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Role of Carbon Nano Tubes on the Emission Characteristics of Diesel Engine - An Overview

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ABSTRACT

The present study focuses on the overview of multiwalled carbon nanotubes (MWCNTs) and exhaust gas recirculation (EGR) of a diesel engine fuelled with the Nano Al, Mg, Zr, Ti, Ni, CuO, CuCl2, CoCl2, FeCl3 and CuSO4 can be used as a catalyst for Diesel engine. This study reveals that the addition of carbon nanotubes to petroleum drived fuel had minimal influence on CO and HC emissions. The data were also showed that there was an average increment in Specific Fuel Consumption (SFC) and decrease in brake thermal efficiency (BTE) in case of blends with MWCNTs and the power was slightly increased on an average of 0.60%-0.80% while operating on blends with MWCNTs.

Keywords : MWCNT, Catalyst, Diesel Engine, Emissions, Exhaust Gas

I. INTRODUCTION

The diesel engine, like other internal combustion engines, converts the chemical energy in the fuel into mechanical power. Diesel fuel, in an ideal combustion process, is a hydrocarbon mixture that produces just carbon dioxide (CO_2) and water vapour (H_2O). The majority of diesel exhaust gases are made up of CO_2, H_2O, and unutilized engine charge air. Diesel emissions include chemicals that are potentially hazardous to one's health and/or the environment. Non-ideal combustion processes, such as incomplete fuel combustion, reactions between mixture components at high temperatures and pressures, combustion of engine lubricating oil and oil additives, and combustion of non-hydrocarbon components of diesel fuel, such as sulphur compounds and fuel additives, are responsible for the majority of these pollutants. Unburned hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter are examples of common contaminants. The total concentration of contaminants in diesel exhaust gases is generally in the tenths of one percent range. Modern diesel engines fitted with emission after treatment equipment such as NO_x reduction catalysts and particle filters emit much reduced, "near-zero" amounts of pollutants.

In automobiles, a catalytic converter serves as an exhaust emission controller. It catalyses a reduction reaction by digesting hazardous pollutants and gases from the internal combustion engine and transforming them into less-toxic pollutants. Catalytic converters are often referred to as "cats" or "cat-cons." The device's function is to minimize air pollution by producing and converting it to steam. A catalyst is a chemical that speeds up a chemical reaction without affecting its characteristics. As a catalyst, a Nobel metal such as platinum, palladium, or rhodium is utilised. Because it requires around 800 degrees Fahrenheit (426 degrees Celsius) to work, the product is put closer to the engine. Another significant element that influences conversion efficiency is the position of the catalytic converter.

Emissions Characteristics and Control Strategies

The exhaust mostly comprises three basic pollutants: unburned or partially burnt hydrocarbons (HCs), carbon monoxide (CO), and nitrogen oxides (NOx), largely NO, as well as other components such as water, hydrogen, nitrogen, oxygen, and so on. In general, emissions are affected by the air-to-fuel (A/F) ratio. The largest power production is obtained by tuning the engine to rich feed, but at the penalty of excessive fuel consumption. Lower combustion temperatures result in lower NOx emissions under lean conditions; nevertheless, at extremely high A/F engine misfire occurs, resulting in significant HC emissions.

The light-off temperature of automotive three-way catalysts (TWCs) is roughly 250-350°C. This implies that within 90-120 seconds, an under-floor catalyst is heated above the light-off temperature. For future automotive applications, an exceptionally efficient and durable catalyst is required which should have the following characteristics.

i. High activity and selectivity (conversions more than 98%), up to 99% for Californians.
ii. Fast light-off (10-20 s), indicating considerable activity at low temperatures.

Typically, cumulative tailpipe emissions exceed such tight limits within 3-15 seconds of the engine starting! This means that the catalyst must be active a few seconds before the limit is reached and convert almost 100% of the time left in the test process. There are two approaches for lowering diesel engine exhaust gas emissions. The first technique is to use exhaust gas treatment equipment such as a catalytic converter and a diesel particle filter to minimise emissions. However, the usage of these devices has an impact on the performance of the Diesel engine.

The use of a fuel additive is the second way for reducing emissions and improving the performance of a CI engine. The main pollutants produced by diesel engines are nitrogen oxides (NOx) and particulate matter (PM). However, controlling NOx and PM at the same time is challenging.

II. Exhaust Emission Characteristics

The influence of nano additions on NOx is made up of nitric oxide (NO) and nitrogen dioxide (NO_2), both of which are produced during the combustion process. As a result, different metal additives such as nanometal oxide of manganese oxide (MnO) and copper oxide (CuO) have been selected and doped with diesel to achieve more complete fuel combustion and reduce the amount of exhaust gases. NOx emission values are relatively higher with the biodiesel of Mn additives compared to biodiesel with Ni additives. This higher NOx value is probably because of the Mn additives having more catalyst effect on combustion causing increase in the maximum temperature (Keskin et al. (2011), Keskin et al. (2007), Guru et al. (2002), Zhu et al. (2012)).

