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PERFORMANCE AND EMISSIONS CHARACTERISTICS OF DIRECT INJECTION DIESEL ENGINE FUELED WITH APRICOT SEED BIODIESEL AND DIESEL

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ABSTRACT
In this experimental work, the main objective is to analyze the performance of an IC Engine using Apricot seed biodiesel as a fuel at various engine loads. Apricot (Prunus armeniaca) seed kernel oil was transesterified with methanol using potassium hydroxide as catalyst to obtain apricot seed kernel oil methyl ester .This work discusses about how the engine performs when this blends are used as a fuel. Several engine parameters such as specific fuel consumption, brake thermal efficiency, mechanical efficiency were investigated. The results indicated that the brake thermal efficiency, mechanical efficiency of B10 are nearer to neat diesel. Apricot seed kernel oil methyl ester and its blends can be successfully used in diesel engines without any modification. Lower concentration of apricot seed kernel oil methyl ester in blends gives equal performance as engine run by diesel and reduction in exhaust emissions. Therefore lower percent of apricot seed kernel oil methyl ester can be used as additive.

INTRODUCTION
Nowadays Energy crisis, Global warming, environmental pollution and limitations in conventional energy resources drive us towards environmentally friendly renewable resource and their efficient utilization. Therefore there is a great deal of interest and research on both alternative energy resource and t heir efficient use.

Internal combustion engines play an important role of energy utilization. They are used in transportation, cogeneration plants for electrical power generation and in mechanized agricultural sectors. Today, Internal Combustion Engines run, not only on conventional fossil fuels like diesel but also on alternative, renewable fuels such as biodiesel, biogas, and hydrogen and with blends. The performance, efficiency of internal combustion engines can be increased by applying new technologies such as combustion control systems, thermal insulation and exhaust recuperation. In this regard the Mechanical efficiencies of internal combustion engines fuelled with alternative fuels are very important. Biodiesel is an environmental friendly, alternative diesel fuel obtained from vegetable, fruit extracted oils and animal fats. Biodiesel and its blends with conventional diesel fuel can be used in diesel engines without significant modification on the engine

Apricot (Prunus armeniaca) is abundant around of Malatya (38 _ 350 0000 North, 38 _ 310 6700 East), the main production area, not only for Turkey but also for the whole world. Substantial quantities (80%) of the world's dried apricots are produced in Malatya. However apricot seed cannot be evaluated efficiently because most of it is bitter. Therefore, apricot seed kernel oil (ASKO) can be especially used by the farmers around Malatya as an alternative diesel fuel. But there has not been study reported in the literature on ASKO and apricot seed kernel oil methyl ester (ASKOME) as a biodiesel. Furthermore, ASKO and ASKOME have not been researched in the diesel engines. In the present investigation, ASKO, which was extracted from bitter apricot seed kernel was considered as a potential alternative fuel for compression ignition engines. Therefore potential apricot production throughout the world and the transesterification process for biodiesel production were investigated. Major physical and chemical properties of produced ASKOME as a biodiesel were determined. The engine tests were carried out on a compression ignition engine fuelled with only ASKOME and diesel fuel-ASKOME blends (containing 10%, 20%, and 50% ASKOME by volume) to determine engine performance and exhaust emissions in comparison with using diesel fuel

NOMECLATURE

ASKO- Apricot seed kernel oil before transesterification
ASKOME- Apricot seed kernel oil methyl ester after transesterification
BP- Brake power (kW)
IP- Indicated power (kW)
FP- Frictional power (kW)
TFC- Total fuel consumption (kg/sec)
SFC- Specific fuel consumption (kg/kW-sec)
CV- Calorific value (kJ/kg)
V- Voltage (Volts)
Q- Quantity of fuel consumed (cc)
I- Current (Amperes)
HI- Heat input (kW)
T- Temperature (^{0}C or K)
N- Speed (rpm)
t- Time (s)
η_{ith}- Indicated thermal efficiency (%)
η_{bth}- Brake thermal efficiency (%)
η_{mech}- Mechanical efficiency (%)

DESCRIPTION

ASKO was produced from apricot, which has been grown around of Malatya in Turkey. The basic composition of ASKO like any vegetable oil is triglyceride, which is the ester of three fatty acids and one glycerol. The fatty acid composition of ASKO is given in Table 1. The major fatty acid in the oil is oleic and linoleic, similar to rapeseed oils. ASKOME has been produced as an alternative fuel by transesterification method. In this study, BX represents a blend including X% ASKOME i.e. B10 indicates a blend including 10% ASKOME

Table 1-Apricot seed kernel oil fatty acid compositions.

