International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

EMISSION 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.**

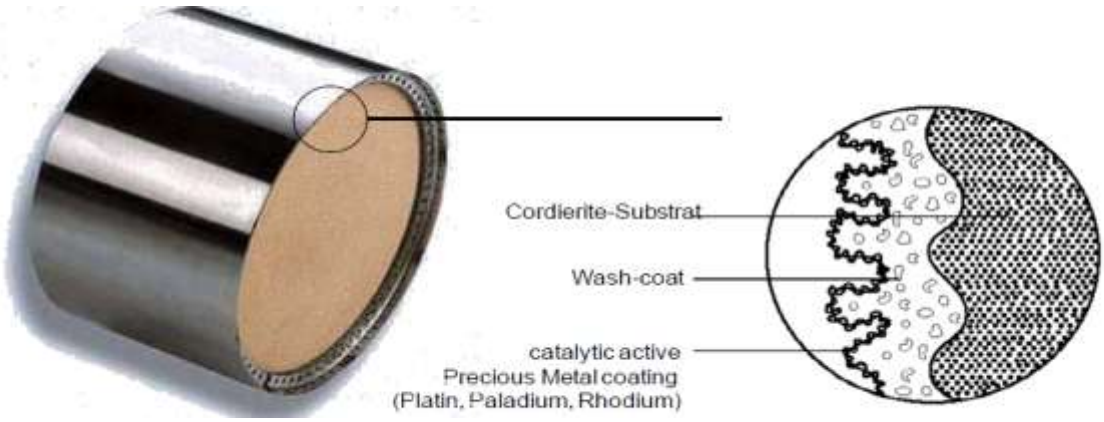
Diesel Oxidation Catalysts (DOC) helps in reducing the particulate matter mass from exhaust gasses, turning hydrocarbons and carbon monoxide into carbon dioxide and water. DOCs also aid the overall performance of after-treatment systems comprising DPF/Selective Catalytic Reduction.

This review will describe work that has attempted to understand the reactions, both desired and undesired, that occur over the catalyst.

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

1 Introduction:

Diesel Oxidation Catalysts (DOC) helps in reducing the 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.



$2\ CO + O_2 \rightarrow 2\ CO_2$
$2\ NO + O_2 \rightarrow 2\ NO_2$
$4\ HC + 5\ O_2 \rightarrow 4\ CO_2 + 2\ H_2O$

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.

2 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.

3 Experiment:

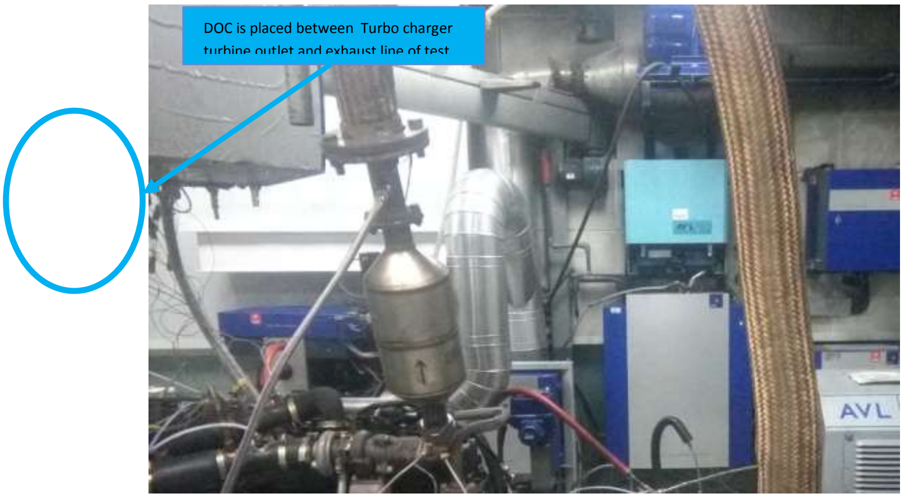
3.1 Engine Specifications:

Diesel engine the engine used in this study was 75HP 3.31 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)	74.5 HP @2000 rpm
Max Torque(Nm)	351 Nm @1400rpm
No of Cylinder/No of valves per cylinder	4 /2
Bore	96
Stroke	109
Swept Volume	3.15
Aspiration	Turbo charged Inter cooler
High Idle	2200rpm
Low Idle	750rpm

3.2 Test Bench Layout:

The engine trials were performed using an engine emission test-bed 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.

