Int.J.HIT.TRANSC:ECCN.Vol.3: Issue 1A (2017) Page 64-71 ISSN: 0973-6875

Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

Comparative Study on Various Parameters of Biodiesel with Synthetic Diesel Collected From Different Sources

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(Received Date: 6th November, 2016; Revised Date: 10th January, 2017; Acceptance Date: 10th February, 2017)

ABSTRACT

With the increase in scarcity of conventional sources of energy and dearth in fossil fuel, concern has been raised in order to raise awareness, which has led to the development of various other sources from which alternative diesel can be obtained .Collectively, this is known as Biodiesel. When compared to diesel fuel on various criteria, it has been found to have greater advantages, in all aspects. Our interest mainly deals with the parameters which affect any synthetic diesel as it is passed through various pipelines and storage tanks considering various environmental fluctuations and their comparison with more eco-friendly options like Biodiesel. In order to determine this, some small-scale laboratory experiments have been performed with diesel collected from different petrol pumps at different locations, as well as with biodiesel. The values that we have obtained corresponding to the various parameters that ascertain lubrication, quick ignition, cost effectiveness, etc. for both diesel and biodiesel have been compared with their respective standard values and analyzed for deviations.

KEYWORDS— Synthetic diesel, Biodiesel, Fuel, Eco-friendly, Standard

1. INTRODUCTION

Diesel engines are used worldwide for transportation, manufacturing, power generation, construction, and farming. Diesel can be directly used from gas stations to fill tankers. It is a specific fractional distillate of petroleum fuel oil, but alternatives that are not derived from petroleum, such as biodiesel, Biomass To Liquid (BTL) or Gas To Liquid (GTL) diesel, are increasingly being developed and adopted. Diesel was originally created to improve engine efficiency, thus cutting down on wasted fuel. Biodiesel, while having many advantages in terms of reducing pollution, requires the diversion of food crops into oil production.

Ultra-Low-Sulfur Diesel (ULSD) is a standard for defining diesel fuel with substantially lowered sulphur contents Petroleum diesel, also called petro-diesel, or fossil diesel is produced from the fractional distillation of crude oil between 200 °C (392 °F) and 350 °C (662 °F) at atmospheric pressure, resulting in a mixture of carbon chains that typically contain between 8 and 21 carbon atoms per molecule. The principal measure of diesel fuel quality is its cetane number. A higher cetane number indicates that the fuel ignites more readily when sprayed into hot compressed air. European (EN 590 standard) road diesel has a minimum cetane number of 51. Fuels with higher cetane numbers, normally "premium" diesel fuels with additional cleaning agents and some synthetic content, are available in some markets. Diesel is generally simpler to refine from petroleum than gasoline, and contains hydrocarbons having a boiling point in the range of 180–360°C (360–680°F). Because of recent changes in fuel quality regulations, additional refining is required to remove sulphur.

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Biodiesel is not widely used and if used, are blended with diesel to make it work properly. There are basically six different types of proportions - B5, B10, B20, B40, B60 and B80, where 'B' indicates biodiesel and the numeric indicated the percentage of biodiesel in the mixture. A B5 mixture would contain 5% Bio-diesel and the remaining is diesel. Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can also be used as a low carbon alternative to heating oil. Biodiesel can be used in pure form (B100) or may be blended with petroleum diesel at any systems may increase the life of the fuel injection equipment that relies on the fuel for its lubrication. Biodiesel is an unconventional form of fuel made out of biodegradable oils, such as soybean or peanut oil, various plant sources like Jatropa or more sophisticated microbial sources.[1,2]

Recent researchers suggested that Biomass-derived biodiesel and producer gas as the alternative sources of renewable fuel. The mixed fuel mode using producer gas as an inducted fuel and near to waste–used vegetable oil biodiesel as an injected fuel in a four-stroke, naturally aspirated, variable compression ratio engine , can be operated. Producer gas can be collected from the gasifier and stored in gas bags and then supplied to the engine through air surge tank to maintain uniform gas quality, whereas biodiesel is used in the form of B23. It can give maximum brake thermal efficiency of 26.77% which is comparable with the dual fuel mode of operation; ignition delay of 13.64° which is less than the dual fuel mode, and smoke opacity can be reduced up to 16% compared with the conventional fossil fuel.[10]

