

EFFECT OF TiO₂/Al₂O₃ CATALYST COATING ON CATALYTIC CONVERTER WITH ETHANOL DIESEL BLEND IN SINGLE CYLINDER FOUR STROKE VCR ENGINE

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ABSTRACT

This paper presents effect of ceramics material on a new catalytic converter to be used for diesel fuelled engine with 10% of ethanol blend in addition of 1% of Diethyl Ether. The catalytic converter was developed based on catalyst materials consisting of metal oxides such as titanium dioxide (TiO₂) and Aluminum oxide (Al₂O₃) with ceramics substrate. In this study experimentally found that the TiO₂/Al₂O₃ based catalytic converter are reduce 12%, 23.46%, 19%, 35% and 77.9% for NO_x, CO, HC, CO₂ and smoke emissions effectively reduce. It is calculated that the TiO₂/Al₂O₃ based catalytic converter with ethanol 10% in addition of DEE 1% reduces 15%, 52.8%, 39%, 40% and 81.7% higher NO_x, CO, HC, CO₂ and smoke emissions in comparison to diesel and ethanol. The objective of this paper is to develop a low-cost three way catalytic converter to be used with the newly developed ceramic catalytic converter. Detailed review on ceramic coated catalytic converter and emission test results have been presented with discussions.

Keywords: Catalytic converter, DEE, Al₂O₃, TiO₂, Ceramic coating, Ceramic substrate.

I. INTRODUCTION

The basic knowledge about catalytic converter is necessary to design a new catalytic converter [1-3]. A catalytic converter consists the substrate, wash coat, catalyst and the mounding system. The substrate act as a catalyst carrier to provide sufficient active sites for the exhaust gas to

be in contact with the catalyst [4, 5]. Some of critical issues while installing the catalytic converter on running condition such as conversion efficiency, long term durability, weight, volume and available space [6- 8].

In existing excellent Oxidation catalyst are platinum, palladium and rhodium (Noble metals) to a catalytic converters. At high temperature the noble metals are release toxicity and causes to hazardous for living substances. So here Titania (TiO₂)/ Alumina (Al₂O₃) is used to avoid the hazardous effect and these materials are withstanding high temperatures. Here to avoid attrition and high back pressure ceramic substrate are used with (TiO₂)/ (Al₂O₃) wash coating [6, 7].

Ethanol can be made from raw materials such as sugarcane, sorghum, corn, barely, cassava, sugar beets ec. A biomass- based renewable fuel; Ethanol has cleaner burning characteristics and a high octane rating. The Ethanol fuel may reduce environmental pollution, strengthen agricultural economy and reduce diesel fuel requirements. In order to improve the fuel properties introducing by oxygenated components such as alcohol (Ethanol) has become essential for reduce or eliminate the exhaust gas emissions from diesel engine [8, 9].

Diethyl ether (DEE), an oxygenated additive can be added to diesel/ biodiesel fuels to reduce the NO_x emission. It is an excellent ignition enhancer and has a low ignition temperature [10]. It is an aid for cold starting and ignition improver for diesel water emulsion [11]. Iranmanesh, *et al.*, in their experimental study found that 5% of DEE with diesel blend was the most effective combination based on performance and emission characteristics [12]. Similarly, Qi

et al. [13] conclude that brake specific fuel consumption (BSFC) is slightly lower when adding 5% of DEE with B30 (30% soybean biodiesel and 70% diesel in vol.), accompanied by more reduction of CO emission, smoke and similar NOx emission compare to B30.

This paper presents effect of TiO_2/Al_2O_3 on the catalytic converter with Ethanol Diesel blends in addition of 1% of DEE. Here the experiment was conducted with and without catalytic converter by ceramic substrate with and without coating. In this analysis the CO, CO_2 , NO_x and smoke emissions were reduced significant amount and the performance was not affected after installing the catalytic converter due to that use of Ethanol and DEE. Because of the vaporization of DEE improved the combustion rate and it can be tolerated by the back pressure.

