NHSEMH - 2023
2nd National Conference on New Horizons in Science, Engineering, Management and Humanities
International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

Impact of Hydrous Ethanol-Diesel-Al_2O_3 Nano Emulsified Fuel on Diesel Engine Performance

Akash Kumar[1], Vishal Vasistha[2]
[1]M.Tech. Student, [2]Assistant Professor
Department of Mechanical Engineering, IIMT College of Engineering Greater Noida, Uttar Pradesh, India

ABSTRACT

The environmental degrade and the fossil fuels diminishment are stimulating the world's desire to discover novel, effective and efficient alternate renewable fuels. The emulsified fuels have gained a lot of attention in the current years to supersede the conventional petroleum fuels. The aim of the present work was to study the hydrous ethanol-diesel-Al_2O_3 nano emulsified fuelen TR-2 and it's testing on 4-cylinder, turbocharged and water-cooled common rail direct injection diesel engine. Authors reported improved diesel engine performance, combustion and emission characteristics with hydrous ethanol-diesel-Al_2O_3 nano emulsified test fuels. HEDA emulsified fuel combustion can exhibit a toxic effect on living beings and the environment in the prolonged period of time because of the presence of Al_2O_3 nano particles.

I. INTRODUCTION

Limited stocks of conventional petroleum fuels (gasoline and diesel) and severe degradation of environment encourages the whole world to find the most suitable alternative fuel in terms of cost, application, availability, engine components compatibility and environment friendly [1]. Water addition in diesel blended fuels reduces environment harmful pollutants nitrogen oxides (NO_x) and particulate matters (PM) in significant amount because of temperature lowering and micro-explosion phenomenon respectively [2, 3]. Proposed emulsified fuel eliminates the exhaust gas after-treatment system that avoids any modification into engine with reduced cost and complexity [3]. Several benefits of ethanol blending make it superior alternative renewable fuel source over others such as efficient combustion, high energy density, lower pollution, non-toxic and non-corrosive nature, easy storage & distribution and applicability to all types of vehicles [4, 5]. Aluminium oxide (Al_2O_3) nano material is the cheapest and mostly used among all nano materials which improve cetane number, calorific value (CV), brake specific fuel consumption (BSFC), brake thermal efficiency (BTE), heat release rate (HRR), cylinder pressure and exhaust emissions. Engine performance improvement by blending of Al_2O_3 nano particle compromises the negative effect of lower CV value of water [6, 7].

II. LITERATURE REVIEW

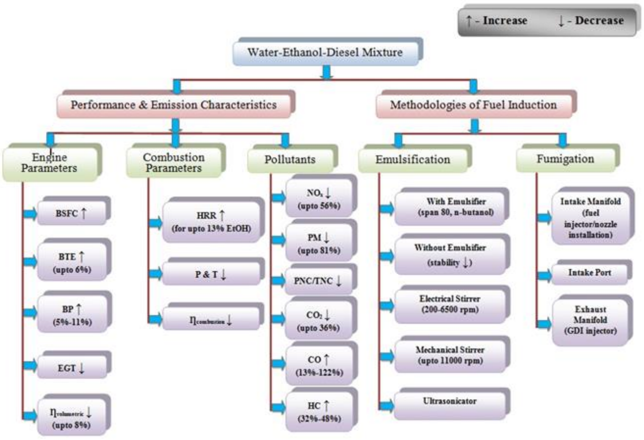

Figure 1: Conclusive literature review schematic diagram showing effect of hydrous ethanol-diesel (HED) mixture on performance, combustion and emission characteristics of diesel engine with methodologies of fuel induction

III. METHODOLOGY

Emulsified HEDA fuel blends will be prepared in five stages. In the first stage, mixture of Span-80 (HLB-4.3) and Tween-80 (HLB-15) in the concentration of 2% will be prepared by the use of ultrasonicator at high frequency 40 kHz at 30°C for 30 minutes or till both the surfactants mixed thoroughly. To prepare surfactants mixture, volume percentage of both the surfactants will be measured by the following relation to achieve the suitable HLB value 10 for HEDA blends:

$\% (A) = \{(X - HLB_B) \times 100\} / \{HLB_A - HLB_B\};$

$\% (B) = 100 - \% (A)$

Where A, B are surfactants, X is the required HLB value. By considering (A) as Span-80 and (B) as Tween-80, we will get 46.7% of Span-80 and 53.3 % of Tween-80.

In the second stage, Pemulen TR-2 (0.4%) will be mixed slowly into rapidly agitating Triple demineralized water (blend specification) using magnetic stirrer at 750 rpm and 30°C for 15 minute until Pemulen TR-2 powder is wetted in the solution completely. In this stage, foaming may occur.

In the third stage, ethanol (blend specification), diesel (blend specification) and surfactant (2% fixed) will be combined by mechanical agitator for approx. 15 minutes at about 1200 rpm. In the fourth stage, second stage prepared solution and neutralizing alkali NaOH (18% solution-0.5 parts of Pemulen TR-2) or Triethanolamine (2 parts of Pemulen TR-2) or Amino methyl propanol (1.5 parts of Pemulen TR-2) will be mixed into running third stage solution at same operating conditions as in third stage (mechanical agitator, 15 minutes, about 1200 rpm)..