1.1 Factors affecting the quality of diesel and biodiesel:

a) Flash Point and Fire point[3]: Flash point and fire point of minimum temperatures are required for proper safety and handling of fuel. The both of biodiesel are significantly higher than that of petroleum diesel or gasoline because it contains high molecular weight compounds.

b) Kinematic Viscosity:[3,4] High kinematic viscosity means the fuel is thicker and does not flow easily. Low kinematic viscosity fuel may not provide adequate lubrication to plungers, barrels and injectors Fuel with either too high or too low value can cause engine or fuel system damage. The increase in kinematic viscosity over a certain number of carbons is smaller in aliphatic hydrocarbons than in fatty compounds. Fuels with viscosities over 5.5 centistokes at 40°C are limited to use in slow speed engines, and may require pre-heating for injection. Kinematic viscosity of diesel fuel is at 40°C is 2.0 to 5.0 centi-stoke**.**

c) Aniline Point, Diesel Index & Cetane number [5]: As we know, Diesel Index = (Aniline Point in °F X °API)/ 100. High aniline point and a high Diesel Index means fuel is highly paraffinic and has a very good ignition quality. All diesel fuels are processed to have a diesel index in the range of 45 to 55. Again, Cetane Number = (0.72* Diesel Index) +10. High cetane number fuel will enhance easy starting of compression ignition engines and lessen engine roughness, noise and exhaust smoke.

d) Specific gravity: Due to lower aromatic content and higher cetane number diesel has lower specific gravity. Higher sp gravity leads to lower cetane no, higher b.p, higher API, lowering thermal energy content, decreasing engine power by same percentage as thermal efficiency, higher fuel consumption. But lower sp gravity leads to higher cetane no, results in cold starting,cold smoking, misfiring, prevents noise and black-smoke emission.

e) Sulphur content: Sulphur in diesel fuel can cause combustion chamber deposits, exhaust system corrosion, and wear on pistons, rings and cylinders, particularly at low water-jacket temperatures. Biodiesel eliminates sulfur emissions (SO_2), because biodiesel does not contain sulfur.

f) Diesel Fuel Colour: [3] Diesel fuel colour varies with the crude source, refinery methods and the use of dyes. However, if the fuel colour darkens during storage, this could indicate oxidation and/or other sources which can cause operating problems. Diesel has darker color and biodiesel has lighter color.

1.2 Low temperature operability parameters (Pour point, Cloud point, Cold filter plugging point, Low temperature flow test): This is important as in cold temperate countries, a high cold filter plugging point, high LTFT, high Cloud point, high pour point will clog up vehicle engines more easily and cause delay in starting. Unlike gasolines, which have freezing points well below even the most severe winter ambient, diesel fuels have pour points and cloud points well within the range of temperatures at which they might be used. Oxidation stability, Ash content, Acidity, Carbon residue value are also the important measurements in a crude oil assay.

Fuel can be contaminated by water and dirt if it is not handled correctly[6]. Usually at low temperature, diesel fuel turns to a gel-like consistency at temperatures approaching the products cloud point value. Filter plugging due to the presence of wax crystals in the fuel can be estimated by measuring the cloud point temperature or other low temperature fluidity and filterability tests.

In diesel fuel, microbial contamination may contribute to aging, instability ; but in general the most important consequences are microbial induced corrosion of the storage tanks and pipe work, and formation of microbial mats, with the ability to block filters and pipelines, and to increase wear in pumps. Aerobic bacteria may also participate in the process. Fuel storage tanks in ground are especially prone to contamination problems, because of the difficulties of drainage.The presence of bacteria in diesel fuel is the leading cause of engine breakdown.

Bacteria and fungi will form insoluble particulate matter that can clog fuel filters, resulting in fuel starving and engine stoppage. They can form organic acids that contribute to fuel instability. [8]

Soluble metallic materials cause deposits while abrasive solids will cause fuel injection equipment wear and filter plugging. Alkali and alkaline earth metal impurities found in diesel fuels are potential poisons for diesel exhaust catalysts..There may be potential compatibility problems with fuel system components made of copper, brass or bronze.[7]

Thus, this research work mainly focused on quality based comparative study of diesel and biodiesel samples with their standard by measuring few important physico-chemical properties (Such as Fire point, Flash point, Aniline point, Diesel index, Kinematic viscosity ,Specific gravity etc) in laboratory scale.

