BLENDING ANALYSIS OF FUELS FOR I.C ENGINE TO REDUCE THE EMISSION & TO IMPROVE THE PERFORMANCE

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ABSTRACT

Internal combustion engine is very important part of our daily life in industrial, agriculture and transportation. Internal combustion engine works by receiving the energy from combustion of fossil fuel. The fossil fuel are the non-renewable source of energy , they are depleted drastically presently so their prices are hiking day to day and exhaust emission emitted by IC engine effected environment so poorly our greenhouse gases and origin global warming. Biodiesel is create to be best alternative fuel for petro-diesel which can be used to run compression ignition engine either directly or blended with diesel.The main objectives of the present work are to produce biodiesel from *Pongamia pinnata* (Karanja) oil using esterification followed by transesterification. A variety of proportions of Karanja oil methyl ester blends (10%, 20%, and 30%) with diesel and used for conduct to be evidence for test at varying load conditions. The experimental result shows that B20 blend was found to be the best and effective blend which get better the brake thermal efficiency and reduced brake specific fuel consumption and also reduced all exhaust emissions like CO, CO_2, HC and smoke, but increase the smoke density and NOx emissions as compared to neat petro-diesel.

Keyword: Biodiesel, karanja oil, esterification and transesterification.

I. INTRODUCTION

The ever increasing number of automobiles has lead to increase in demand of fossil fuels (petroleum). The increasing cost of petroleum is another concern for developing countries as it will increase their import bill. The world is also presently confronted with the twin crisis of fossil fuel depletion and environmental degradation. Fossil fuels have limited life and the ever increasing cost of these fuels has led to the search of alternative renewable fuels for ensuring energy security and environmental protection. For developing countries fuels of bio-origin can provide a feasible solution to this crisis. This is known as the bio fuel.

Bio-fuels have become a high priority in the European Union, Brazil, the United States and many other countries, due to concern about oil dependence and interest in reducing green house gas emissions. All these regions have provided massive subsidies, tax credits, tariff imposition and/or mandates for renewable energy production from agricultural sources. The impacts of these incentives and mandates reach far beyond the borders of these economies. **In 2009, Brazil** and the United States were the leading producers of ethanol, and their production is expected to reach 6.5 and 10.5 billion gallons, respectively, which accounts for more than 90 percent of the world's production, in 2008. World ethanol production has grown at a compound growth rate of 10 percent per annum since 1975, and it grew rapidly at **19** percent per annum **from 2001 through 2008**, which is attributed to the push towards ethanol in the United States. Similarly, world bio-diesel production has grown at a rate of 42 percent per annum since 1991; the majority of the boom coming from the bio-fuel initiative in the European Union countries. **In 1911, Rudolf Diese**l presented the world with the compression ignition engine, which at that time did not have a specific fuel. Diesel claimed that the engine could be fed by vegetable oils which could help the agricultural development in countries using this engine. **Biodiesels** are derived from vegetable oils or animal fats, more specifically the alkyl esters from these. The esters from vegetable oils are considered to be superior since they have a higher energetic yield and essentially no engine modifications are necessary for their use. Biodiesels have been traced back to the **mid-1800s**, where **transesterification** was used to make soap and the alkyl esters (biodiesels) were just considered by products. Early feedstocks were corn, peanut, hemp oils, and tallow. Oil straight vegetable oils (SVOs) have their fair share of problems in unmodified CI engines. These problems include: **cold-weather starting; plugging and gumming** of filters **lines, and injectors; engine knocking; coking of injectors on piston and head of engine; carbon deposits on piston and head of engine; excessive engine wear**; and **deterioration of engine lubricating oil.** Vegetable oils decrease power output and thermal efficiency while leaving carbon deposits inside the cylinder. Most of these problems with vegetable oil are due **to high viscosity, low cetane number, low flash point**, and resulting incomplete combustion.

