ISSN : 2248-9622, Vol. 5, Issue 2(Part 3), February 2015, pp.18-23

RESEARCH ARTICLE OPEN ACCESS

Investigating On Use of Different Blends of White Grape Seed Biodiesel and Diesel on 4 - Stroke Single Cylinder DI Diesel Engine

C. Sreedhar*, Dr. B. Durga Prasad**,
*Associate Professor, Department of Mechanical Engg, Sri Krishnadevaraya Engg. College, Gooty, A.P, India.
**Professor, Department of Mechanical Engg., J.N.T.U.C.E., Anantapuramu, A.P, India.

ABSTRACT
Diesel engine is an internal combustion engine which has made life easy and faster in today's modern life. These engines are consuming lot of diesel fuel and have been substantially increasing the atmospheric pollution. There is a concern over the availability of diesel fuel a derivative of fossil fuel, as these sources are limited and in near future they may get exhausted. Hence, there is a need for an alternative source of fuel which is abundant and environmentally friendly. A promising renewable and clean burning diesel replacement is biodiesel fuel. This is an alternative fuel made by different methods like standard base-catalysed transesterification, pyrolysis, thermal cracking etc., An alternative method called catalytic cracking, a fast reaction process is investigated for production of quantitative and qualitative biodiesel. Among many available catalysts, alumina catalyst is selected for production of biodiesel. Catalytic cracking process is carried out on white grape seed oil to convert it into white grape seed biodiesel. On production of biodiesel, physicochemical properties are tested and compared with diesel. Biodiesel thus obtained is a very near quality diesel fuel as per ASTM standards this can be used in the existing diesel engines. Experimental work is carried out on a single cylinder [Kirloskar TV-1 (DI), Water cooled, 4-Stroke] diesel engine with diesel fuel and also with biodiesel blended in various proportions with diesel at different engine loads. On analysis, it is inferred that there is a minimal deviation in engine characteristics with white grape seed biodiesel and with its blends when compared to characteristics of engine fueled with diesel. This gives a scope for further research to be carried out with other catalysts to produce biodiesel with different vegetable or animal fat based oils.
Key words: Alumina, Biodiesel, Catalytic cracking, Engine characteristics.

I. INTRODUCTION

The recent research shows renewed interest on biodiesel as a fuel in diesel engines, concept of using plant based derived oil as engine fuel. The lower cost of the petroleum diesel has so far attracted the world to use it as fuel in diesel engines. But nowadays due to global political crises and other reasons, the cost of petroleum diesel has been varying constantly. Moreover, the emission norms are more stringent as ever before. In this context, many biodiesels have been used by different countries as an alternative fuel to overcome dependency on crude oils and to convert the unwanted biodegradable products into useful products. Indian modern wine market is one such promising solution, although it is very small compared to international level. Indian economy paving path towards globalisation, people are getting opportunities to earn more, their exposure to different cultures and its influence on them reignited the crave for beverages thus increasing demand for them, as well for raw material of beverage industry. This demand leads to increase in grape plantations with added advantage of favourable Indian climatic conditions in some states like Andhra Pradesh, Tamilnadu and Karnataka. Crop can be produced twice a year from grapevines. In the month of February harvesting is normally done by handpick. From many years for wine manufacturing industry tons of this unviable by-product grape seeds was a concern. Concept of biodiesel is actually a brilliant idea that can be considered for extracting oil by cold pressing of white grape seeds and bringing into utilization of this oil as biodiesel, which is economically affordable to some developing nations like India in particular.

Biodiesel is a fatty acid methyl ester or mono-alkyl esters extracted from vegetable oils or animal fat and from other sources of biomass that satisfy certain standard specifications set by ASTM. Transesterification is a chemical reaction process of conversion of plant oils to mono-alkyl esters. Several available methods are: acid, alkaline, enzyme catalyzed or non-catalyzed. Reaction rate of transesterification process catalyzed by acid catalysis is much slower compared to that of alkaline catalysis. This process of transesterification by alkaline catalysts has its own limitations. Commonly used alkaline catalysts (KOH, NaOH, CH_3ONa) react with free fatty acid content in the oil to form soap. This reaction is undesirable because soap lowers the yield of biodiesel, inhibits separation of esters from the glycerol and also requires lot of water for washing to remove residues. So, one among alternate production methods of biodiesel is catalytic cracking to improve quality of oil. This process is selected for production of biodiesel from white grape seed oil.

