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EXPERIMENTAL INVESTIGATION ON DI-DIESEL ENGINE USING ETHANOL BLENDS AND AQUEOUS ALUMINIUM OXIDE NANOPARTICLES AS ADDITIVES

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Abstract: The experimentation was carried out on Direct Injection Diesel (DI-diesel) engine to study the performance and emission characteristics under various load conditions using additives of nanoparticles (AAONF). To produce the fuel mixtures, an ultrasonic sonicator was used. Three blends were tested: the first blend (D93+E5+S2) consisted of 93% diesel, 5% ethanol, and 2% surfactant; the second blend (D88+E10+S2) consisted of 88% diesel, 10% ethanol, and 2% surfactant; and the third blend (D83+E15+S2) consisted of 83% diesel, 15% ethanol, and 2% surfactant. In addition, the chosen blend was supplemented with 50 and 75 parts per million of AAONP (AAONP50 and AAONP75, respectively).The Investigation revealed that the third blend, consisting of D83+E15+S2, provided the best performance, emission, and combustion characteristics. Furthermore, it has been discovered that there was an increase in break thermal efficiency and decrease in fuel consumption when engine is operated with AAONP. At full load, the nitrogen oxide emissions for the blend augmented with AAONP75 were comparable , this study suggests that the use of fuel additives, particularly AAONP, can have a significant impact on the performance and emissions of DI-diesel engines. The findings also highlight the importance of optimizing fuel blends to achieve the desired balance of performance and emissions characteristics. drop.

KEYWORDS: DI-Diesel engine, Diesel, Ethanol, Aqueous aluminum oxide, Surfactant, performance, Emission, Combustion.

I. INTRODUCTION:

Nanoparticles are a new category of additives that contain suspended nanoparticles that are less than 40 nm in size. The addition of aluminum oxide nanoparticles to the mixes encourages complete combustion and serves as an oxygen buffer, boosting the thermal effectiveness of the brakes (Karthikeyan which raises the flash point temperature. Fuel with nanoparticles added is inherently safer to handle than base fuel (Ajin et al., 2013). The addition of CERIA prolongs the ignition delay, which causes more fuel to accumulate during the premixed combustion phase, which speeds up combustion and raises peak pressure (Vairamuthu et al., 2011). When using a water-diesel-nano fluid emulsion as diesel engine fuel, less carbon monoxide and hydrocarbon emissions were produced than when using diesel fuel (Sasi Kumar et al., 2015) Aqueous aluminum nanoparticles are used as diesel engine additives to increase total combustion heat and reduce smoke and nitrous oxide emissions in the exhaust (Mu-Jung Kao et al., 2008). By acting as a catalyst, cerium oxide lowers NOx and enhances combustion (Arul MozhiSelvan et al., 2009). The inclusion of cerium oxide lowers the light-off temperature and considerably speeds up oxidation (Heejung Jung et al., 2005). Aluminum nanoparticles can serve as energy carriers and catalysts. Aluminum oxide has a variety of properties, including high thermal conductivity, low melting and ignition temperatures, environmental stability, and the ability to be recycled back into pure aluminum via an electrolytic reduction (Matthew Jones et al., 2011). In diesel ethanol blends, adding aqueous cerium oxide nanofluid as an additive reduces emissions including HC, CO, and smoke, although there is a minor increase in NOx emission that is still within allowable limits (Ravichandra Ganesh et.al 2015). Using nanoparticles results in a high surface area to volume ratio, which can significantly enhance the amount of mixture of fuel with oxidizer. Moreover, it affects the rate of chemical reactions, which reduces the ignition delay (Shafii et al., 2011). When compared to diesel fuel, smoke emissions were decreased while using bioethanol diesel blends; this is because the fuel's increased oxygen content inhibited the formation of soot in the fuel-rich zone (Hwanam Kim et al., 2010). When 10% ethanol and diethyl ether were added to biodiesel, it was found that there were no differences in emissions when compared to diesel fuel; this is due to the intricate interactions among variables including combustion temperature, reaction time, and oxygen content (Pushparaj et al., 2013). Compared to iron oxide nanoparticles, aluminum oxide nanoparticles (AONP) are effective in increasing performance and lowering harmful exhaust emissions (Syed Aalam et al., 2015). When AONP is added to diesel fuel, it is seen that diffusion combustion shortens, causing an increase in cylinder pressure (Syed Aalam et al., 2015). Due to its lower temperature efficiency, which causes incomplete fuel combustion, diesel fuel emits more carbon monoxide than n-al2O3 mixed fuels (Venkatesan et al., 2015). According to Srinivasa Rao et al. (2015), normally oxygenated fuel blends result in the complete burning of the fuel in the combustion chamber at high temperatures, which increases NOx emission at the exhaust.