2. MATERIALS AND METHOD

Samples for both diesel and biodiesel were collected from different locations in and around Haldia which can be tabulated in *Table 1*.

Table 1:

Samples	Collection site
S1	Indian Oil Corporation Ltd (Brajlalchak)
S2	Indian Oil Corporation Ltd (Bhawanipur)
S3	Bharat Petroleum (Nandakumar)
S4	Indian Oil Corporation Ltd (Hatiberia)
S5	Bharat Petroleum (Township)
S6	Hindustan Petroleum(Santragachi)
S7	Hindustan Petroleum (Bagnan)
S8	Indian Oil Corporation Ltd (Uluberia)
S9	Indian Oil Corporation Ltd (Indian Oil Corporation
S10	Indian Oil Corporation Ltd (Manjushree)
S11	Emami Biotech(Biodiesel sample)

After collecting samples from these above mentioned sites, they were checked for deviations based on different parameters like

Colour and appearance, pH, Kinematic viscosity, Specific gravity, Fire point, Flash point, Aniline point, Diesel index, Cetane number etc. Colour and appearance was measured by visual inspection using Comparator disc; pH measured using digital pH meter; Kinematic viscosity by Redwood viscometer; Specific gravity with specific gravity bottle; Fire point and Flash point by using Pensky- Martin apparatus and Aniline point using a heater and annular tube. Diesel index and Cetane number were calculated from the data values obtained from the other parameters.

3. RESULT AND DISCUSSION

After the experimentation is complete, the results were analyzed and verified with the standard data[9] which is shown in ***Table 2***.

Samples	**Colour & Appearance**	**pH**	**Kinematic Viscosity (stokes)**	**Specific Gravity**	**Fire Point (°C)**	**Flash Point (°C)**	**Aniline Point (° F)**	**Diesel Index**	**Cetane Number**
	Standard Diesel	5.6	0.013-0.014	0.85	68	60-80	107.6	35	40
Standard Biodiesel	Clear Liquid (Between golden and dark brown — depending on the production feedstock)	6.8-7	0.015-0.04	0.86-0.9	138	130	129.2	30	47

The comparative graphs that are obtained from the results are hereby given for better understanding of the parameters in the following list of figures.

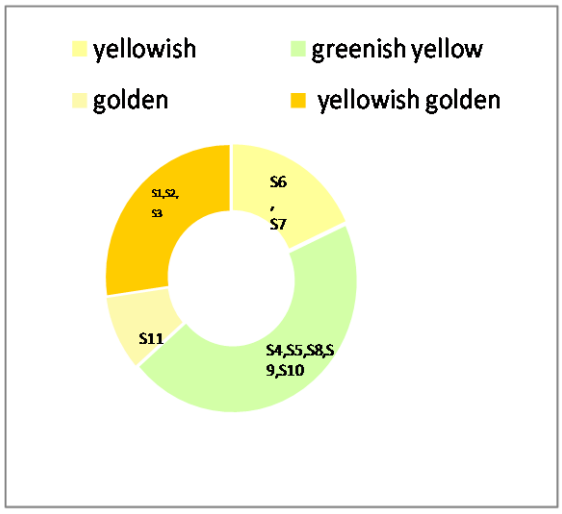

Figure 1.

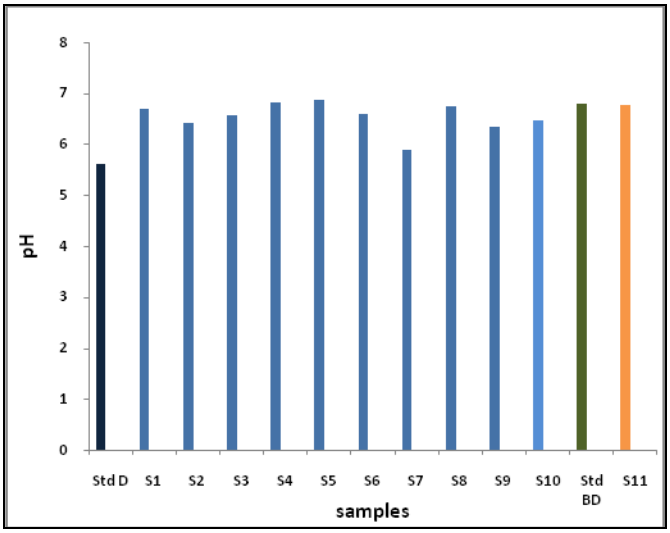

Figure 2. (a)

