efficiency Calculation:
PM with DOC = 0.023
PM without DOC 0.027

$$\eta = (1-0.023/0.027) \text{ X } 100$$
$$=14.81\%$$

$$\boxed{\eta = 14.81\%}$$

The efficiency of the sample DOC with subject engine found to be 14.81%.

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