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Performance Analysis of Bio-Diesel Blend (B20) Mixing with the Nanoparticles of AL_2O_3

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***Abstract*: The main theme of this project is to analyze the performance Bio-Diesel blend (B20) mixing with the nanoparticles of AL_2O_3 (0.025g) to reduce the gas emissions like CO, CO2 and NO_x etc compare to the conventional fuels like Diesel and Petrol and to reduce usage of conventional fuels by improving the efficiency and performance of the given Bio-Diesel blend (B20 i.e. 80% Diesel and 20% cotton seed oil) by adding the Al_2O_3 (0.025g) nanoparticles. In this way we can reduce the demand of conventional fuels like petrol and diesel.**

***Keywords*: Bio-Diesel, Cotton seed oil, Ultrasonicator, Transesterification.**

1. Introduction

Bio-Diesel is the Bio-Fuel which is the best alternative of the usual Diesel used in the Engines. It is produced by the decomposition of vegetable oils obtained from the plants. Bio-Diesel has the same composition just like mineral diesel. It is observed that people who use Bio-Diesels in their Diesel engines do not face any difficulty and their engine runs as smooth as before and in some cases even better. In this experiment the Bio-Diesel blend (B20) is prepared and mixing with nanoparticles of AL_2O_3 (0.025g) with aid of Ultrasonicator. And analyzed the performance the blend to reduce the gas emissions like CO, CO2 and NO_x etc compare to the conventional fuels like Diesel and Petrol and to use the blend as the substitute of conventional fuels.

A. Preparation of the blend

1) Transesterification

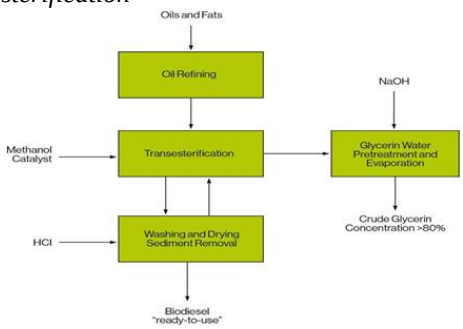
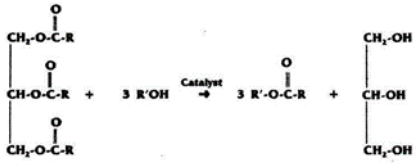


Fig. 1. Transesterification process

Modifying the vegetable oil can be achieved in many ways including Pyrolysis, Micro-emulsification, Dilution and Transesterification. Among these, Transesterification is the most commonly used commercial process to produce clean and environmentally friendly light vegetable oil fuel i.e. Bio-Diesel. The fatty acid triglycerides themselves are esters of fatty acids and the chemical splitting up of the heavy molecules giving ride to simpler esters is known as Transesterification. The triglycerides are reacted with a suitable alcohol in the presence of a catalyst under a controlled temperature of 60C to 70C for a given length of time. The final products are Alkyl esters and Glycerin. The Alkyl esters having favorable properties can be used as fuel in C.I engines is the main product and the Glycerin is a by-product. The chemical equation of the transesterification is given as



2) Preparation of Nano-Fluid of AL_2O_3 (0.025g)

The Nanoparticles Bio-Diesel is prepared by mixing the aluminum oxide nanoparticles (AL_2O_3) in the cotton seed oil with the aid of an Ultrasonicator. The Ultrasonicator technique is the suited method to disperse the nanoparticles in base fuel i.e. cotton seed oil as it facilitate possible agglomerate nano particle back to nanometer range. Nanoparticles are generally having higher surface area and hence surface energy will be high and it will tend to agglomerate to form a micro molecule and starts to sediment. In order to make nanoparticle to be stable in a base fluid, it should be evolved to surface modification, TWEEN 80 & SPAN 80 is a cationic surfactant and it forms an envelope on the surface of the particle and makes the surface as a negative charge. Hence the particle sedimentation was controlled. In order to disperse the nanoparticle to base fluid ultrasonication procedure was followed. A known quantity of additive and of CTAB were weighed and poued in the Bio-Diesel and ultrasonicated for 1 hour. Then it forms a stable Nano-fluid.

2. Literature review

V.K Shahir, C.P Jawahar, P.R SUresh. They have decribed Bio-Diesel as renewable, nontoxic, eco-friendly and sustainable alternative fuel for compression ignition engines. In spite of having some application problems, Bio-Diesel in recent times being considered as one of the most promising alternative fuels in internal combustion engine. It has been proven that the pollutants in the vehicular emissions have significant impact on the ecological systems and on the health of human being. Bio-Diesel use, when compared to diesel as a fuel in conventional diesel engines with little or no more modification leads to the substantial reduction in particulate matter (PM), Hydro carbon (HC) and Carbon monoxide (CO) emissions. This is accompanied by a light power loss, increase in fuel consumption and an increase in nitrogen oxide (NOx) emissions.