II. PRODUCTION OF KARANJA METHYL ESTER

To prepare Karanja oil methyl ester from the neat Karanja oil first the acid value of the oil is measured by titration. The acid value of the oil is found to be 6.3 mg KOH/gand is decreased by esterification method. In esterification method acid catalyzed reaction of the oil with methanol is done. Samples are taken from the products of reaction in every half an hour and acid value measured. The reaction is stopped when acid value of the oil becomes below 5 mg KOH/g. The products of reaction are then allowed to be settled in a separating funnel. After 24 hours of settling, triglyceride comes to the bottom of the funnel and untreated alcohol comes to the top. The triglyceride of Karanja oil is then collected from the bottom of the separating funnel. The triglyceride of the oil is transesterified to produce biodiesel or Karanja oil methyl ester (KOME or Biodiesel) on the same reactor. Then, reaction is carried out at 600C with continuous stirring. The products of the reaction is kept in the separating funnel and allowed to settle down. Glycerol is settled at the bottom of the separating funnel and collected. The top part of the funnel contains Karanja oil methyl ester. Then, it is water washed three times to remove the untreated methanol. The dissolved water particles are removed by heating the collected Karanja oil methyl ester. Biodiesel are blended with diesel fuel at 10, 20, 30,…, 100% on a volume basis. Blends of 20, 40 and 60vol% of KOME with diesel which are known as B20, B40, B60 respectively, are used for experiment

Properties of biodiesel

Table-1

Fuel properties of the petro-diesel, karanja biodiesel, B10, B20 and B30						
Properties	Unit	Petro-diesel	Karanja biodiesel	B1	B2	B3
Density(20oc)	KG/M3	837	872	825	76	848
Kinematic viscosity(45oc	cST	2.3	4.9	2.28	2.8	2.93
Flash point	Degree	63	105	69	74	79
Calorific value	Mj/kg	42	39	43.55	41.1	40.65

III. ENGINE SET UP

The experimental setup shows in figure-1. This is a single cylinder diesel engine. The engine has rated output 5.6kw at speed 2000rpm and compression ratio of engine is 20.The injection pressure is 189kg/cm3 and coupled with rope break dynamometer. The comprehensive specification of engine is given in Table 2. Performance test are carried out on compression ignition engine using various blends of biodiesel and diesel as fuel. Emission such as carbon dioxide, carbon monoxide (CO) nitrous oxide (NOx) and unburned hydrocarbon (HC) were measured by an exhaust gas analyzer and smoke density was measured by smoke meter. Initially, the engine was started on neat diesel fuel and warmed up, once the engine was reached the stabilized working condition. Then parameters like the speed of operation, fuel consumption, engine load and exhaust emission were measured. Further the experiment was repeated with B10, B20 and B30 blends with diesel.

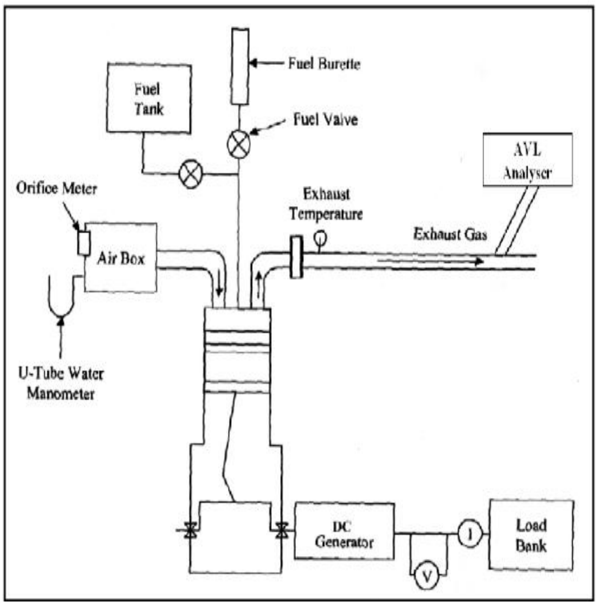
Table -2

Engine specifications	
Engine speed	2000 rpm
BHP	5
Bore	80mm
Stroke	95mm
No. of cylinder	1
Dynamometer	Mechanical loading
Drum dynamometer	32cm
Do	24mm
Cd (coefficient of discharge)	0.6