II. Experimental Setup and Procedure: An air-cooled, single-cylinder diesel engine

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with four-stroke direct injection and naturally aspirated combustion was used to test the engine's performance and emission characteristics. A graduated burette is attached to the gasoline tank to measure how much fuel is used per unit of time. To regulate engine speed and load,

the engine was connected to an eddy current dynamometer. Fig. 1 depicts the experimental setup's schematic arrangement. Table 1 lists the specifics of the engine specifications. The attributes of the fuels are listed in Table 2 and were utilised to generate the engine fuel mixes of diesel, ethanol, and aqueous aluminium oxide nano fluids. Surfactant prevents the phase separation of diesel and ethanol fuel (span 80). To increase the stability of the blended combination, the mixture was created using an ultrasonic sonicator that blends at a high speed in an ultrasonic bath. To create a homogenous mixture without nanoparticle segregation, use a steady agitation time of 30 minutes using an ultrasonic sonicator. A calibrated K-type chromel-alumel thermocouple is used to detect the temperature of the exhaust gas. The AVL-444 Digasanalyzer was used to measure the exhaust emissions of CO, HC, and NOx. The Botch smoke metre is used to gauge the opacity of the smoke.

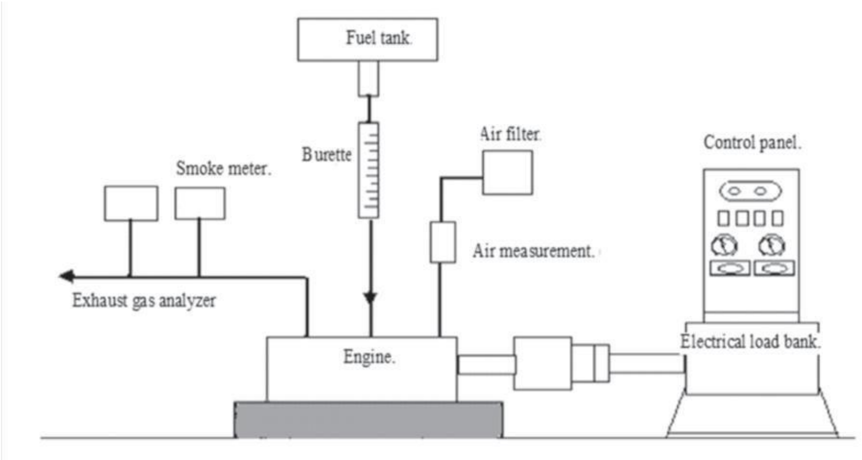

Fig.1. SchematicdiagramofengineSetup

Table :1 Engine Specifications

Brake Power	4.4KW
Speed	1500Rpm
Compression Ratio	17.5:1

Bore	87.5mm
Stroke	110mm
Type of ignition	Compression ignition
Loading system	Eddy current Dynamometer

Table:2: Properties of Diesel and Ethanol

Fuel	Diesel	Ethanol
Formula	$C_{14} H_{30}$	CH CH OH
Molecular weight (g/mol)	198.4	46.07
Density (g/cm^3)	0.856	0.785
Normal boiling point (^{0} C)	125-400	78
LHV (Mj/kg)	41.66	26.87
Carbon content (Wt%)	87	52.2
Cetane number	46	6

Pressure transducer and rotary encoder convey the engine cylinder's fuel combustion phenomenon to the AVL combustion analyzer. It was afterwards transformed and delivered to the computer. Using neat diesel to start and warm up the engine before moving to mixed mixes is the method used for all tests. In order to remove the fuel mixture from the fuel line and the injection system, the engine is operated with neat diesel after the test.

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that are widely used to indicate the presence or absence of light or to quantify light power. A photoresistor is a semiconductor with high obstruction. If the light landing on the device is of adequate frequency, photons consumed by the semiconductor provide bound electrons with enough energy to go into the conduction band. The succeeding free electron (and its first accomplice) lead power, knocking down opposition.