II. LITERATURE SURVEY

C.M. Fernandez et al. [1] explained techniques to extract grape seed oil from winery waste and usage of transesterified grape seed oil as biodiesel, as ethyl esters showed good flow properties. Morvarid Yousef et al. [2] investigated two types of shahrodi grape seed oil (Lal and Khalili) for their physico-chemical properties, their oil content and concluded that Lal variety is better than Khalili. Ester Foppa Pedretti et al. [3] investigated production of bio ethanol from hybrid varieties of grapes and also evaluated greenhouse gas emissions in comparison with European laws. Sophi damayanti et al. [4] using gas chromatography identified, quantified linoleic acid one of the main compounds of unsaturated fatty acids in grape seed oil and also successfully transesterified grape seed oil. Agarry, S.E et al. [5] evaluated the citrus seeds (orange, grape, tangarine) as a potential source of valuable oil due to presence of unsaturated fatty acids, studied some of its properties and concluded their suitability as a biodiesel. Silvia mironeasa et al. [6] studied physico-chemical, structural characteristics, content and quality of grape seed oil. M.M.Yunus et al. [7] extracted oil from african grape seed and tested its properties, compared them with recommended standards of biodiesel for its suitability as a fuel for running diesel engines. They suggested the potential of wild grape seed oil as a good source of biodiesel, which could be exploited as an alternative source of fuel.. S Karthikeyan et al. [8] investigated use of aluminium nano particles mixed in blends of grape seed biodiesel fuel in a single cylinder diesel engine of horizontal type. It is concluded that there is improvement in brake thermal efficiency and reduction in emissions.

III. CATALYTIC CRACKING PROCESS

This method is able to crack complex hydrocarbons to yield less complex structures. With the help of a catalyst, the reaction is conducted at lower temperatures and pressures, moreover the quality and quantity of the product is very near to that of diesel which is far more superior to oil produced by transesterification process. In catalytic cracking process, a batch reactor is filled with white grape seed oil which has a highly bonded chemical structure along with 50gms of alumina catalyst per litre of oil. When heat is applied a rapid chemical reaction process takes place, in the process complex structure is broken down in the reactor to a simple structure producing low density and low viscosity biodiesel. Yielding of biodiesel starts at a temperature of 275^0C and continues up to 310°C with some ten percent residue remaining in the reactor.

Catalytic cracking biodiesel plant consists of a batch reactor with oil inlet to pour grape seed oil mixed with alumina catalyst, pressure gauge to indicate pressure in the reactor, drain hole to remove residue and safety valve to safe guard reactor.

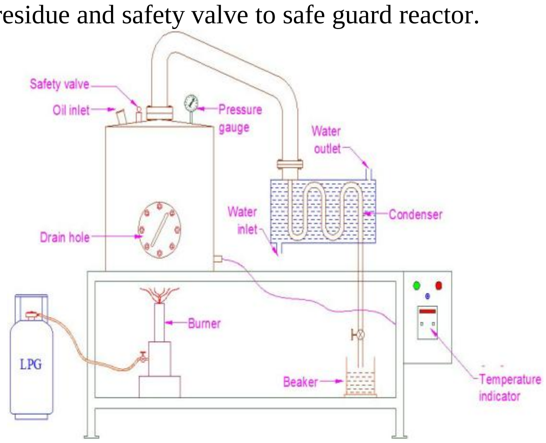


Fig 3.1: Schematic diagram of Catalytic cracking biodiesel plant

Heat is supplied at the bottom of the reactor by using gas burner. Temperature indicator to display temperature inside the reactor. Smoke produced in the reactor passes through piping, condenser and finally smoke is condensed into liquid called biodiesel that is collected in the beaker.

