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Characterization of Fuel Properties of WCOME/AONP Biodiesel Using Taguchi Technique

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ABSTRACT

The fuels which are derived from the biological process such as anaerobic digestion from the agricultural wastes are called bio fuels. These fuels are better than the fuels which are produced from geological processes which are involved in the formation of fossil fuels such as coal and petroleum. The fuels can also be extracted from the plants and industrial wastes which are renewable in nature. The biomass can also be used as biofuel which gives a good result in testing of engine performance. The biomass is obtained in three forms like solid, liquid and gaseous.

Biodiesel, as a fuel, can be used in vehicles directly, but due to emission effects, it is mixed with the diesel which reduces the level of carbon-dioxide and NOx. In European countries it can be seen the use of biodiesel which are produced from fats and oils using the transesterification process. The aim of the present research work is to compare different Biodiesel blends from different percentages of waste cooking oil as a suitable fuel replacement for Diesel engines. Engine performance based on the blends of Diesel and Biodiesel was recorded and tabulated.

Keywords : Biodiesel, WCOME, Flash and Fire Point, Taguchi

I. INTRODUCTION

The Indian economy is heavily dependent on fossil resources for transportation of all types of goods. But in recent times, there has been a growing realization that the availability of these fuel sources are harmful to the environment and are also depleting. [1] This depletion has led to research in the alternate energy sources sector, where biodiesel or biofuels in general are in the forefront. To obtain a desired component the technology used for this transformation and the component used as feedstock for the biomass, at least three general platforms have been envisioned: the sugar [2], synthesis gas [3], and oil [4] platforms. Today, the best platforms established are from oil and sugar, with bioethanol and biodiesel being the examples of their commercial products respectively. Bio ethanol is produced through microbial fermentation of sugar derived from corn, sugarcane or sugar beet [5].

Esters are created by transesterification process using vegetable oils with alcohol that leads to delivery of Biodiesel [4]. Given the expanding interest for bio powers [6], there is a critical need to research new and more proficient choices for their creation. For instance, the change of lignocelluloses biomass to ethanol and the utilization of oil amassing green growth in the creation of biodiesel are being explored [7, 8]. These methodologies are exceptionally encouraging and will give plentiful non food feedstocks to the creation of bio fills with natural advantages and huge net energy gains. Be that as it may, a remarkable issue in both current and future biofuel creation stages is financial practicality. The execution of bio processing plants has been proposed as a way to build the financial practicality of the biofuel business [9]. In its 'regular' structure, a bio processing plant would utilize a negligible part of the feedstock to co - produce a higher worth, little - market synthetic alongside the biofuel. The higher income from the co - item, which benefits itself from economies of scale accessible in an enormous bio energizes plant, would work on the financial aspects of biofuel creation. An all the more financially reasonable model for a bio treatment facility, nonetheless, ought to consider the utilization of results or waste streams created during the development of biofuel. Glycerol-rich streams created by the bio fills industry can possibly be utilized in this specific situation. As its name proposes bio diesel is a fuel oil got from natural sources. Bio-diesel is a locally delivered, inexhaustible fuel that can be produced from vegetable oils, creature fats, or reused eatery lubes and it can supplant petroleum derivative [10]. Bio-diesel has become more appealing as of late as a result of its natural advantages and the way that it is produced using inexhaustible assets [11]. Biodiesel has exhibited various promising attributes, including decrease of fumes discharges [12]. Albeit momentary tests utilizing flawless vegetable oil showed promising outcomes, longer tests prompted injector coking, more motor stores, ring staying and thickening of the motor oil. These encounters prompted the utilization of adjusted vegetable oil as a fuel. Despite the fact that there are numerous ways and systems to change over vegetable oil into a Diesel like fuel, the trans-esterification process was viewed as the most practical oil adjustment process [13]. Over 100 years prior, Rudolph Diesel tried vegetable oil as the fuel for his motor [14]. Albeit vegetable oils can be utilized in diesel motors yet because of high consistency, low unpredictability and unfortunate virus stream properties it creates many issues [15]. There are in excess of 350 oil bearing harvests recognized, among which just sunflower, safflower, soybean, cottonseed, rapeseed and nut oils are considered as possible elective powers for Diesel motors [16]. Trans-esterification was notable as soon as 1864, when Rochleder portrayed glycerol readiness through ethanolysis of castor oil [17-18].