LDRs, often referred to as photoresistors, are minuscule light-sensi

III. Experimental Fuels:

Local diesel outlets provide the commercial diesel fuel utilised in the fuel preparation. From Reinste nano Ventures Pvt. Ltd. in New Delhi, AAONP fluid is purchased. On the local market in Chennai, ethanol (purity 99.9%) and span80 are bought.

Preparation of Fuel:

The amount of aluminium oxide particles that were dosed into the diesel ethanol fuel ranged from 50 to 75 ppm. In order to create a homogenous mixture without nanoparticle segregation, aqueous aluminium oxide nanoparticles and diesel ethanol fluid are mixed using an ultrasonic sonicator for a constant agitation time of 30 minutes. Surfactant prevents the phase separation of diesel and ethanol fuel (span80).

Determination of Fuel Properties:

The calorific value, viscosity, and flash and fire points were tested using conventional test methods. Fuel characteristics are measured using ASTM standard procedures. The Pensky-Martens closed cup apparatus was used to measure the flash point at temperatures between 50 and 190° C. A bolt viscometer, for example, is used to test viscosity, and a bomb calorimeter was used to determine the fuel mixture's calorific value. Table 3 is a list of the characteristics of the study's experimental fuel.

Table3. PropertiesofDieselandAAONPBlend

Fuel	Diesel	50ppm AAONP Blend	75ppm AAONP Blend	Code
Flash point (^{0} C)	50	58	59	ASTM D93
Kinematic viscosity @ 40^0 C (cSt)	2	3.17	3.0	ASTM D445
LHV (Mj/Kg)	41.66	41.70	41.84	ASTM D240

RESULTS AND DISCUSSION

Performance Characteristics

Performance The following section includes a brief discussion of characteristics like brake thermal efficiency and brake-specific fuel consumptions.

Brake Thermal Efficiency

In comparison to diesel fuel, the inclusion of AAONP nanoparticles increases brake thermal efficiency. This improvement is brought about by the nanoparticles' promotion of hydrogen H involvement in the combustion process, which raises the temperature of the combustion combustion chamber. According to Fig. 2, there is an increase in BTE of 6.9% when AAONP75 is added to fuel blends compared to diesel fuel.

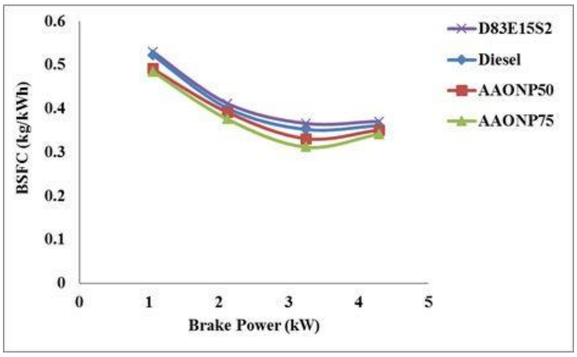

Fig.2. BTE Variation with load

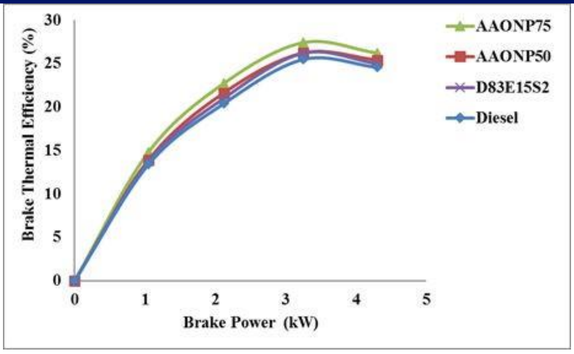

Fig.3.BSFC Variation with load

Emission Characteristics

Carbon Monoxide(CO)Emission

When compared to diesel fuel, aluminium oxide nanoparticles significantly reduce CO emissions because they operate as an oxidation catalyst and cause complete combustion with higher carbon combustion. When compared to diesel fuel, AAONP75 has a 19% CO decrease. As depicted in Fig. 4, the CO emission VS load graph.