IV. FUEL PROPERTIES

Table 4.1: Fuel blend percentages

Notation	Fuel Quantity (litres)	Biodiesel Quantity (ml)	Diesel Quantity (ml)
B25	1	250	750
B50	1	500	500
B75	1	750	250
B100	1	1000	-

Comparison of fuel properties of diesel and different blends of white grape seed oil are given in the table 4.2. Properties of B25 are close to diesel.

Properties	Diesel	Catalytically Cracked White Grape seed oil with Alumina			
		B25	B50	B75	B100
Kinematic viscosity @40^{0}C (c St)	2.56	2.61	4.74	7.35	9.82
Gross calorific value (kcal/kg^{0}C)	10660	10404	10080	9756	9429
Sp.gravity @15/15 ^{0}C	0.835	0 .841	0.855	0.870	0.884
Flash point (PMCC method)^{0}C	44	48	54	61	68
Fire point (PMCC method)^{0}C	48	67	72	78	84
Pour point ^{0}C	-14	-12	-10	-8	-6
Density @ 15^{0}C (gm/cc)	0 .834	0.840	0.855	0.869	0.883

Table 4.2: Comparison of properties of Test fuels

V. EXPERIMENTAL SET UP

Investigation work is carried out on a naturally aspirated Kirloskar TV-1, 5.2 kW. Diesel engine with the specifications tabulated in table 3.

TYPE	Single Cylinder, Vertical, Water cooled, Four Stroke Diesel Engine
Loading Device	Eddy current dynamometer
Dynamometer Arm Length	0.195m
Stroke length	0.11m
Compression ratio	17.5:1
Bore diameter	0.0875m
Speed	1500 rpm
Power	5.2kW(7hp)
Orifice Diameter	.02m
Mode of Starting	Manually Cranking
Injection Pressure	215.7 bar
Injection Timing	23^{0}C before TDC

Table5.1: Specifications of Kirloskar TV-1 Engine

Engine is fitted with eddy current dynamometer for varying loads and to get accurate readings. Fuel combustion characteristics of the engine are recorded using 619 Indi meter hardware preloaded with Indwin - software version2.2. Time is noted for 10cc fuel consumption of the engine using stop watch indicated by equivalent fuel drop in glass burette. Digital tachometer is used to measure the speed of the engine. Using AVL gas analyzer exhaust gas emissions CO, HC, NO_x are measured. Density of smoke is recorded with AVL smoke meter. Before conducting tests on the diesel engine it's important to check for prevailing ambient conditions such as atmospheric pressure and temperature. These conditions have their own impact on fuel-air mixing ratios as well combustion process. So it is necessary to conduct the tests on engine at constant ambient atmospheric conditions.

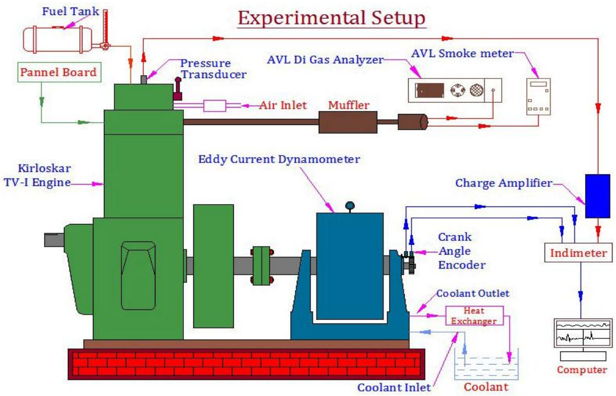
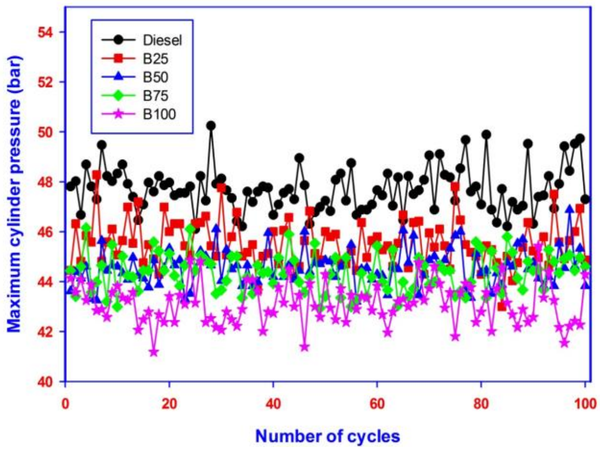