3. Test procedure

After engine start, the engine must warm up commences with a 2-3 minutes idle period. After the idle period, the engine loaded with no load i.e.0, 3, 6, 9 and full load i.e. 12 in steps and allow the engine stabilized at each load maintaining a constant speed of 1500 r.p.m. Recorded all the required readings in the given tables. Then calculate the necessary parameters for the blend and compared the values with conventional fuel i.e. diesel in order to analyze the performance the blend (B20) mixing with the nanoparticles AL_2O_3 (0.025g). At first all readings are taken and tabulated in table 1a and 1b with the diesel as fuel. And then again the readings are taken and tabulated in table 2a and 2b with the Bio-Diesel mixing with the nanoparticles AL_2O_3 (0.025g) as fuel. Here the reading of tables 1a and 1b are useful to analyze the nano fluid Bio-diesel.

4. Calculations

1. Brake Power (B.P) = $\frac{2\pi NR(S1-S2)(9.81)}{60{,}000}$ kW

   N-Speed (1000) r.p.m
   R-Effective radius of brake drum (0.171) in meters
   S1-Load on rear end of the spring
   S2-Load on front end of the spring

2. Fuel Consumption/hour (F.C/hr) = $\frac{x(Sp.Gravity)(3600)}{t(1000)}$ Kg/hr

   x- Quantity of the fuel (10 ml)
   t- Time in seconds

3. Brake Specific Fuel Consumption (BSFC) = $\frac{F.C}{B.P}$ Kg/kW hr

4. Brake Thermal Efficiency (η_{bth}) = $\frac{B.P(3600)(100)}{(F.C)(C.V)}$ %

Table 1a
Performance of the engine runs with Diesel

Load	CR	BP	FP	IP	BMEP	IMEP	BTHE	ITHE	Mech Eff
0	18	0.1	1.9	2.1	0.12	2.35	2.55	50.30	5.07
3	18	0.9	1.8	2.7	1.04	3.13	15.28	46.09	33.14
6	18	1.7	1.7	3.4	2.09	4.09	23.02	45.00	51.17
9	18	2.5	1.7	4.2	3.05	5.07	26.96	44.81	60.17
12	18	3.3	1.5	4.8	4.12	5.93	30.24	43.47	69.56

Table 1b
Characteristics of engine run with Diesel

Load	Air Flow	Fuel Flow	SFC	Vol Eff	A/F	HBP
0	27.07	0.35	3.36	73.69	77.66	2.55
3	26.48	0.50	0.56	73.35	53.18	15.28
6	25.82	0.65	0.37	73.51	39.89	23.02
9	25.37	0.80	0.32	73.08	31.84	26.96
12	24.83	0.95	0.28	72.55	26.24	30.24

Table 2a
Performance of the engine runs with blend of Bio-Diesel (B20) and AL_2O_3

Load	CR	BP	FP	IP	BMEP	IMEP	BTHE	ITHE	Mech Eff
0	18	0.01	1.9	1.9	0.01	2.28	0.22	38.39	0.58
3	18	0.9	2.2	3.1	1.13	3.37	11.81	39.05	30.24
6	18	1.7	1.9	3.6	2.06	4.33	18.00	37.95	47.42
9	18	2.5	1.7	4.2	3.09	5.17	20.16	33.79	59.68
12	18	3.3	1.6	4.9	4.11	6.03	21.55	31.65	68.09

Table 2b
Characteristics of engine run with blend of Bio-Diesel (B20) and AL_2O_3

Load	Air Flow	Fuel Flow	SFC	Vol Eff	A/F	HBP
0	26.15	0.49	45.03	73.76	62.83	0.22
3	25.75	0.79	0.84	73.17	32.52	11.81
6	25.56	0.94	0.55	73.05	27.17	18.00
9	24.84	1.24	0.49	72.35	20.07	20.16
12	24.46	1.53	0.46	71.52	15.94	21.55

5. Mechanical Efficiency (η_{mech}) = $\frac{B.P}{I.P} \times 100$ %

I.P = B.P + F.P

6. Indicated Thermal Efficiency (η_{ith}) = $\frac{I.P(3600)(100)}{(F.C)(C.V)}$ %

5. Performance analysis

After the perform the test on the Diesel and the prepared Bio-Diesel mixing with the nanoparticles of AL2O3 (0.025g), the values of the different parameters like Brake Power (B.P), Compression Ratio (CR), Friction Power (F.P), Indicated Power (I.P), Brake Mean Effective Pressure (BMEP), Integrated Mean Effective Pressure (IMEP), Brake Thermal Efficiency (BTHE), Indicated Thermal Efficiency (ITHE) and Mechanical Efficiency (Mech Eff.) are Tabulated below the tables 1a and 2a. And the characteristic parameters like air flow, fuel flow, specific fuel consumption (SFC), Volumetric Efficiency (Vol Eff.) and air fuel ratio (A/F) are tabulate in the tables 1b and 2b. These are useful to analyze the bio-fuel.