Table 3: Specifications of instruments

Particulars	Specifications
Speed measurement	Mechanical Tachometer Analogue Hand Tachometer Model : LZ-30 Range: 30-12000 rpm.
Air flow measurement	Air box method Orifice type with orifice diameter 30 mm. Overall dimensions 2' x 2' x 2'
Temperature measurement	Thermocouples Range : -100 ^{0}C to 600 ^{0}C Type : 'J', Length : 12" Digital temperature indicator, Type : FE / K
Fuel measurement	Burette and stop watch
Voltmeter	Make : Snipper, Range : 0-300 V Scale : Non linear type
Ammeter	Make : Snipper, Range : 0-30 A Resolution : 0.2 A

Figure-1



IV. ENGINE PERFORMANCE

The biodiesel obtained from karanja oil by two step transesterification was blended with petro-diesel in three different portions, i.e., 10%, 20%, 30% by volume. For obtaining karanja biodiesel blend B-10, 90% of diesel is mixed with 10% of karanja biodiesel by volume. Similarly for B20 and B30 blend were obtained. The properties of the different blends (B10, B20 and B30) and petro-diesel are measured as per ASTM standards for experimentation as shown in Table 3**,** and performance of engine with blended biodiesel are given below:-

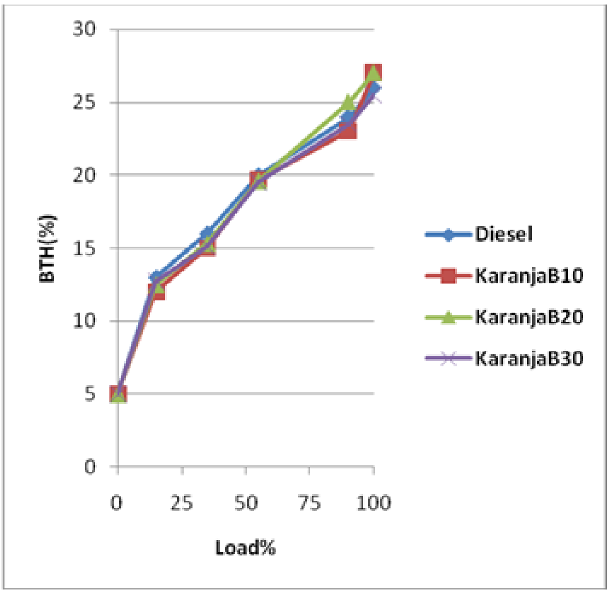
4.1 Brake thermal efficiency

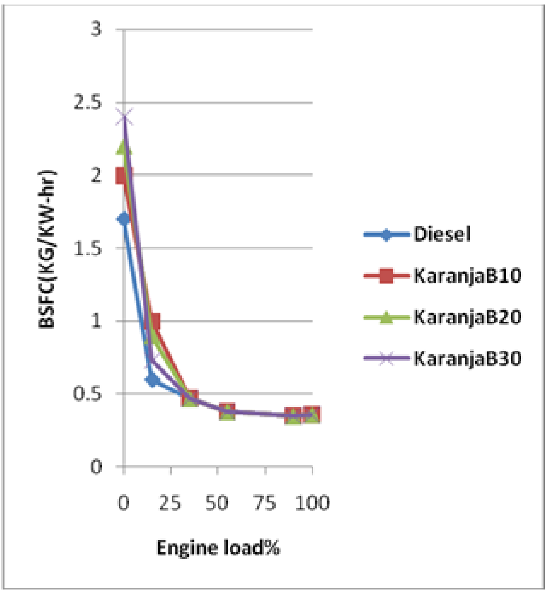
Figure 2 represents the brake thermal efficiency vs. load. It was found that as the load on the engine was increases the BTH is increasing. It is found that karanja B20 blend shows the maximum BTH at higher load as compared to all other fuels (B10, B30 and petro-diesel). it was concluded that the oxygen present in the biodiesel improved combustion which results higher pressure rise and heat releases rate as compared to neat diesel which results more BTH in karanja B20 as compared to diesel at full load. It was found that at higher load in case of B20 the BTH was 28% as compared to neat diesel was 27.2%.