Figure 5.1: Schematic Diagram of Test Rig Set Up

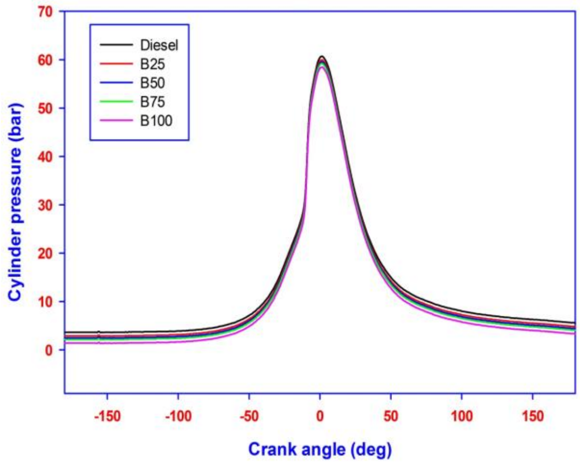
VI. RESULTS AND DISCUSSION

6.1. Combustion Characteristics



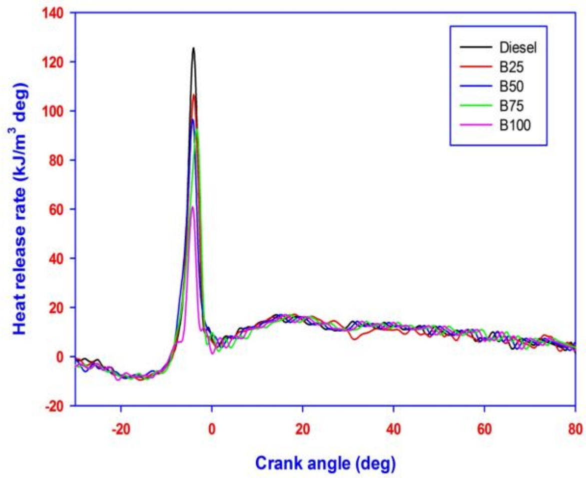
Graph 6.1.1: Maximum cylinder pressure versus Number of cycles

Graph 6.1.1 above is about occurrence of maximum in cylinder pressures attained in diesel engine for 100 cycles of operation of engine with all test fuels. Maximum in cylinder pressures are observed in case of diesel fuel because of better atomization and complete combustion process. B25 has recorded near in cylinder pressures as its properties nearly match with properties of diesel. B50 and B75 are exhibiting cylinder pressures in between diesel and B100.Compared to all B100 is giving least cylinder pressures of all tested fuels.



Graph 6.1.2: Cylinder pressure against Crank angle

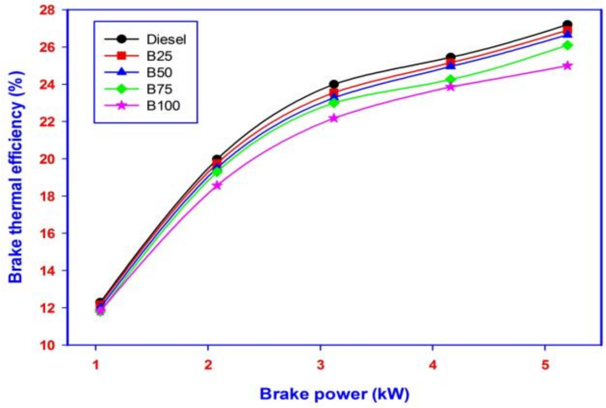
Graph 6.1.2 shows the rise in cylinder pressure for different fuels at rated load with respect to crank angle. Curves closeness tells that cylinder pressure rise for all test fuels is similitude in nature. Pressure rise is maximum for diesel compared to other test fuels. B25 gives very close or equal pressure rise with a maximum difference of approximately 2 to 3% due to similar atomization. Increase in percentage of grape seed biodiesel in diesel reduces the cylinder pressure. This can be due to more density of vegetable oils compared to fossil fuel derived diesel. It is clear from the above graph cylinder pressure is least for B100.