II. EXPERIMENTAL SETUP AND PROCEDURE

The schematic line diagram of the experimental setup is shown in Fig 1. In this a Kirloskar SV1 model single cylinder, water cooled four stroke direct injection diesel engine, the test rig of 5.2 kw rated power at 1500rpm, was directly coupled with AG 250 model water cooled Eddy Current dynamometer to the engine. It is provided with necessary instruments for the provisions are also made for interfacing fuel flow, airflow, temperature, speed, and load measurements. The setup has a stand-alone panel box consisting of air box, fuel tank, manometer, fuel measurements unit, speed indicator, load indicator, temperature indicator, Rota meters (provided for cooling water) and calorimeter (water flow measurements). The initial arrangements of the system are properly checked and test fuel is filled in the fuel tank. The engine was operated at different loads (NO load, 3 Kg, 6 Kg, 9 Kg, 12 Kg, 15 Kg, and 18 Kg). For every load air flow, fuel flow, temperatures at water inlet and exhaust, Rota meters values are noted. The smoke level of the engine is measured by using AVL 437C smoke analyser and values of exhaust gases like CO, HC, CO_2 , NO_x and O_2 are noted by using AVL Di Gas 444 gas analyzer.

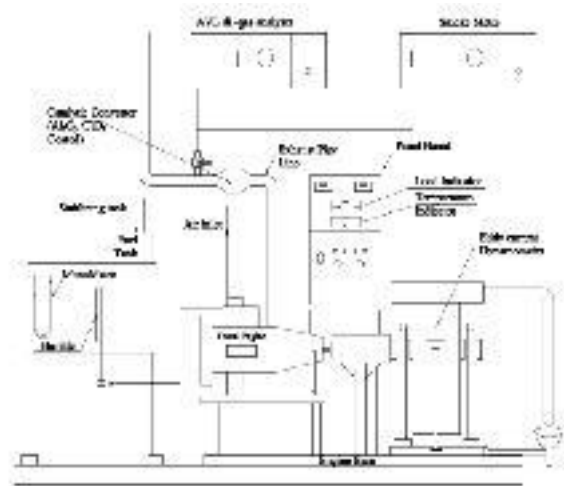


Fig 1: Experimental setup

III. RESULTS AND DISCUSSION

EXHAUST EMISSION ANALYSIS

1. Carbonmonoxide (CO) Emissions

The variation of CO emissions with brake power is shown in Fig 2. In this graph shows that various load condition the diesel fuel had maximum CO emission while kept new catalytic converter without coating reduce up to 20% of CO emission because of the substrate has aluminum content. With catalytic converter CO was reduced 35% and also using ethanol the conversion efficiency increased near to 88% at full load condition.

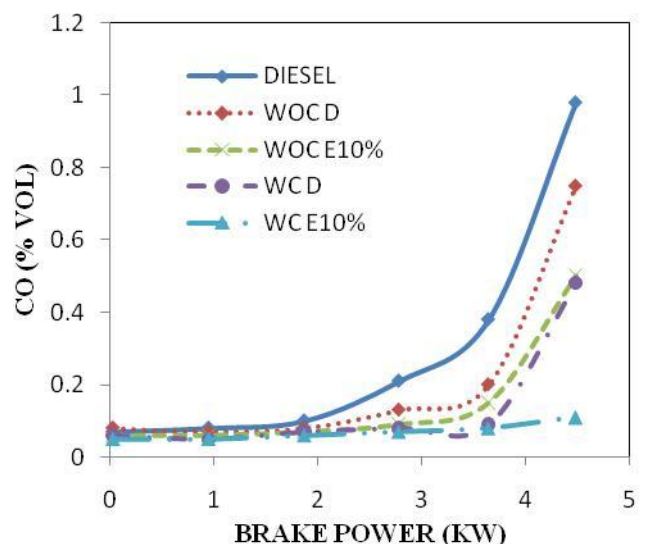


Fig 2: Variation of Carbon monoxide (CO) with Brake Power

2. Hydrocarbon (HC) Emissions

The variation of HC emissions with brake power is shown in Fig 3. The unburned hydro carbon of diesel was more while without catalytic converter. When using catalytic converter the UBHC value reduced due to reduction process of TiO_2/Al_2O_3 catalyst material. By using of ethanol blend 10% with the additive DEE 1% the conversion efficiency of catalytic converter increase without coating 19% and with coating 39% due to that oxygen content of ethanol and DEE high comparatively diesel fuel. So there may be a chance to complete combustion.