4.2 Brake specific fuel consumption

Figure 3 shows the BSFC vs. load. It is clear from figure that at low load in case of biodiesel due to poor atomization, the more BSFC is required as compared to neat diesel. On the other side as the load on the engine is increase the BSFC start decreasing. It is found that at full load the BSFC is almost same in all fuels.

Figure 2 **Figure 3**

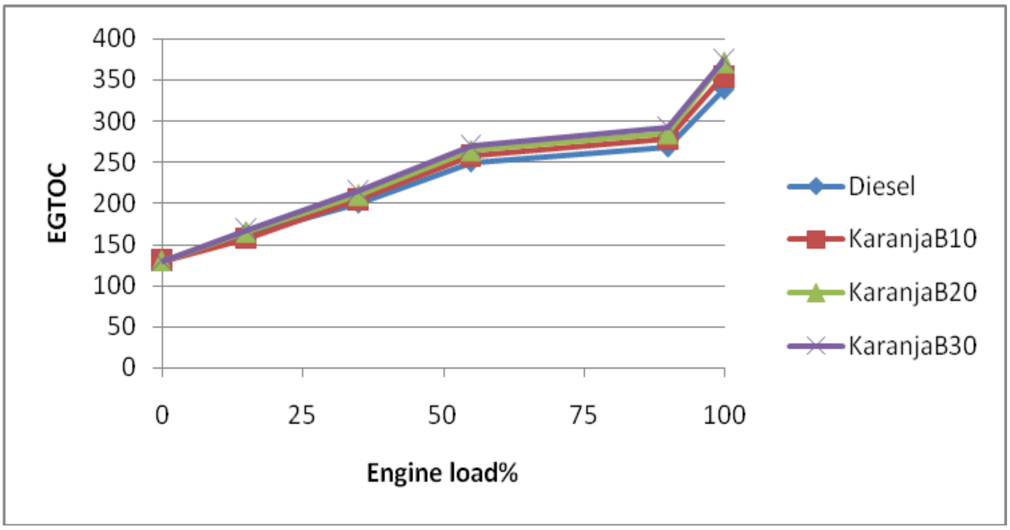




4.3 Exhaust gas temperature

Figure 4 represents the exhaust gas temperature vs. engine load. It is clear from figure that as the load on the engine increases the EGT is also increases. It is found that at higher load karanja B30 blend has higher EGT than all fuels. It was concluded that oxygen present in the cylinder improves the combustion quality which result in higher peak pressure and heat release rate. Thus higher EGT was found in karanja biodiesel as compared to neat diesel. It is found that at higher load in case of B30 the EGT was 3750 °C as compared to neat diesel 335 °C