II. EXPERIMENTAL PROCEDURE

At 1450rpm rated speed maintaining 22 degree BTDC(Before Top Dead Centre), the experiments are carried out for diesel and biodiesel. The experiments were conducted using B10 (10% WCOME, 100% diesel), B20 (20% WCOME, 80% diesel), B30 (30% WCOME, 70% diesel), B40 (40% WCOME, 60% diesel) under different load conditions on the engine and the results are presented in Table 3. The Injection Pressure was varied (160, 180, 200 and 220 bar). After each experiment the fuel was replaced and cleaned and the engine was left idle for about 30min without operating to stabilize for the next test. Figure 1 shows the whole engine assembly used for the experiment. The engine exhaust (CO, HC, CO2, O2, and NOx) was analysed and calculated by AVL DIG AS 444 gas analyser fitted with DIGAS SAMPLER at the exhaust. The orthogonal array selected for the present research work is given below.

TABLE 1: ASSIGNMENT OF THE LEVELS FOR L16 ORTHOGONAL ARRAY FOR ENGINE PERFORMANCE STUDY

PARAMETERS	UNIT	NOTATION	LIMITS			
			Level 1	Level 2	Level 3	Level 4
Load (A)	%	L	25%	50%	75%	100%
Bio-diesel (B)	%	WCOME	B10	B20	B30	B40
Nanoparticles (C)	ppm	AONP	0	25	50	75
Injection Pressure (D)	bar	IP	160	180	200	220

TABLE 2: DESIGN OF MATRIX FOR ENGINE PERFORMANCE OF WCOME/AL2O3 BIODIESEL USING L16 ORTHOGONAL ARRAY

Exp no.	Design of matrix				Load (A)	Bio-diesel (B)	Nanoparticles (C)	Injection Pressure (D)
	A	B	C	D				
1	1	1	1	1	25%	B10	0	160
2	1	2	2	2	25%	B20	25	180
3	1	3	3	3	25%	B30	50	200
4	1	4	4	4	25%	B40	75	220
5	2	1	2	3	50%	B10	25	200
6	2	2	1	4	50%	B20	0	220
7	2	3	4	1	50%	B30	75	160
8	2	4	3	2	50%	B40	50	180
9	3	1	3	4	75%	B10	50	220
10	3	2	4	3	75%	B20	75	200
11	3	3	1	2	75%	B30	0	180
12	3	4	2	1	75%	B40	25	160
13	4	1	4	2	100%	B10	75	180
14	4	2	3	1	100%	B20	50	160
15	4	3	2	4	100%	B30	25	220
16	4	4	1	3	100%	B40	0	200

III. RESULTS AND DISCUSSIONS

Load and injection pressure have zero effect on the properties of WCOME/AONP biodiesel blends. Hence these variables can be neglected during the characterization of biodiesel.

TABLE 3: EXPERIMENTAL RESULTS FOR FUEL PROPERTIES OF WASTE COOKING OIL BIODIESEL WITH NANO ADDITIVES AND DIESEL BLENDS

Sl No	Bio-diesel (%)	Nano particles (ppm)	Kinematic Viscosity @38°C cst	Density @38°C kg/m³	Flash Point °C	Fire Point °C	Calorific Value kJ/kg
1	B10	0	3.000	834.800	69.500	90.000	41950.000
2	B20	25	3.340	841.700	72.300	93.100	41521.000
3	B30	50	3.707	847.038	74.792	95.578	41061.497
4	B40	75	4.015	846.532	75.660	95.200	40361.520
5	B10	50	3.064	839.579	70.666	91.467	42159.750
6	B20	0	3.300	838.500	71.500	92.000	41400.000
7	B30	75	3.695	845.816	74.369	94.447	41020.382
8	B40	50	4.078	850.792	76.944	97.702	40523.146
9	B10	50	3.064	839.579	70.666	91.467	42159.750
10	B20	75	3.400	845.100	73.100	93.700	41690.000
11	B30	0	3.630	842.216	73.558	94.044	40857.211
12	B40	25	4.035	848.371	76.309	96.918	40422.342
13	B10	75	3.129	844.385	71.852	92.959	42370.549
14	B20	50	3.370	843.300	72.700	93.500	41607.000
15	B30	25	3.669	844.627	74.175	94.811	40959.354
16	B40	0	3.993	845.949	75.674	96.134	40321.538

Table 3 shows the experimental results for fuel properties of waste cooking oil biodiesel with varying nano additives and diesel blends. The WCOME was mixed with diesel in a 10% interval with nano additives in a 25ppm interval and then the properties were determined. The main properties under consideration were calorific value, kinematic viscosity and Density. The maximum value of the properties was seen at the biodiesel percentage of 40% and a nano additive of 50ppm except for calorific value which is seen to be maximum for a biodiesel percentage of 10% and nano additives of 75ppm. The results also indicate that the maximum value of properties reaches for the maximum percentage of biodiesel (40%).