Gas emissions: AIR REX HG-5404 Gas Emission Analyzer is used to examine the emissions of the prepared nano fluid blend (B20 with AL_2O_3) and the conventional fuel i.e. Diesel. The gas emissions such as Hydrocarbons (HC), CO, CO_2, O_2 and NOx of the fuels are tabulated in the table 3.

Table 3a
Gas emissions of Diesel

Load	HC (ppm)	CO (%)	CO_2 (%)	O_2 (%)	NO_x (ppm)
3	39	0.129	3.18	16.50	263
6	79	0.195	5.20	14.67	617
9	79	0.196	5.21	14.77	620

Table 3b
Gas emissions of the blend B20 with AL_2O_3

Load	HC (ppm)	CO (%)	CO_2 (%)	O_2 (%)	NO_x (ppm)
3	46	0.229	2.93	16.55	63
6	31	0.174	3.90	14.03	374
9	42	0.120	5.60	11.93	1286

Fig. 2. Load vs. Specific fuel consumption

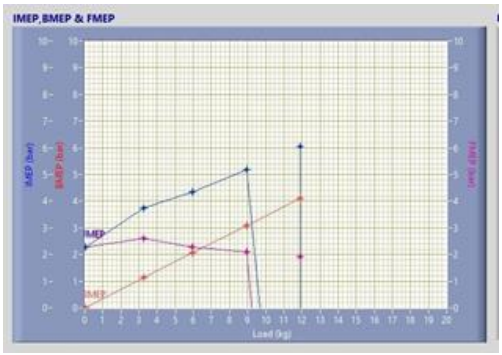


Fig. 3. Load vs. IMEP, BMEP & FMEP

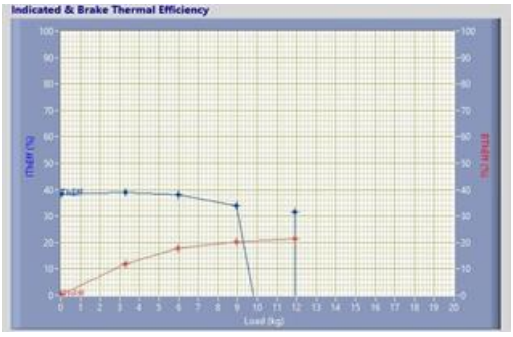


Fig. 4. Load vs. Indicated & Thermal Efficiency

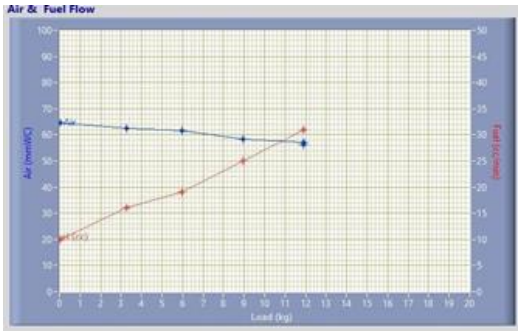


Fig. 5. Load vs. Air & Fuel Consumption

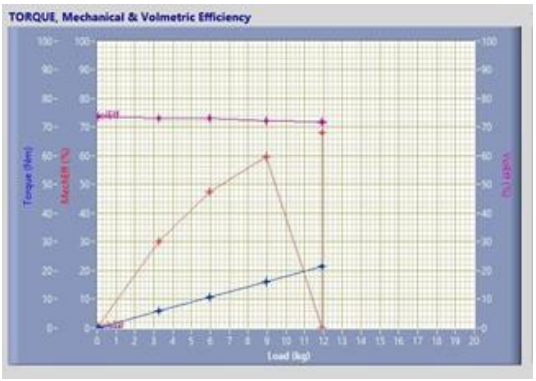


Fig. 6. Load vs. Mechanical & Volumetric Efficiency

6. Conclusion

The Bio-Diesel blend mixing with the nanoparticles AL_2O_3 has Brake thermal efficiency very close to the Diesel at all loads and thus can be considered as suitable fuel blend. And the

mechanical efficiency for B20 mixing with AL_2O_3 is very close to Diesel at all loads. The Indicated mechanical efficiency of the blend B20 mixing with AL_2O_3 is better than the diesel. The gas emissions also reduced compare to the diesel.

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