The Hydrocarbon emissions are caused by incomplete fuel combustion. The majority of researches observed that the inclusion of nano gasoline additives reduced hydrocarbon emissions. The exhaust gas from the engine increased in HC by 4% and 9% with nano aluminium (n-Al) and nano silicon (n-Si) in water-diesel emulsion, respectively (Mehta et al. 2014). The influence of nano particles on HC emissions are caused by incomplete fuel combustion. The majority of researches observed that the inclusion of nano gasoline additives reduced hydrocarbon emissions. The exhaust gas from the engine increased in HC by 4% and 9% with nano aluminium (n-Al) and nano silicon (n-Si) in water-diesel emulsion, respectively.

III.Nano additives for Diesel Engine

This section discusses the usage of nano particles as a fuel additive in diesel engines by researchers and scientists. Nano Al, Mg, Zr, Ti, Ni, CuO, $CuCl_2$, $CoCl_2$, $FeCl_3$ and $CuSO_4$ can be used as a catalyst for Diesel engine. Nanosized silicon granules and nanoporous silicon wafers have recently been investigated for energy uses. Basha et al. (2011) created samples of alumina nanofluid in 15% water with concentrations of 25, 50, and 100 ppm and utilised jatropha biodiesel emulsion fuel as a base fuel in a diesel engine. Fangsuwannarak et al. (2013) investigated 0.20% nano TiO2 in diesel fuel and 5% palm oil and 95% diesel as base fuel. Sajith (2020) investigated cerium oxide nanoparticles with dosing level varied from 20 to 80 ppm in a base fuel as a jatropha biodiesel on a single cylinder, WC, 4-stroke Diesel engine. Sarvestany et al. (2010) investigated the compression ignition engine's response to magnetic nanofluid fuel (Fe_3O_4) in diesel at concentrations of 0.4 and 0.8% by volume.

IV.Performance and Emission Parameters of a Carbon Nanotube Fueled CI Engine

Carbon nanotubes are one of the nanomaterials that researchers are interested in because of its unique qualities such as aspect ratio (length-to-diameter ratio), mechanical strength, and excellent thermal and electrical conductivity. Carbon nanotubes tend to congregate due to their hydrophobic surface. Their surface is modified with various functional groups to improve dispersion in solution. Carbon Nanotubes (CNTs) were blended with B5 and B10 fuel mixes as an additive to assess the performance and emissions of a CI single-cylinder engine. For each fuel combination, CNTs with concentrations of 30, 60, and 90 ppm were employed. Power, brake thermal efficiency (BTE), specific fuel consumption (SFC), exhaust gas temperature (EGT), and emissions of CO, CO2, unburned hydrocarbons (UHC), NOx, and soot were all tested for full load engines at 1800, 2300, and 2800 rpm. CNTs added to gasoline mixes were shown to significantly improve power (3.67%), BTE (8.12%), and EGT (5.57%) at all engine speeds (Seyyed et al., 2017).

Mohammad et al., (2020) studied the diesel-biodiesel fuel had 5% biodiesel and 95% diesel combined with MWCNTs-OH at 30, 60, and 90ppm concentrations at E4 and E8 concentrations. Engine speeds of 1800, 2100, and 2400 rpm, as well as full load, were used to measure performance and emissions. The addition of the additive to diesel+biodiesel+ethanol blends (B5+E4 and B5+E8) enhanced torque and power without decreasing BSFC. UHC and CO emissions dropped, whereas NOx emissions increased. Seyyed et al. (2017) discovered that CNTs added to gasoline mixes significantly improve power (3.67%), BTE (8.12%), and EGT (5.57%) at all engine speeds. The results also revealed a considerable reduction in SFC as a result of the additional CNTs in the diesel-biodiesel combination. CO, UHC, and soot exhaust emissions reduced, whereas NOx emissions increased, according to the findings of emissions characteristics. There was a statistically significant negative relationship between CO and CO_2 emissions. Furthermore, increasing EGT has a significant impact on NOx emissions.

Tariq et al. (2021) investigated the performance and exhaust emissions of CI engines using B10 and B15 biodiesel blends generated from cottonseed oil and diesel with Multi-Walled Carbon Nanotubes (MWCNTs) as an additive. Carbon Nanotubes were employed in the fuel mixes at levels of 100 and 150 ppm. Brake power, brake thermal efficiency (BTE), specific fuel consumption (SFC), and exhaust gas analysis such as hydrocarbons (HC), CO2, CO, and smoke were all tested attributes. In the case of blends including MWCNTs, the results revealed an average increase in SFC of 7.69% and a drop in BTE of 5.50%. When using MWCNT mixes, the power was marginally boosted on average by 0.60%. It was also discovered that the amount of CO, HC, and smoke in exhaust gases was reduced by an average of 6.25%, 11.32%, and 7.31%, respectively, when CNTs were added to plain diesel fuel.