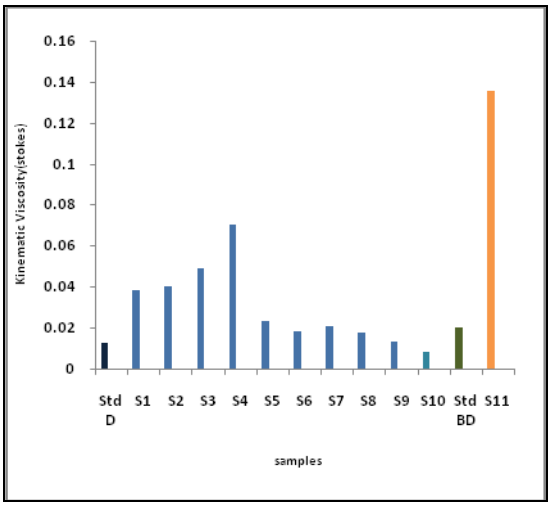

Figure .2. (b)

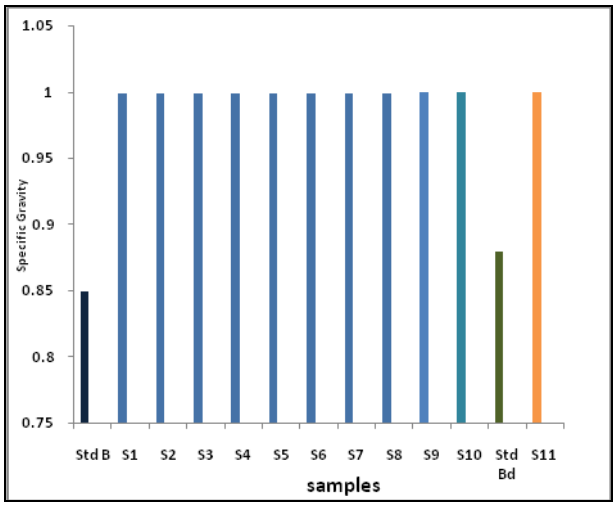

Figure 2. (c)

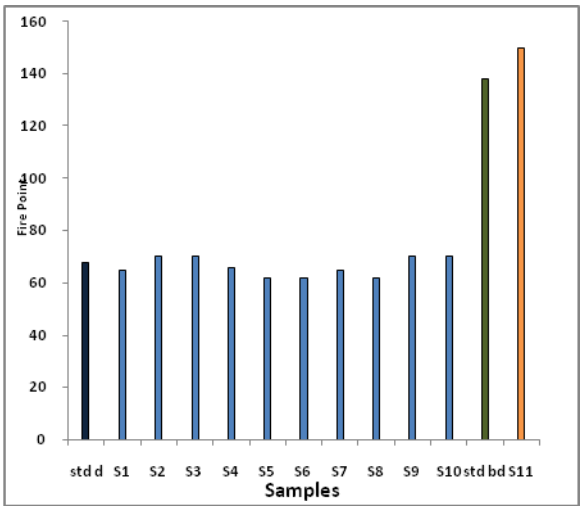

Figure .2.(d)

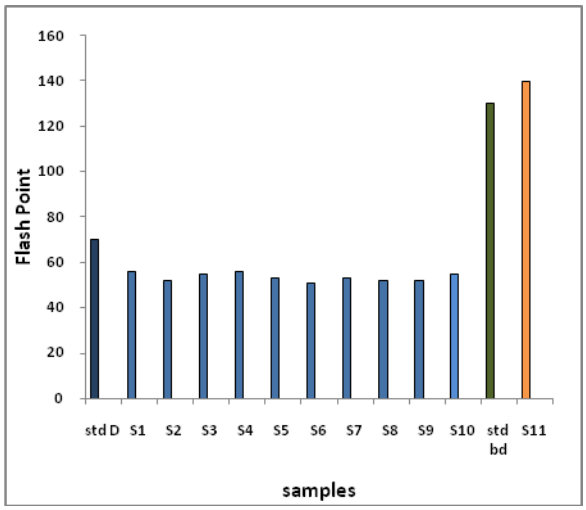

Figure 2.(e)