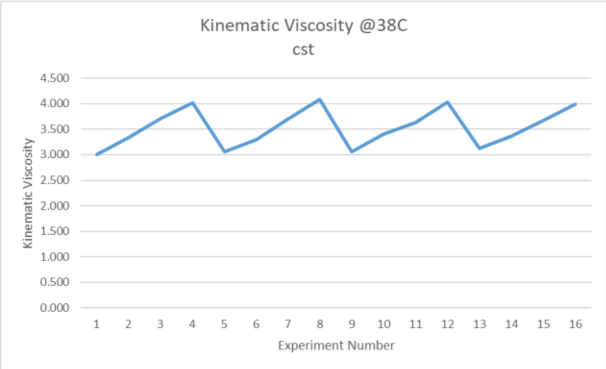

Figure 1: Graphical representation of Kinematic Viscosity vs Experiment Number

Figure 1 gives the graphical representation of kinematic viscosity vs the experiment number. The plot indicates that the value of kinematic viscosity varies with respect to the percentage of the biodiesel in the blends. The presence of nanoparticles improves the kinematic viscosity with increase in the amount of AONP in the blend. This is clearly indicated in the graph with the comparison of changes between exp numbers 5 to 6, 9 to 10 and 13 to 14. The percentages of change are 7.7%, 10.96% and 7.7%.

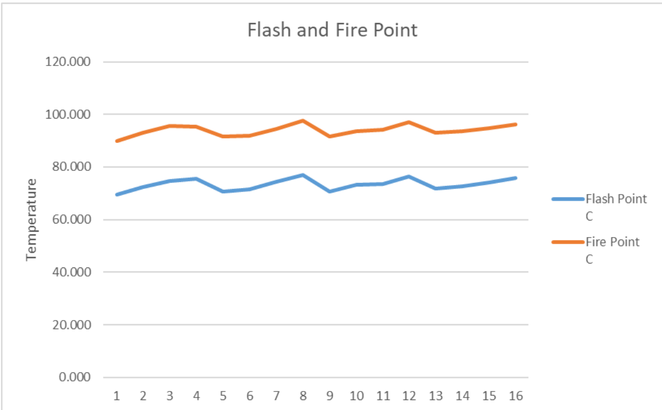

Figure 2 : Graphical representation of Temperature vs Experiment Number

Figure 2 gives the graphical representation of flash and fire point temperature vs experiment number. The plot indicates that the value of flash and fire point vary within a range of values indicating that the percentage of biodiesel and the percentage of nanoparticles have a low impact on the flash and fire point of the samples. The variation of temperature is in the range of 90°C and 97°C for Fire point and between 69.5°C and 76.944°C for the flash point.

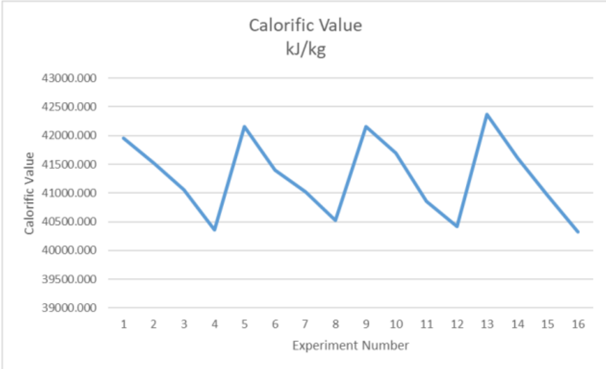

Figure 3: Graphical representation of Calorific Value vs Experiment Number

Figure 3 gives the graphical representation of calorific value vs the experiment number. The plot indicates that the calorific value varies with respect to the percentage of the biodiesel in the blends within a certain range. The presence of nanoparticles improves the calorific value with increase in the amount of AONP in the blend. This is clearly indicated in the graph with the comparison of changes between exp numbers 5 to 8 and 9 to 12. The percentages of change are 4% and 4.3% respectively.

IV. CONCLUSIONS

The present work investigates the suitability of different biodiesel blends as an alternative for diesel fuel. The work was initiated by an extensive literature survey which identified the shortcomings of the present research done on the selected non-edible oils. The research review helped in selecting the non-edible oil and the nano additives for biodiesel production and characterization. The properties of the methyl esters of these samples were compared with diesel to understand their suitability.

Transesterification process was performed on the oils to extract methyl ester of the oils and their properties like density, viscosity, calorific value were measured. After this, the biodiesel was mixed with diesel to get different blends ready for comparison. The properties of the blends were measured and the Engine performance test was performed. The test results noted were Brake Power, Brake Specific Fuel

Consumption, brake thermal Efficiency and Exhaust gas Temperature. The exhaust gas analysis was also performed to understand the effect of biodiesel percentage and nanoparticles on the exhaust gases.

The results, under the given conditions, show that the individual parameter analysis of the engine performance parameters give a single point of optimum value. Considering all the parameters and analyses, the optimum value of the engine performance parameter are 50% load, 20% biodiesel, 25ppm nanoparticles and 200Bar of injection pressure.

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