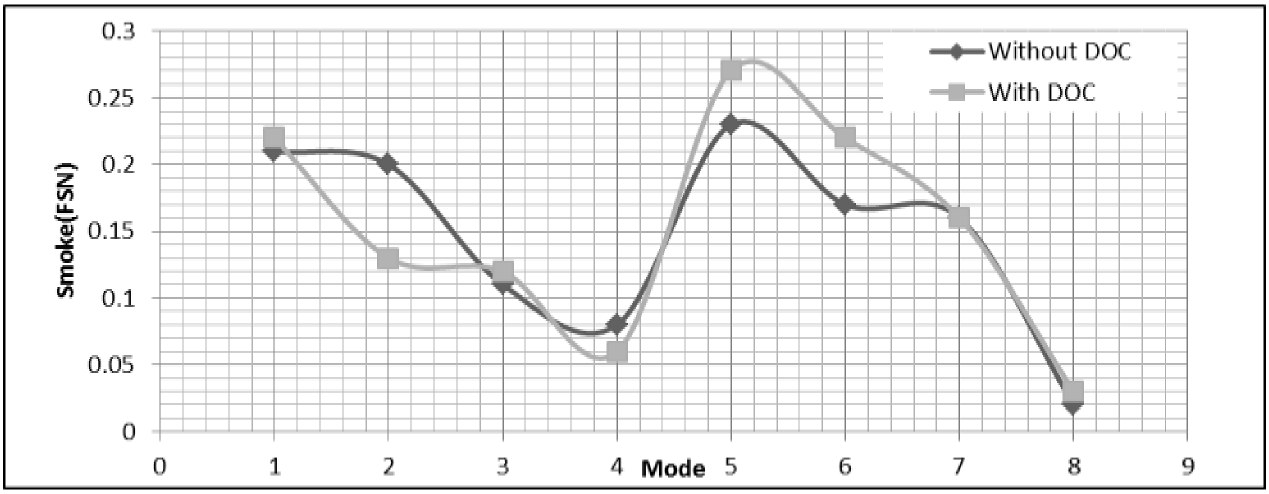


4 Engine Control & Data acquisition system:

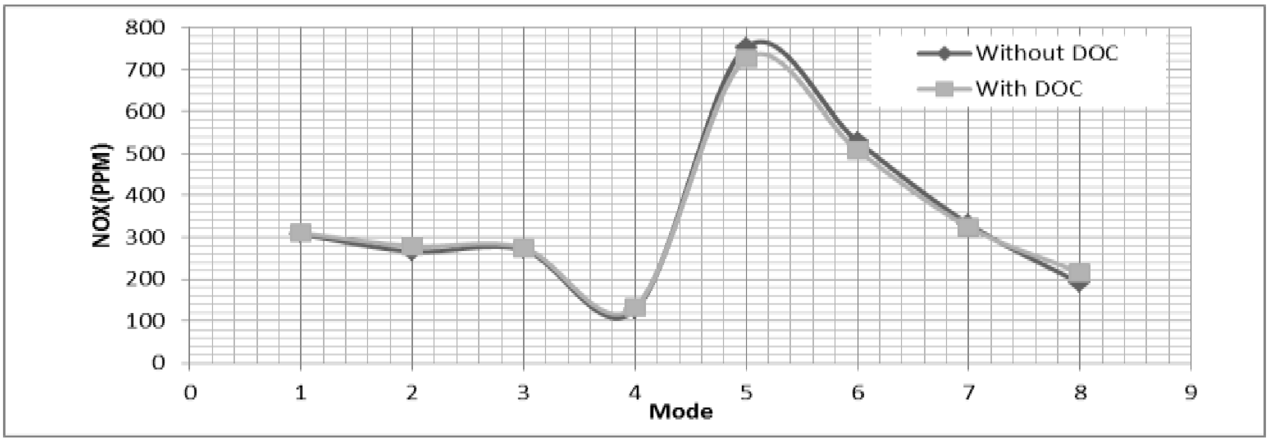
The test cell was equipped with data logging facilities made by AVL. The data logging box consisted of three pressure and thirty temperature channels. The computer in the control room used Puma 2.0 software, which recorded all the temperatures, pressures, gas concentrations and engine operating conditions 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.