Fatty acid	Structure (xx:y)	Formula	ASKO
Palmitic	(16.0)	$C_{16}H_{32}O_2$	5.62
Palmitoleic	(16.1)	$C_{16}H_{30}O_2$	0.72
Stearic	(18.0)	$C_{18}H_{36}O_2$	1.27
Olaic	(18.1)	$C_{18}H_{34}O_2$	67.31
Linoleic	(18.2)	$C_{18}H_{32}O_2$	24.68
Linolenic	*(18.3)*	$C_{18}H_{30}O_2$	0.08
Arachidic	(20.0)	$C_{20}H_{40}O_2$	0.1
Others	-	-	0.22

xx indicates number of carbons.
Y number of double bonds in the fatty acid chain.

EXPERIMENTAL SETUP:

The performance of biodiesel and its blends (B10, B20, and B50) were studied in comparison with diesel fuel. The compression ignition engine used for the study was a single cylinder, fourstroke, direct injection, air-cooled engine and the details are given in Table 2

Table 2.Engine Specifications

TYPE	SPECIFICATIONS
Engine Model	Kirloskar Engine
Applied Load Type	Electrical load
Maximum HP	5 HP
Cylinder Bore	85 mm

Stroke length	110 mm
Engine speed	1500 rpm
Type of dynamometer	Coupled with generator
Cooling type	Air cooled
Number of cylinders	1

Fig.1 Experimental Setup

The engine was coupled with an electric dynamometer to apply different engine loads. The engine was started on neat diesel fuel and warmed up. Then parameters like the speed of operation, fuel consumption and load were measured. After the engine reached the stabilized working condition, emissions were measured using an exhaust gas analyzer. The engine performance and exhaust emissions were studied at different engine loads and constant engine speed, 1500 rpm obtained maximum torque.

FUEL PROPERTIES:
The properties of biodiesel produced are very important and should be taken into consideration before testing it in the engine. The properties of diesel fuel, ASKO, and diesel fuel-ASKOME blends are given in Table 3

Table 3.Fuel Properties

Properties	Diesel	ASKO	B50	B40	B30	B20	B10
Density (kg/m^3)	830	884.3	884.3	856.7	845.9	835.9	831.7
Kinematic viscosity (mm^2/sec)	2.4	4.92	4.08	3.92	3.36	2.74	2.48
Calorific value (Mj/kg)	43.15	39.95	40.39	40.64	41.25	42.01	42.19
Flash point (^{0}c)	59	111	86	80	69	67	64
Fire point (^{0}c)	68	121	89	85	79	78	74

From the above table it was showed that the properties of ASKOME and diesel fuel-ASKOME blends are in the acceptable ranges. The kinematic viscosity values of ASKOME and the diesel fuels used in the experiments were measured at 40 ^{0}C.

The kinematic viscosity of ASKO was found to be approximately 2 times more than that of diesel determined at 40^{0}C.Transesterification of ASKO provided a significant reduction in viscosity. The variation of ASKOME viscosity is very close to the diesel fuel. It was further reduced with increase in diesel amount in the blend. A similar reduction in specific gravity was also observed. However, the calorific value of ASKOME was found to be 42.19 MJ kg_1, which is less than the calorific value of diesel (43.15 MJ kg_1) and greater than that of the ASKO (39.64 MJ kg_1). As the percentage of diesel in the blends increased, the calorific value increased. The flash points of ASKO and ASKOME were found to be greater than 100 ^{0}C, which represents a safety for storage and handling.

RESULTS AND DISCUSSIONS

Performance Analysis:

Brake specific fuel consumption:

Brake specific fuel consumption (BSFC) measures the amount of input fuel required to develop one-kilowatt power. The BSFC is an important parameter of an engine because it takes care of both mass flow rate and heating value of the fuel. As shown in Fig. 2, the BSFC initially decreases with increasing of engine load until it reaches a maximum value and then increases slightly with further increasing engine load for all kind of fuels. According to addition of biodiesel content in the blend, the BSFC initially decreases until it reaches a maximum value at B20 blend and then increases with more increase of the biodiesel content in blend. Biodiesel has maximum BSFC when applied only on the engine. In the using of blends B10 and B20, the BSFC of the engine nearer that of diesel for all loads for the reason that, biodiesel includes oxygen which improves combustion of fuel. The BSFC for diesel, B10 and B20 0.75, 0.82 was 0.79. The BSEC for B50 more values than diesel fuel due to the lower heating value and the higher viscosity, which results in slightly poorer atomization and poorer combustion.