Figure-4



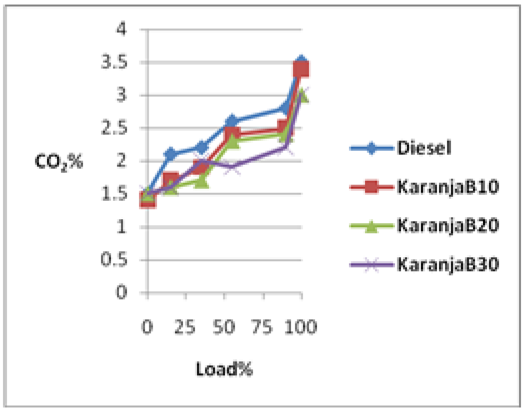
V. ENGINE EMISSIONS

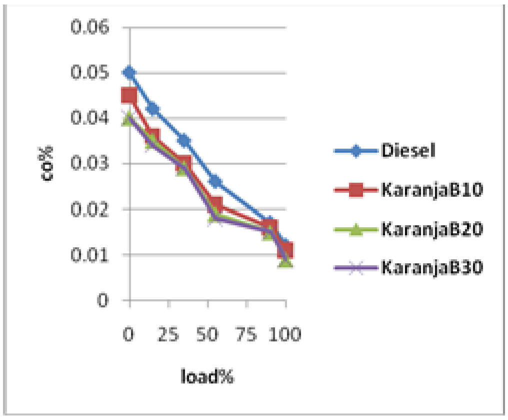
5.1 Carbon dioxide

Figure 5 shows the carbon dioxide vs. load. It is clear from figure that as the load on the engine increases the carbon dioxide increases. It was found that at higher load in case of biodiesel blends the carbon dioxide concentration is decreases n as compared to neat diesel. It was found that at higher load in case of karanja B30 the carbon dioxide was 3.07% as compared neat diesel was 3.3%.

5.2 Carbon monoxide

Figure 6 represents the carbon monoxide vs. load. It is clear from figure that as the load on the engine increases the carbon monoxide concentration decreases. Higher viscosity, density and evaporation energy of biodiesel results in inadequate fuel–air mixing, especially at lower engine speeds and loads which results higher concentration of CO at lower load. On the other side, at higher load oxygen present in the biodiesel enhance the combustion quality which results complete combustion take place inside the cylinder in case of biodiesel as compared to neat diesel. It was found that at higher load in case of B30 the less concentration was observed as compared to all fuels.





5.3 Unburned hydrocarbon

Figure 7 represents the unburned hydrocarbon vs. load. It is clear from figure as the load in the engine is increases the unburned hydrocarbon decreases. Reduction in over-mixing at lower engine loads due to poor biodiesel volatility. (b) Reduction in stoichiometric air requirement owing to fuel-bound oxygen in biodiesel, which enhances diffusion combustion and also increases heat release/gas temperature as compared to mineral diesel. At higher engine loads, oxygen present in biodiesel molecules helps in reduction of HC emissions, when the HC emissions are mainly caused by deficiency of oxygen in the fuel-rich zones. It was found that hydrocarbon is almost similar in case of B20 and neat diesel as compared to all fuels. It was found that in case of B20 blend the oxygen present in the biodiesel improves the combustion which results less hydrocarbon as compared to all fuels.

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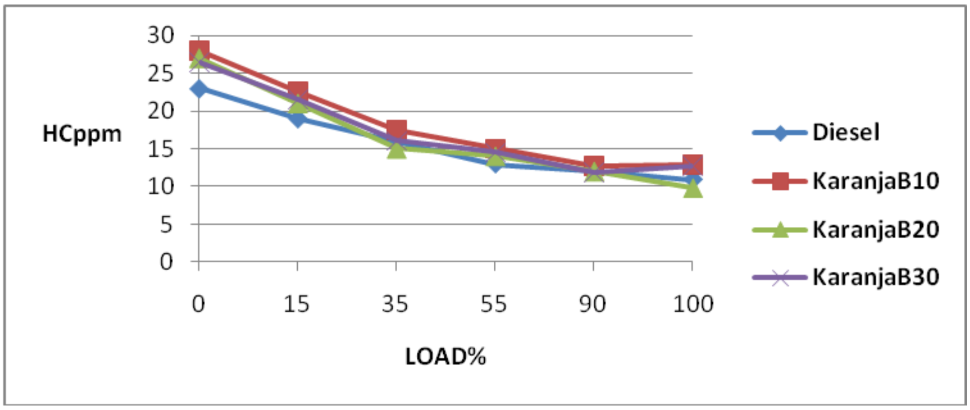
Figure-7