Graph 6.1.3: Heat Release Rate against Crank angle

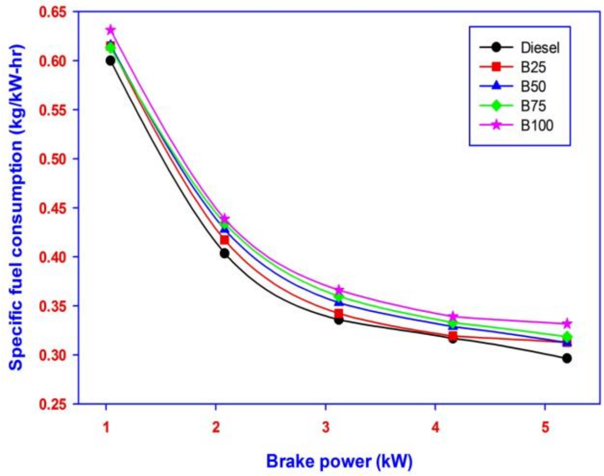
The above graph is all about heat release rate pattern per degree of crank angle for the fuels at full load. The diesel curve is followed by that of B25, B50, B75 and B100 at full load. Diesel accumulation is more in the delay period, which releases the maximum heat as it is having higher calorific value. Heat release rates for B25, B50, B75 and B100 are lower due to shorter ignition delays and higher viscosities compared to diesel at full load. Heat release rate of B100, B75, B50, and B25 is approximately 50%, 35%, 20%, and 10% less than diesel. B25 gives the maximum heat release rate and B100 gives the least compared to other blends.

6.2 Performance Characteristics



Graph 6.2.1: Comparison of BTE between diesel, white grape seed biodiesel and blends.

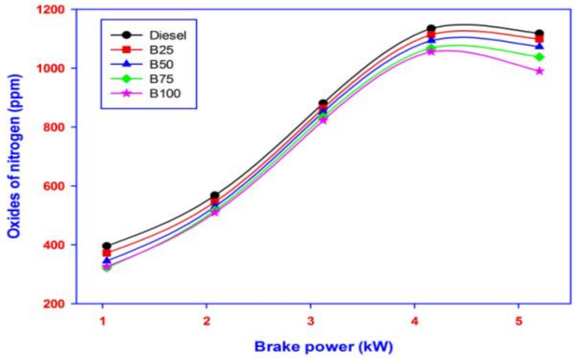
From graph 6.2.1, it is evident that *Brake Thermal Efficiency (BTE)* in general of white grape seed biodiesel blended with diesel and diesel is very close in nature. The maximum brake thermal efficiency is 27.1% for diesel and very next close value recorded is for B25 that is 26.9%. Remaining B50, B75 and B100 maximum brake thermal efficiencies are 26.6%, 26.1%, and 25% at full load. Percentage of white grape seed biodiesel in diesel increases, there is reduction in brake thermal efficiency compared to engine run by diesel fuel. This can be attributed to low calorific value of white grape seed biodiesel.