5 Experimental Results:

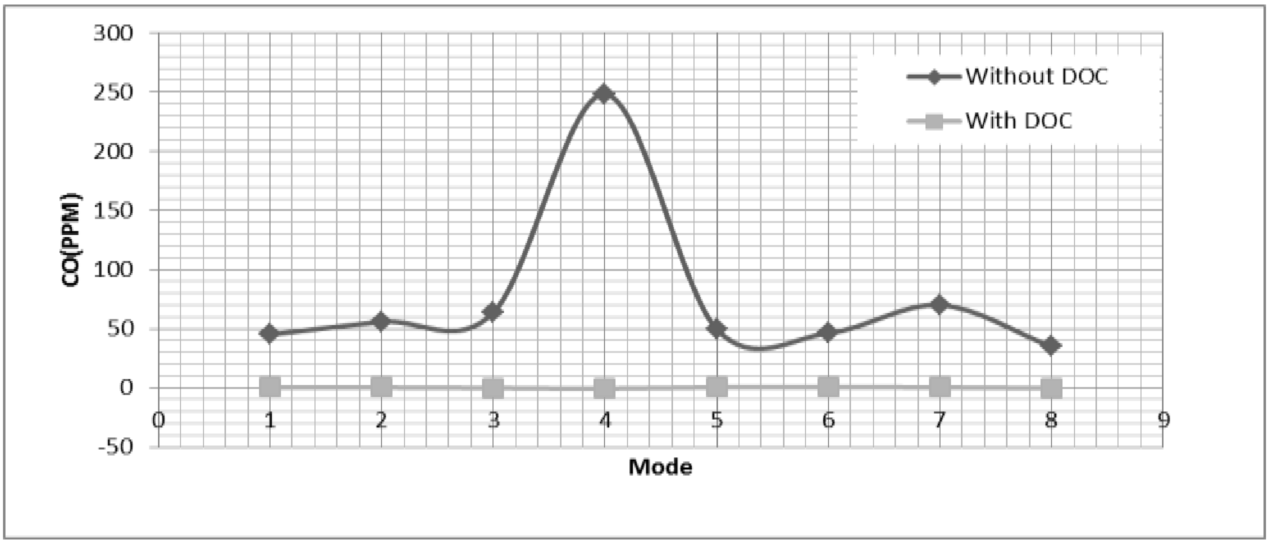
i. Smoke



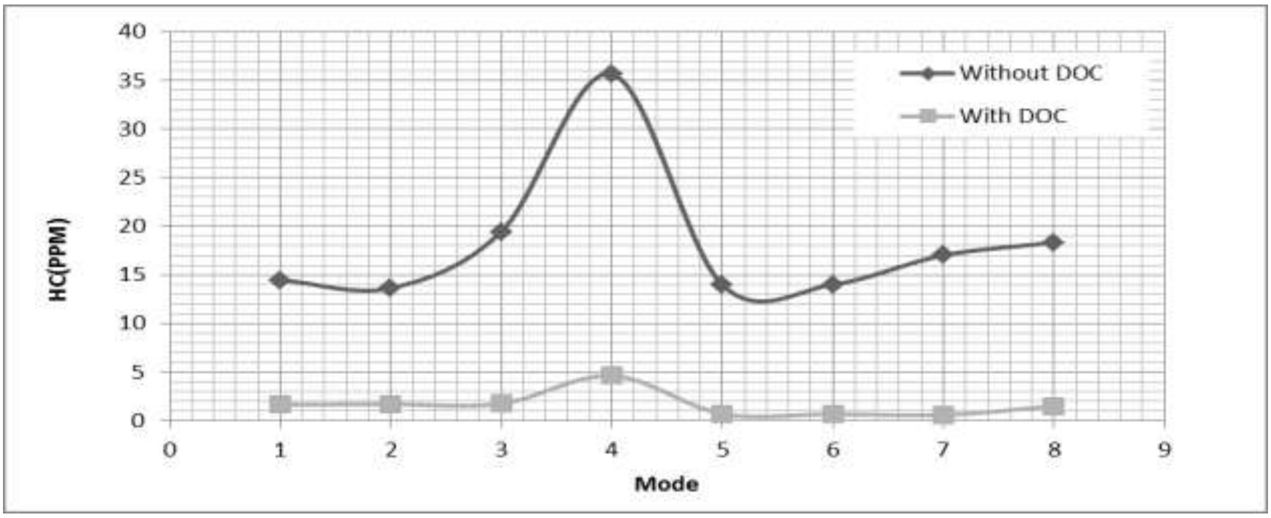
ii. NOX:



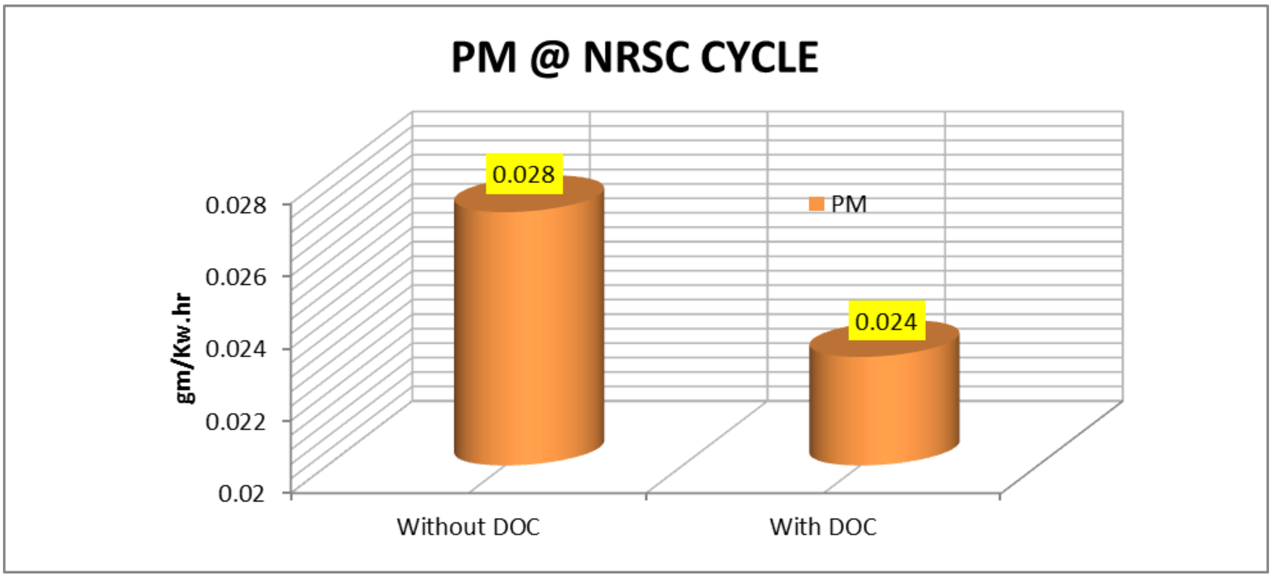
iii. CO:



iv. HC:



v. **PM @ NRSC Cycle:**



6 Conclusions:

The efficiency of the Diesel oxidation catalyst for various emissions is calculated as follows

PM with DOC = 0.023
PM without DOC 0.027
η = (1-0.024/0.028) X 100
=14.81%

η =14.3%

	With DOC	Without DOC	Efficiency (*η*)
MASS CO	0.0011	0.42	99.7%
MASS THC	0.0157	0.164	90.4%
MASS PM	0.024	0.028	14.3%

It can be seen that the Diesel oxidation catalyst is phenomenally successful in curbing CO and HC emission while also reducing PM emission by a noticeable margin.

7 Acknowledgment:

I owe my deep gratitude to our project guide Rupesh Dagar (Assistant Professor) & Nausad Khan (Assistant Professor) at DITMR who took keen interest on our project work and guided us all along, till the completion of our project work by providing all the necessary information for developing a good system.

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