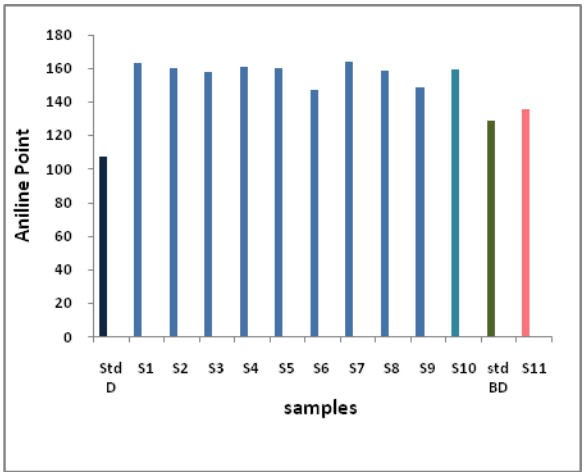

Figure .2.(f)

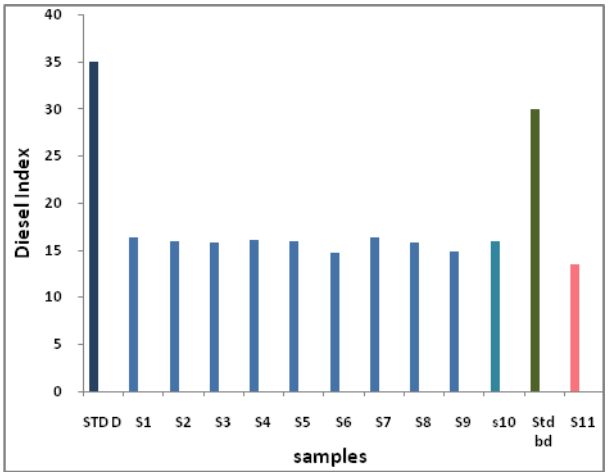

Figure 2.(g)

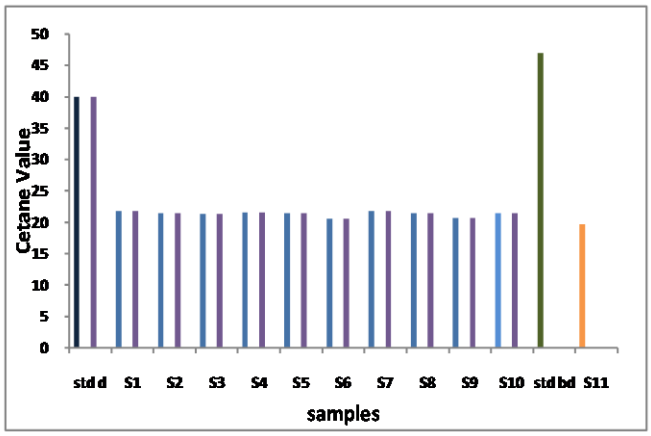

Figure .2. h)

Figure 3

Figure 1. 2. a, b, c, d, e, f, g, and h represents color comparator disc of samples, variation of pH, variation of kinematic viscosity, variation of specific gravity, variation of fire point, variation of flash point, variation of aniline point, variation of diesel index and variation of cetane number respectively. Figure 3 shows collected Biodiesel (Left) and one of the Diesel samples (right).

After testing the different parameters of both diesel and biodiesel collected from different locations in and around Haldia, their values with each other and those with their standard values were compared; graphical analysis reveals some vivid details.

Firstly, the appearance of all the samples was clear without any deposition or precipitation. Mild colour variation of samples can be seen during collection of diesel fuel from different outlets which may arise due to heavy contaminations by metals entering the fuel due to corrosion or drastic variations in pH. Majority (S4, S5, S8, S9, S10) of them are greenish yellow while few of them yellowish (S6, S7). Biodiesel (S11) has a golden tinge probably due its vegetative source as seen from Figure 1.

Overall variation of pH can be seen for the entire diesel samples which are approximately close to 6.5. Acidic compounds during storage present in the fuel may react with atmospheric compounds and metals of storage equipments forming basic salts. Microbial reactions may also give rise to changes in acidity (Figure 2.a).