Graph 6.2.2: Specific fuel consumption versus Brake power

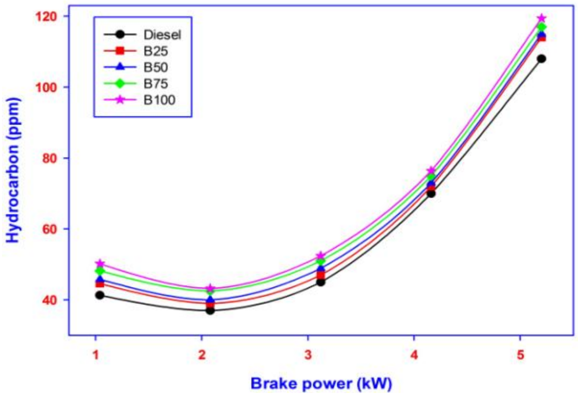
Graph 6.2.2 is comparative analysis of *Specific Fuel Consumption (SFC)* of test fuels against varying load conditions. Specific fuel consumption of the engine is decreasing for all test fuels on increasing loads. The fuel consumption is increasing with white grape seed biodiesel blends from B25 to B100 when compared to diesel to develop same power output. This is because of lower calorific value of blends leads to injection of more fuel to maintain power output in comparison with diesel. B25 is giving similar specific fuel consumption compared with diesel and at 80% load it is equal to diesel. At full load specific fuel consumption for B-100 is much more than diesel. Reason is higher density of vegetable oils leads to more fuel discharge with respect to diesel fuel.

6.3 Emissions



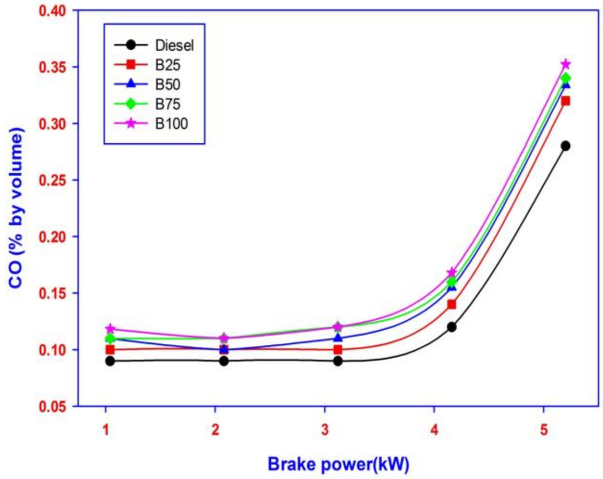
Graph 6.3.1: Comparison of Oxides of nitrogen with Brake power

From the graph 6.3.1 it is observed that formation of oxides of nitrogen are increasing for all test fuels up to 80% load and slightly decreasing at full load. Diesel is emitting more NO_x for all loads the reason may be higher heat release due to higher calorific value compared to blends of the white grape seed biodiesel. Considerable reduction in NO_x emission is noticed with increase in biodiesel blend in fuel. B100 recorded least NO_x emissions among all tested fuels.



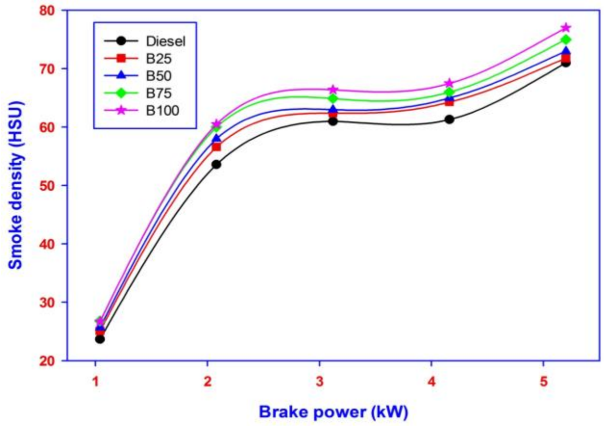
Graph 6.3.2: Release of Hydrocarbon with increase in Brake power

It is inferred from graph 6.3.2 that hydrocarbon (HC) emissions are increased with increase in load or brake power however, hydrocarbon emission for diesel is less compared to all other test fuels. With increasing percentage of white grape seed biodiesel there is increment in hydrocarbons emissions the reason could be due to the flow of fuel rich mixtures at higher loads and escaping of unburned hydrocarbons due to incomplete combustion of fuel in the combustion chamber.