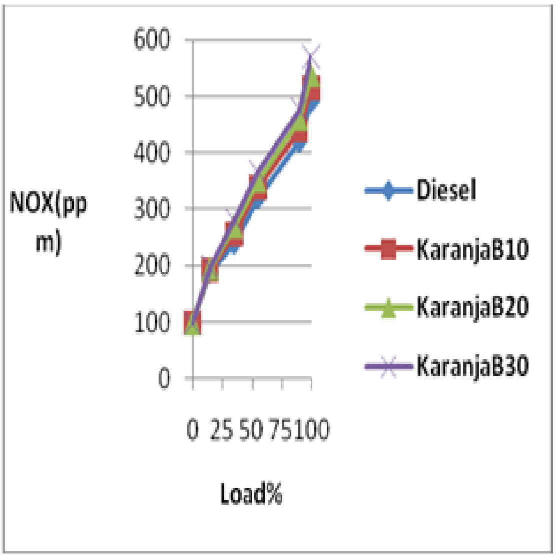
5.3 Oxides of Nitrogen

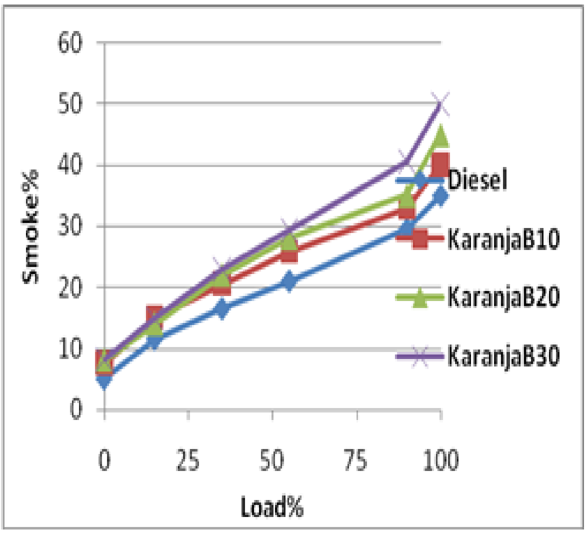
Figure 8 represent the NOx vs load. It is clear from figure the NOx level increases as the load on the engine is increases. Basically, NOx level depends upon higher temperature and oxygen content. It was found that oxygen present in the biodiesel enhance the combustion which results higher peak pressure and temperature rise inside the cylinder. It was found that at higher load in case of B30 the NOx level was 560ppm as compared to neat diesel was 500ppm. Further, it was concluded that in all blends the NOX level was higher as compared to neat diesel.

5.4 Smoke Density

Figure 9 represent the smoke density vs. load. It is clear from figure as the load on the engine increases the smoke density increases. It was found that at full load in case of B30 the smoke density was 40% as compared to neat diesel was 48%. It was found that in all blends the smoke density was low as compared to neat diesel at all loads.

Figure 8 **Figure 7**





VI. CONCLUSIONS

It was found that karanja is non-edible oil which is available in Rajasthan, India. Karanja oil has potential that can be converted into biodiesel. The characteristics of karanja biodiesel are found to be closed as per ASTM and BIS standards. Further the engine performance and emissions shows that karanja biodiesel can be used in CI engine without any modification. The experiment results shows blend B10 and B20 shows the same results. They improved BTH, EGT and reduced BSFC. Further they also reduced emissions like CO2, CO, HC and smoke density and increases NOx level as compared to diesel.

REFERENCES

[1]. Mofijur, M., Masjuki, H. H., Kalam, M. A., Atabani, A. E., Arbab, M. I., Cheng, S. F., et al. (2014). Properties and use of Moringa oleifera biodiesel and diesel fuel blends in a multi-cylinder diesel engine. Energy Conversion and Management, 82(0), 169-176.

[2]. BP Statistical Review of World Energy. January 2014. Outlook/Energy_Outlook_2035_booklet.pdf

[3]. Rahman, M. M., Hassan, M. H., Kalam, M. A., Atabani, A. E., Memon, L. A., & Rahman, S. M. A. (2014). Performance and emission analysis of Jatropha curcas and Moringa oleifera methyl ester fuel blends in a multi-cylinder diesel engine. Journal of Cleaner Production, 65(0), 304-310.