HydroCarbon(HC)Emission

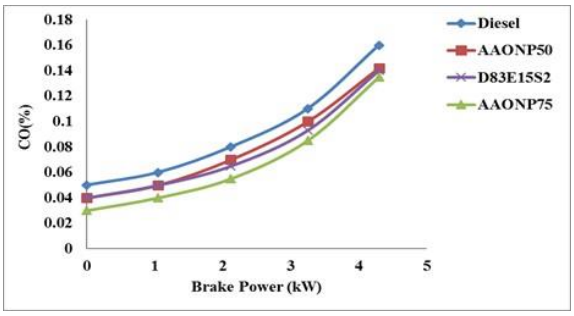

Fig.4. CO Emission variation with load

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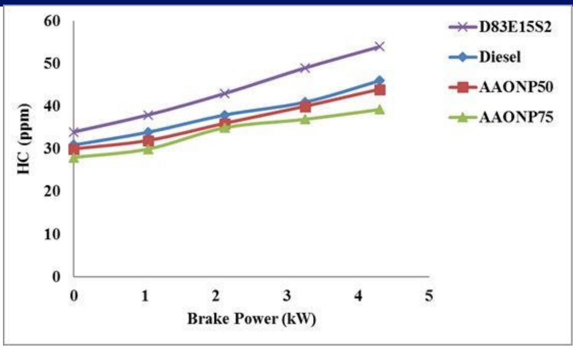

Fig.5. HC emission variation with load.

A graph of how HC emission changes with load is shown in Fig. 5. AAONP increases the oxygen content of fuel blends, enables complete combustion, and reduces HC emissions by 17% when added to fuel blends as compared to diesel fuel. A graph between NOx and load is shown in Fig.

6. When AAONP is added to fuel blends, there is a complete combustion, which raises the temperature of the exhaust gas and produces more NOx than diesel fuel does. Comparing AAONP75 to diesel fuel results in a 6% increase in NOx emissions; however, AAONP50 results in a comparable increase in NOX emissions.

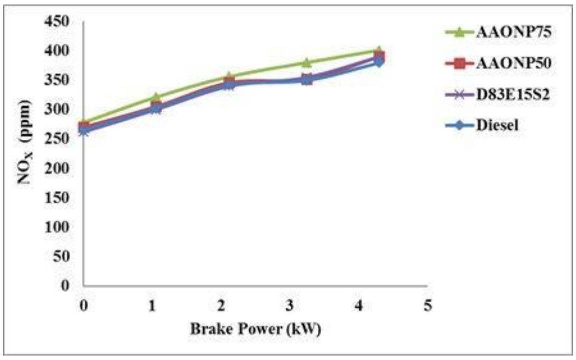

Fig.6.NO_XEmission variation with load

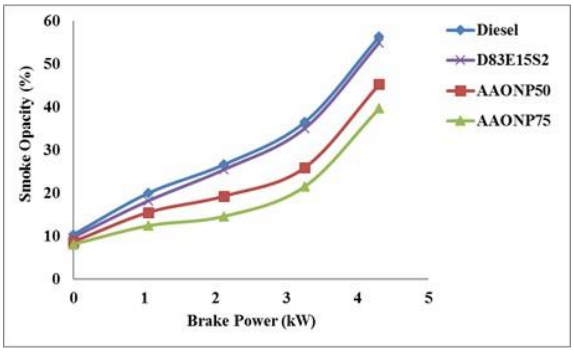

Fig.7. Smokeemission variation with load.

Smoke Emission

The graph of smoke emission change with load is shown in Figure 7. More smoke is released from the exhaust as the load increases. The amount of smoke at the exhaust is reduced when AAONP is added to the fuel blends. When using AAONP 75 in place of diesel fuel, smoke emissions are reduced by 42%.

CONCLUSION

The key observations and findings of the experiments, which compared many features including physicochemical, performance, emission, and combustion with diesel fuel, are presented below. The experiments were conducted at different dosage levels of nanoparticles (50 ppm and 75 ppm) to the blends.In comparison to diesel fuel, it was discovered that adding nanoparticles to blends of diesel, ethanol, AAONP, and surfactant fuel raised their flash points. By adding nanoparticles, the viscosity of the blend was raised in comparison to diesel fuel. It is concluded that the presence of nanoparticles directly affects the viscosity and flash point. In a performance test, it was shown that adding nanoparticles in various dosages improved engine performance. It was also discovered that using AAONP significantly reduced exhaust emissions such HC, CO, and smoke when compared to using diesel fuel. Moreover, it has been found that AAONP are thermally stable, encourage the oxidation of hydrocarbons, and result in a decrease in emissions.The size of the nanoparticles and their dosage levels are still being tested in order to enhance performance and lower combustion pressure, NOx emissions, and heat release rates.

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