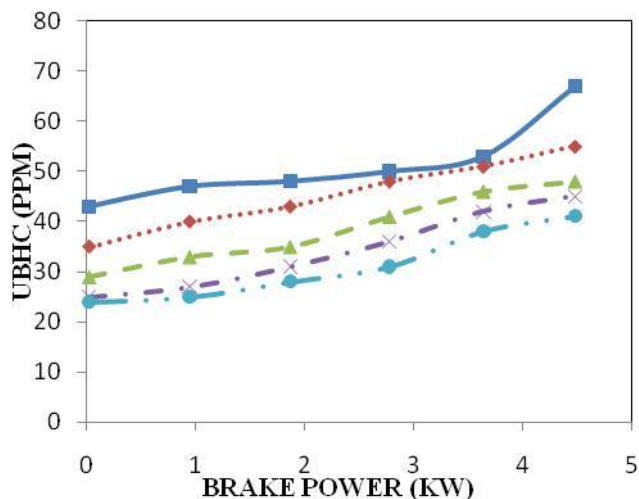


Fig 3: Variation of Hydro Carbon (HC) with Brake Power

3. NOx Emission

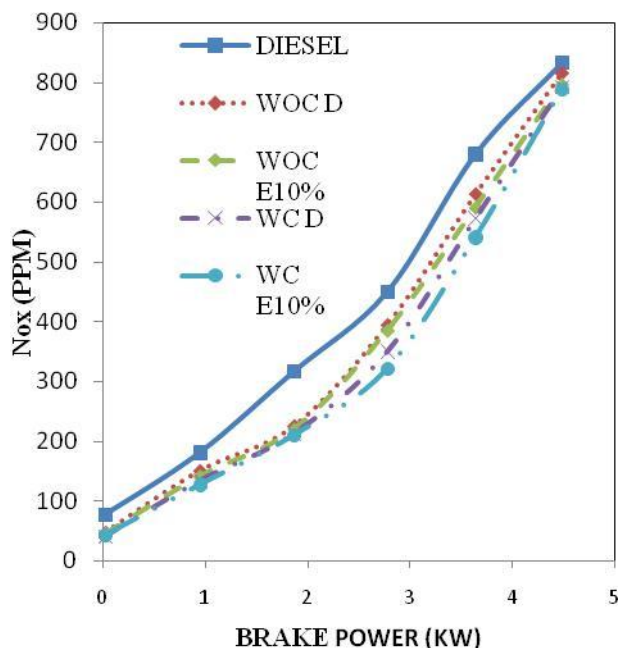


Fig.4: Variation of NOx with Brake Power

The variation of NO_x with brake power is shown in Fig.4. Here the catalyst material TiO_2/Al_2O_3 which effectively reduce 12% in without coating and with coating 15% of NO_x reduce at 75% of load condition. Ethanol and DEE blending into diesel fuel reduces temperature both by increased heat of vaporization and by reduced flame temperature. Consequently, combustion temperature abates, and hence NO_x emissions are significantly diminished. So that Nox emission minimize up to 10% without coating and 20% reduce with coating by using Ethanol blend with DEE. This is 5% increases conversion efficiency of catalytic converter.

4. CO₂Emission

The complete combustion process takes place inside the combustion chamber amount of CO₂ exhaustion by the diesel engine is normally high. But using catalytic converter using with ethanol blend in addition of DEE reduce. By the catalytic converter the amount of CO₂ reduce 35% without coating and 40% with coating of catalytic converter.