[4]. Swiss Agency for Development and Cooperation SDC-Natural Resources and Environment Division.

[5]. Cardona CA, Sánchez ÓJ. Fuel ethanol production: Process design trends and integration opportunities. *Bioresource Technol* **98 (2007)** 2415-2457.

[6]. Hulwan DB, Joshi SV. Performance, emission and combustion characteristic of a multicylinder DI diesel engine running on diesel– ethanol–biodiesel blends of high ethanol content. *Appl Energ* **88 (2011)** 5042-5055.

[7]. Shahir SA, Masjuki HH, Kalam MA et al. Feasibility of diesel–biodiesel–ethanol/bioethanol blend as existing CI engine fuel: An assessment of properties, material compatibility, safety and combustion. *Renew Sust Energ Rev* **32 (2014)** 379-395.

[8]. Atabani AE, Silitonga AS, Badruddin IA et al. A comprehensive review on biodiesel as an alternative energy resource and its characteristics. *Renew Sust Energ Rev* **16 (2012)** 2070-2093.

[9]. Mofijur, M., Masjuki, H. H., Kalam, M. A., Atabani, A. E., Fattah, I. M. R., & Mobarak, H. M. (2014). Comparative evaluation of performance and emission characteristics of Moringa oleifera and Palm oil based biodiesel in a diesel engine. Industrial Crops and Products, 53(0), 78-84.

[10]. Labeckas G, Slavinskas S, Mažeika M. The effect of ethanol–diesel–biodiesel blends on combustion, performance and emissions of a direct injection diesel engine. *Energ Convers Manage* **79 (2014)**: 698-720.

[11]. Yilmaz N, Vigil FM, Burl Donaldson A, Darabseh T. Investigation of CI engine emissions in biodiesel–ethanol–diesel blends as a function of ethanol concentration. *Fuel* **115 (2014)** 790-793.

[12]. Fang Q, Fang J, Zhuang J, Huang Z. Effects of ethanol–diesel–biodiesel blends on combustion and emissions in premixed low temperature combustion. *Appl Therm Eng* **54 (2013)**: 541-548.

[13]. Ferreira VP, Martins J, Torres EA et al. Performance and emissions analysis of additional ethanol injection on a diesel engine powered with A blend of diesel- biodiesel. *Energy Sustain Dev* **17(2013)** 649-657.

[14]. Zhu L, Cheung CS, Zhang WG et al. Effects of ethanol–biodiesel blends and diesel oxidation catalyst (DOC) on particulate and unregulated emissions. *Fuel* **113 (2013)** 690-696.

[15]. Armas O, Gómez A, Mata C, Ramos Á. Particles emitted during the stops of an urban bus fuelled with ethanol–biodiesel–diesel blends. *Urban Climate* **2 (2012)** 43-54.

[16]. Yilmaz N. Comparative analysis of biodiesel–ethanol–diesel and biodiesel–methanol– diesel blends in a diesel engine. *Energy* **40 (2012)** 210-213.

[17]. Pidol L, Lecointe B, Starck L, Jeuland N. Ethanol–biodiesel–Diesel fuel blends: Performances and emissions in conventional Diesel and advanced Low Temperature Combustions. *Fuel* **93 (2012)** 329-338.

[18]. Zhu L, Cheung CS, Zhang WG, Huang Z. Combustion, performance and emission characteristics of a DI diesel engine fueled with ethanol–biodiesel blends. *Fuel* **90 (2011)** 1743-1450.

[19]. Randazzo ML, Sodré JR. Exhaust emissions from a diesel powered vehicle fuelled by soybean biodiesel blends (B3–B20) with ethanol as an additive (B20E2–B20E5). *Fuel* **90 (2011)** 98-103.

[20]. Kim K., Kim H., Kim B., Lee K. and Lee K., Effect of Natural Gas Composition on the Performance of a CNG Engine, Oil & Gas Science and Technology – Rev. IFP, 2009;64(2); 199-206.