Graph 6.3.3: Release of Carbon monoxide with increase in Brake power

Graph 6.3.3 reveals that carbon monoxide emissions are increasing from B25 to B100 when compared to diesel. At lower loads CO emissions are close to that of diesel fuel but at higher loads CO emissions are increasing this is clearly noticed with widening gap of curves in the figure. In the catalytic cracking process oxygen in biodiesel escapes out to atmosphere or it might be consumed in the reaction process for better oil yield depriving the complete oxidation of carbon atom.



Graph 6.3.4: Smoke density versus Brake power

Graph 6.3.4 gives clear indication of increase in smoke density from B25 to B100 compared to diesel. At top load the smoke opacity is 71, 71.8, 73, 75 and 77 HSU for diesel, B25, B50, B75, and B100 respectively. This may be due to heavier molecular structure, vegetable oil double bonded chemical structure, and higher viscosity of white grape seed biodiesel and their blends. The number of double bonds present in the fatty acid is strongly related to emissions. These factors may be responsible for incomplete and slow combustion resulting in higher smoke emissions.

VII. CONCLUSION

Extracted oil from white grape seeds by cold pressing is treated by catalytic cracking method using alumina as catalyst with constant supply of heat for breaking complex bond structure making it suitable for biodiesel. White grape seed biodiesel and diesel fuels are tested on the four stroke single cylinder diesel engine. Test results are plotted and on analysis it is inferred that performance characteristics such as brake thermal efficiency for B25 is similar to diesel, specific fuel consumption for B25 & B50 is similar at full load but it is more in case of B100 when compared to all other test fuels. A combustion characteristic like maximum cylinder pressure of B25 is nearer to that of diesel. Emissions such as NO_x are reduced considerably whereas CO, HC and Smoke density are increasing with the blend percentage of white grape seed biodiesel in diesel compared to diesel.

REFERENCES

[1] Carmen Maria Fernandez, Maria Jesus Ramos, Angel Perez, Juan Francisco Rodriguez, Production of biodiesel from winery waste: Extraction, refining and transesterification of grape seed oil, *Elsevier Journal of Bioresource Technology, 101*, 2010, 7030-7035.

[2] Morvarid Yousefi, Leila Nateghi and Mohammad Gholamian, Physicochemical properties of two types of shahrodi grape seed oil(Lal and Khalili), *European Journal of Experimental Biology*, *3(5)*, 2013, 115-118.

[3] Ester Foppa Pedretti, Daniele Duca, Giuseppe Toscano, Giovanni Riva, Andrea Pizzi, Giorgio Rossini, Matteo Saltari, Chiara Mengarelli, Massimo Gardiman, Riccardo Flamini, Sustainability of grape-ethanol energy chain, *Journal of Agricultural Engineering*, *XLV (425)*, 2014,119-124.

[4] Sophi Damayanti, Virginia Agustina Sigi, Elin Julianti, Transeterification of Linoleic acid in grape seed[Vitis Vinifera L.] oil and its analytical method development using gas chromatography, *International Journal of Pharmacy and Pharmaceutical Sciences, 6(4)*, 2014, 528-531.

[5] Agarry, S.E., Aremu, M.O., Ajani, A.O. and Aworanti, O.A., Alkali-Catalysed production of biodiesel fuel from Nigerian citrus seeds oil, *International Journal of Engineering Science and Technology, 5(09)*, 2013, 1682-1687.

[6] Silvia Mironeasa, Ana Leahu, Georgiana-Gabriela Codina, Silviu-Gabriel Stroe, Costel Mironeasa, Grape seed: physico-chemical, structural characteristics and oil content, *Journal of Agroalimentary Processes and Technologies*, *16(1)*, 2010, 1-6.

[7] M.M.Yunus, A.A.Zuru, U.Z Faruq and A.A.Aliero, Assesment of physicochemical Properties of Biodiesel from African Grapes, *Nigerian Journal of Basic and Applied Science*, *21(2)*, 2013, 127-130.

[8] S Karthikeyan, A Elango, S M Silaimani and A Prathima, Role of Al_2O_3 nano additive in GSO biodiesel on the working characteristics of a CI engine, *Indian Journal of Chemical Technology,21*, 2014, 285-289.