In the fifth stage, Al_2O_3 nano particles (100 ppm) will be added into the solution prepared in fourth stage with the aid of ultrasonicator at a frequency of 40 kHz for 30 minutes at 30°C. The ultrasonication technique is the best suited technique for nano particles dispersion to prevent agglomeration of nanoparticles into base fluid. Check pH after sixth stage. PH should be 7.3 to 7.8. If pH is too high, start test procedure again and holding out a small amount of neutralizer.

IV. DIESEL ENGINE EXPERIMENTAL SETUP

The engine setup consists of turbocharged four cylinder water cooled four stroke CRDi diesel engine coupled with eddy current dynamometer for obtaining different loading conditions. Turbocharger is of variable geometry type (VGT) and ECU controlled. The engine setup includes all necessary instruments and sensors like temperature sensor, pressure sensor, position sensor, and speed sensor etc. for measuring the coolant temperature, fuel temp., inlet air temp., manifold pressure, fuel pressure, atmospheric pressure, camshaft and crankshaft position. The setup has electronic panel which consists of fuel tank, load indicator, speed indicator, fuel measuring unit, air box, dynamometer loading unit, engine and calorimeter rotameter. Engine and calorimeter rotameter give us water flow rate to engine and calorimeter. The computer will be connected with our engine and electronic panel with the help of “Engine Soft” software. The setup has capabilities to find parameters to evaluate combustion and performance characteristics. For measurement of exhaust emissions HC, CO, CO_2 and NO_x, AVL 4000 Di-Gas Analyzer will be used and smoke opacity will be measured with the help of AVL 437 smoke opacity meter. The actual picture of proposed C.I. engine test rig, AVL 4000 Di-Gas Analyzer and AVL 437 smoke opacity meter is shown in Figure 2, 3, and 4 respectively. Detailed specifications of the engine are given in the Table 7.

Figure 2: Actual picture of multi-cylinder C.I. research engine

S. No.	Description	Specification
1	No. of Cylinders	04
2	Volume	1994 cc
3	Bore x Stroke (mm)	84.45 X 88.95
4	No. of Valves per Cylinder	02
5	Camshaft	SOHC (Belt Drive)
6	Compression Ratio	17.5:1
7	Firing Order	1-3-4-2
8	Cooling	Water Cooled (Mechanical Fan)
9	Fuel Injection	Common Rail Direct Injection
10	Injection Pressure	1400 bar (Max.)
11	Turbocharger	VGT – Variable Geometry Turbocharger (ECU Controlled)
12	EGR	Cooled, ECU Controlled
13	Injectors	Piezo Technology
14	Injector – No. of Holes	08
15	Torque/Power	260 Nm @1750 – 2500 RPM, 90 hp@4000 RPM

Table 1: Engine Specifications

V. EXPERIMENTAL MATRICES

The following experimental matrices will be followed during the investigation.

Type of Fuel	Brake Load	Performance, Combustion and Emission Characteristics
Diesel HEDA I HEDA II HEDA III HEDA IV HEDA V	No Load, 20% Load, 40% Load, 60% Load, 80% Load, 100% Load	Brake Power, Torque, Fuel Consumption, Brake Thermal Efficiency, Volumetric Efficiency, Lubricating Oil Temperature, Cylinder Head Temperature, Exhaust Gas Temperature Pressure – Crank angle Diagram, Heat Release Rate pattern, Ignition Delay, Rate of Pressure rise Exhaust Emissions (UBHC, CO, CO_2, PM & NO_x)

Table 2: Experimental matrices

VI. REFERENCES

[1]. MacLean HL, Lave LB. Evaluating automobile fuel/propulsion system technologies. Progress in Energy and Combustion Science 2003, 29:1-69.

[2]. Khan MY et al. Current Trends in Water-in-Diesel Emulsion as a Fuel. Hindawi Publishing Corporation, The Scientific World Journal 2014, Article ID 527472, 15 pages.

[3]. Bach F et al. Influence of diesel-ethanol-water blended fuels on emissions in diesel engines. Research Emissions, MTZ 2011, Vol. 72:62-68.
[4]. Central Pollution Control Board, India. Alternative transport fuels an overview – A newsletter, 2003.
[5]. Nebraska Ethanol Board and Clean Fuels Development Coalition. Ethanol blended fuels: A study guide and overview.
[6]. Aalam CS, Saravanan CG. Performance enhancement of common-rail diesel engine using Al2O3 and Fe3O4 nanoparticles blended biodiesel. International Research Journal of Engineering and Technology (IRJET) 2015, Vol. 02, Issue 05, pages 1400-1410.
[7]. Venkatesan H et al. A comprehensive review on the effect of nano metallic additives on fuel properties, engine performance and emission characteristics. International Journal of Renewable Energy Research 2017, Vol. 7, Issue 2, Pages 1-22.