Anchupogu Praveen et al., (2017) showed that brake thermal efficiency increases by 7.6% with the addition of MWCNTs to the B20 fuel, decreases by 2.42% with the EGR to the B20 fuel, and increases by 2.26% with the addition of MWCNTs and EGR to the B20 fuel compared to the B20 fuel. The maximum cylinder pressure and heat release rate was occurred as 67.35 bar and 74.80 kJ/m3 deg for the B20MWCNT40 fuel at full load condition. The CO and HC emissions for the B20MWCNT40+20%EGR fuel sample were lower compared to the B20 fuel. The Smoke emissions were reduced for B20MWCNT40 fuel compared to the B20 fuel. The NOx emissions were reduced by 25.6%, 29.7% for B20+20%EGR, B20MWCNT40+20%EGR fuel samples compared to the B20 fuel.

V. CONCLUSIONS

Overall, the experimental findings demonstrate that adding carbon nanotubes to petroleum diesel fuel is an efficient way of enhancing the emission performance of transportation diesel engines. The inclusion of CNTs had the largest impact on smoke opacity. Under normal running circumstances, increasing the quantity of CNT added in petroleum DF from 0 to 500 mg/L resulted in a reduction in exhaust smoke. The addition of carbon nanotubes to petroleum DF had minimal influence on CO and HC emissions; there was a modest tendency toward a decrease in CO emission, but the change in HC emission of the examined diesel engine was negligible.

VI.REFERENCES

[1] Seyyed Hassan; Hosseini; Ahmad; Taghizadeh-Alisaraei, Performance and emission characteristics of a CI engine fuelled with carbon nanotubes and diesel-biodiesel blends, Renewable energy, ISSN : 0960-1481.
[2] Anchupogu Praveen, The combined effect of multiwalled carbon nanotubes and exhaust gas recirculation on the performance and emission characteristics of a diesel engine, International Journal of Ambient Energy, Volume 40, 2019 - Issue 8, 791-799.
[3] M. Tariq, Influence of carbon nanotubes as additive in diesel-biodiesel blends in CI engine - an experimental investigation, International Journal of Sustainable Engineering, Volume 14, 2021 - Issue 5, 1110-1125.
[4] Basha JS, Anand RB. Role of nanoadditive blended biodiesel emulsion fuel on the working characteristics of a diesel engine. J Renew Sustain Energy 2011;3 (023106):1–17.
[5] Mohammad S, Tarahom M, Ahmad Jahanbakhshi, Aram Heidari-Maleni, Performance and emission characteristics of a diesel engine fueled with functionalized multi-wall carbon nanotubes (MWCNTs-OH) and diesel–biodiesel–bioethanol blends, Energy Reports, 6, 2020, 1438-1447.
[6] Seyyed H, Hosseinia A, Taghizadeh A, Barat G, Ahmad A, Performance and emission characteristics of a CI engine fuelled with carbon nanotubes and diesel-biodiesel blends, Renewable Energy, Volume 111, October 2017, Pages 201-213.
[7] Guru M, Karakaya U, Altiparmak D, Alicilar A. Improvement of diesel fuel properties by using

additives. Energy Convers Manag 2002;43:1021–5

[8] Fangsuwannarak K, Triratanasirichai K. Effect of metalloid compound and bio solution additives on biodiesel engine performance and exhaust emissions. Am J Appl Sci 2013;10(10):1201–13.

[9] Sajith V, Sobhan CB, Peterson GP. Experimental investigations on the effects of cerium oxide nanoparticles fuel additives on biodiesel. Adv Mech Eng 2010:1–6.

[10] Sarvestany Farzad A, Bajestan EE, Mir M. Effects of magnetic nanofluid fuel combustion on the performance and emission characteristics. J Dispers Sci Technol 2010, 10.1080/01932691.2013.874296.

[11] Keskin A, Guru M, Altiparmak D. Influence of metallic based fuel additives on performance and exhaust emissions of diesel engine. Energy Convers Manag 2011;52:60–5.

[12] Guru M, Karakaya U, Altiparmak D, Alicilar A. Improvement of diesel fuel properties by using additives. Energy Convers Manag 2002;43:1021–5.

[13] Keskin A, Guru M, Altiparmak D. Biodiesel production from tall oil with synthesized Mn and Ni based additives: effects of the additives on fuel consumption and emissions. Fuel 2007;86:1139–43.

[14] Zhu M, Ma Y, Zhang D. Effect of a homogeneous combustion catalyst on the combustion characteristics and fuel efficiency in a diesel engine. Appl Energy 2012;91:166–72.

[15] Mehta RN, Chakraborty M, Parikh PA. Impact of hydrogen generated by splitting water with nanosilicon and nano-aluminum on diesel engine performance. Int J Hydrogen Energy 2014;39:8098–105.

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