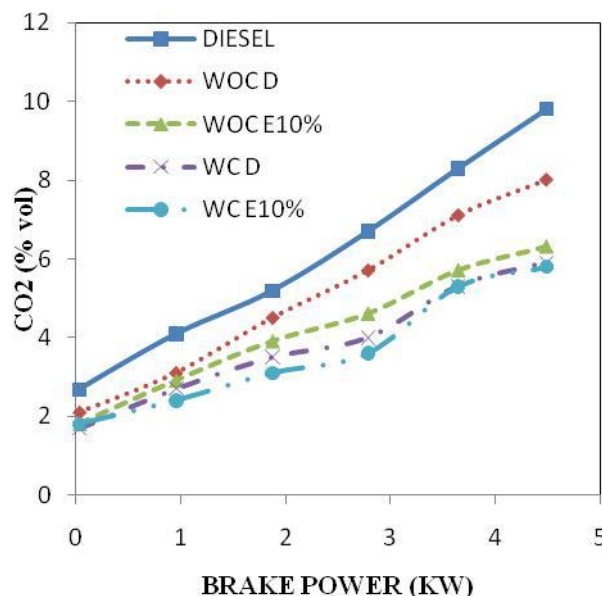


Fig.5: Variation of CO₂ with Brake Power

5. BRAKE POWER Vs SMOKE

The Fig 5, smoke is produced mainly in the diffusive combustion phase, the addition of oxygenated fuel leads to an improvement in diffusive combustion. On the other hand enhancing the oxygen content in the charge, can overcome poor mixing of the fuel with air, which is responsible for smoke formation in diesel engines. So the Oxides of the material TiO_2/Al_2O_3 can reduce smoke at full load condition also influence of oxygen content of ethanol and DEE opacity

of smoke can reduce 77.9% without coating and 81.7% of with coating of metal coating.

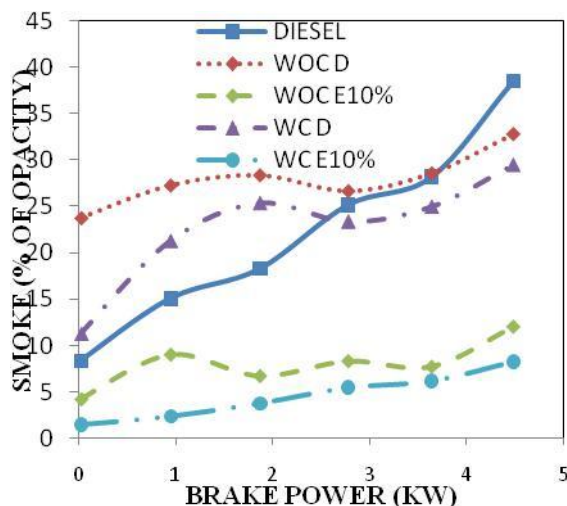


Fig 6: Variation of Smoke with Brake Power

IV. CONCLUSION

TiO₂ /Al₂O₃ catalyst of ceramic substrate was reduce CO emission 23.46% without coating by using ethanol and also reduce up to 52.8% with coating using Ethanol blend with DEE. When using catalytic converter the UBHC value reduced due to reduction process of TiO₂/Al₂O₃ catalyst material. By using of ethanol blend 10% with the additive DEE 1% the conversion efficiency of catalytic converter increase without coating 19% and with coating 39%. By the catalytic converter the amount of CO₂ reduce 35% without coating and 40% with coating of catalytic converter. The complete combustion process takes place inside the combustion chamber amount of CO₂ exhaustion by the diesel engine is normally high. But using catalytic converter using with ethanol blend in addition of DEE reduce. By the catalytic converter the amount of CO₂ reduce 35% without coating and 40% with coating of catalytic converter. The catalyst material TiO₂/Al₂O₃ which significantly reduce 12% in without coating and with coating 15% of NO_x reduce at 75% of load condition. The Oxides of the material TiO₂/Al₂O₃ can reduce smoke at full load condition also influence of oxygen content of ethanol and DEE opacity of smoke can reduce 77.9% without coating and 81.7% of with coating of metal coating.

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