Kinematic viscosity for all the samples came within the standard range except S4 (0.07 stokes) maybe due to deposits and gum formation. Besides, exposure to low temperature decreases flowability and increases kinematic viscosity as at low temperatures wax crystal formation takes place that leads to deposits. Biodiesel had slightly greater value may be due to its high saturated compound content or due to presence of high molecular weight compounds. (Figure 2.b)

Specific gravity for all samples came as uniform value of 1, while standard value of that of diesel is around 0.85. This variation may be due to some manual handling error of instruments. (Figure 2.c)

Flash point and fire point for both diesel and biodiesel complied with their respective standard values with negligible variation. (Figure 2.d& e)

Aniline point of almost all the diesel samples exceeded the standard values to quite an extent (range of 130°F-160°F) probably due to higher paraffin content or due to reaction of the unsaturated hydrocarbons with the atmospheric

compounds to form saturated compounds thereby increasing the paraffin content. But, the value for biodiesel slightly exceeded its standard value (135°F). (Figure 2.f)

Cetane value, which was calculated from the specific gravity, came quite low (range below 20) from the standard value (40).Lack of precise specific gravity values due to lack of high precision instrument resulted in low cetane values. Besides, reaction of the fuel components with the environmental compounds like atmospheric gases, metals, other fuel contaminants like dirt and sulfur leads to saturation of unsaturated compounds thus increasing the content of paraffins and high molecular weight compounds which causes increase the viscosity of oil, decrease in flowability, decrease in volatility and thereby causing delay in the ignition time (Figure 2.g).

Diesel index derived from less precise specific gravity values arising varied from their standards too. Besides, reasons mentioned for cetane value also may be responsible for variation in values of diesel index (Figure 2.h).

4. CONCLUSION

Our current study focuses mainly on the comparative study of synthetic diesel with respect to an available biodiesel sample collected from a definite source. After thorough experimentation and result analysis many conclusions can be drawn from this study. As a whole, biodiesel is much more safer during handling and storage as well as eco-friendly than synthetic diesel; whereas diesel scores better in terms of cost effectiveness in its production and have good ignition quality. The aniline point, diesel index and cetane number of diesel is slightly higher than biodiesel which actually accounts for its better ignition quality than biodiesel. Therefore, we can say that biodiesel can be a 'better vehicle runner of the future' if it's cost effectiveness and some of its ignition quality can be improved by improving the aforesaid characteristics. If this can be achieved then biodiesel will surely going to be the replacement fuel of the future and will also aid in the promotion of sustainable development.

References

[1] Sheehan, J., Camobreco, V., Duffield, J., Graboski, M. And Shapouri, H.(1998). An Overview of Biodiesel and Petroleum Diesel Life Cycles. A report of the U.S. Department of Energy(NREL),1-42

[2] Ellis, J.(2003).Difference between diesel and biodiesel. In B.Harris(Ed.),Conjecture Corporation

[3] Bacha, John., Freel,J., Gibbs, A. and Gibbs, L.(2007)Diesel Fuel : Technical Review. In D. Scott, J. Mills(Ed.), Chevron Corporation

[4] Marcus, A. (1999).Diesel Fuel Basics: What Is Diesel Fuel, And Where Does It Comes From?.Passagemaker,1-6

[5] Jääskeläinen, H.(2007).Fuel Property Testing: Ignition Quality. Copyright protected by Ecopoint Inc.

[5] He, B. B. J., Thompson, C., Routt, D. W. and Gerpen J. H.(2007). Moisture Absorption In Biodiesel And Its Petro-Diesel Blends. American Society of Agricultural and Biological Engineers, 23(1),71-76

[7] Williams, Aaron., Burton, J. and McCormick, L. R.(2013). Impact of Fuel Metal Impurities on the Durability of a Light-Duty Diesel After Treatment System. In *Proceedings of the Conference* SAE 2013 World Congress and Exhibition

[8] Srivastava, N. K. and Nandan, N. K. (2012).Microbial Growth Control in Diesel by Optimization of Sulphur. International Journal of Environmental Pollution and Remediation, 1, 119-125

[9] Setting National Fuel Quality Standards; Paper 2; Proposed Standards For Fuel Parameters (Petrol And Diesel).(2000). A report of Environment Australia. CPP Instant Printing,6-119

[10] Srithar,K., Balasubramanian ,K. A., Vivar, M. and Skryabin, I. (2013). An Experimental Investigation on Diesel and Low Heat Rejection Engines with Dual Biodiesel Blends..International Journal of Green Energy 1041 -1055