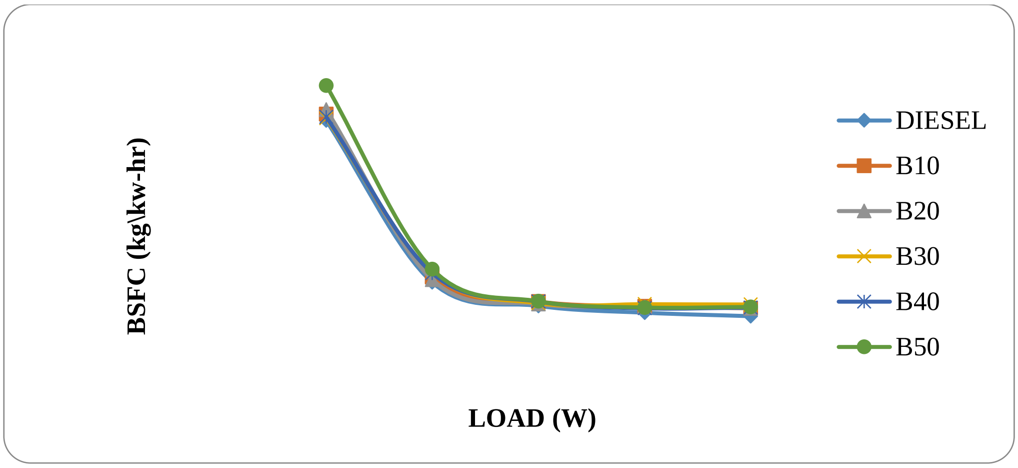

Fig 2. Variation of BSFC with respect to load

Brake Thermal Efficiency:

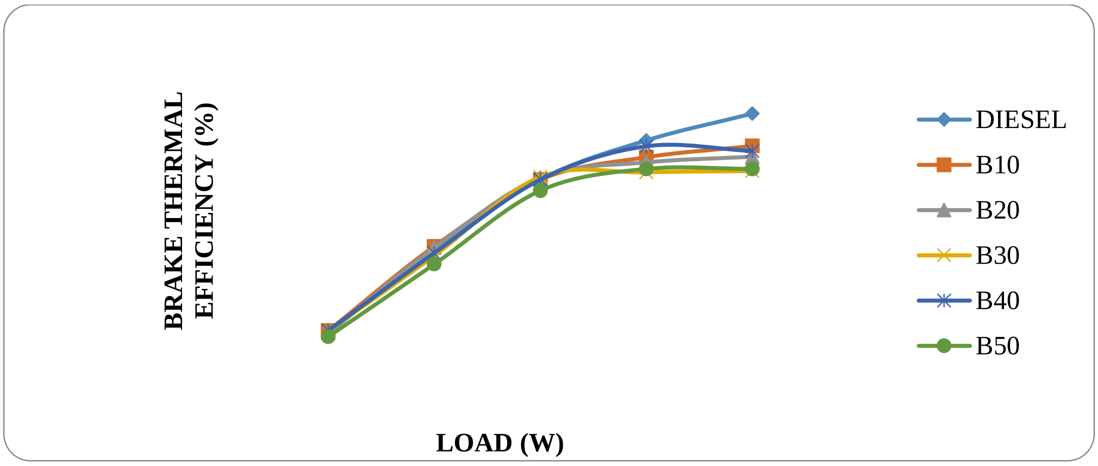

Fig3.Variation of Brake Thermal efficiency with Load

Thermal energy of an engine is defined as the ratio of output to that of the chemical energy input in the form of fuel supply. It may be based on brake or indicated output. It is the true indication of efficiency with which the thermodynamic input is converted into mechanical work. Brake thermal efficiency indicates how much amount of heat energy is converted into brake power. In above graph all blends have lower brake thermal efficiency than diesel because of having lower calorific value than diesel, more viscosity than diesel. B10 has near brake thermal efficiency to diesel due to having properties near to diesel and most of heat energy converted to bake power without loss in frictional power when compared to other blends.

Mechanical Efficiency:

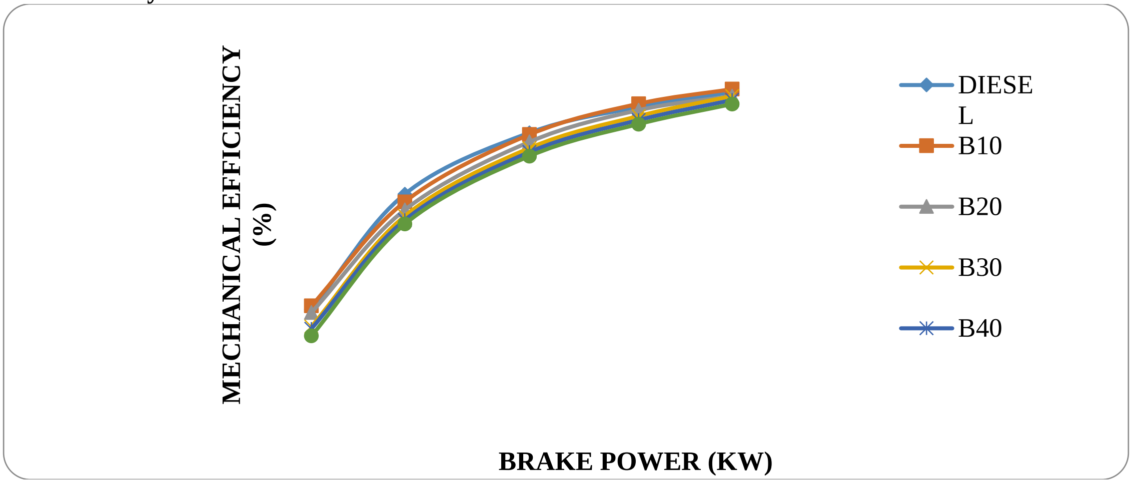

Fig4.Variation of Mechanical Efficiency with Load

Mechanical efficiency tells the performance of engine that is how much percent of input energy (indicated power) is converted to output energy (brake power). B10 and B20 has mechanical efficiency near to that of diesel because of proper combustion of fuel due to low viscosity, near calorific value to diesel and remaining blends has less mechanical efficiency than diesel because of improper combustion of fuel due to high viscosity and most of its power developed lost due to friction.

Emissions Analysis:

Carbon Dioxide(CO_2):

Fig.5. compares the Carbon dioxide (CO_2) production per input energy for all kind of fuels at different output power. The CO_2 emission of all fuels has the tendency to increase with increases in output power. Biodiesel emit the lowest level of CO_2 emissions. Using blends as the fuel, CO_2 emission is found to increase. The CO_2 emission initially increases with the addition of biodiesel content in the blend and reaches a maximum value at the B20 blend and then decreases with more increase of the biodiesel content. More amount of CO_2 in exhaust emission is an indication of the complete combustion of fuel. So higher CO_2 emission of B20 indicates effective combustion due to biodiesel includes oxygen, which improves combustion of fuel. This is confirmed by variation of BSFC. Higher percentage of biodiesel blends emits low amount of CO_2 emissions as a consequence of higher viscosity of biodiesel. Fuel spray cone angle, in which air entrainment depends, decreases with increased fuel viscosity. Decrease in cone angle results in reduction of amount of air entrainment in the spray. Lack of enough air in the fuel spray impedes completion of combustion and decreases formation of CO_2 emissions.

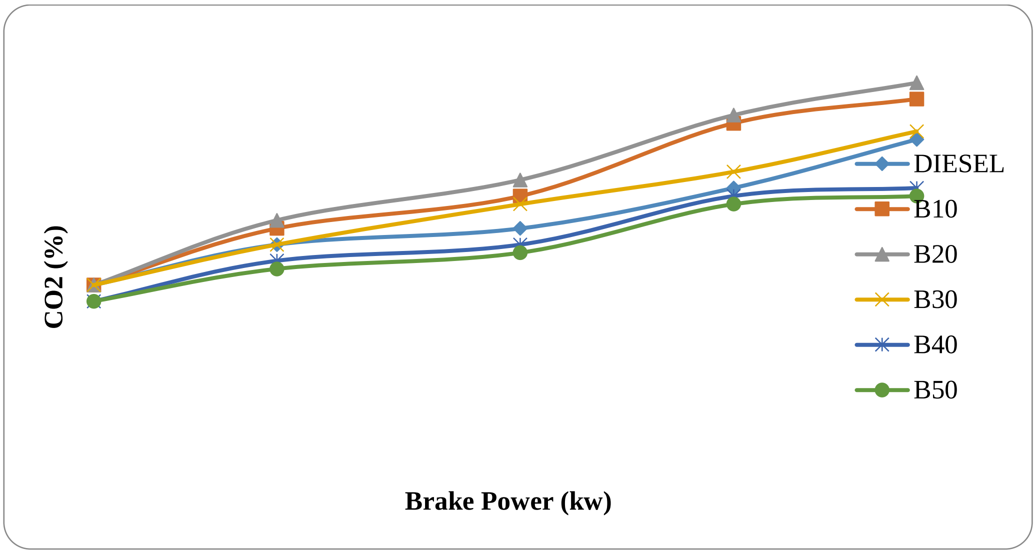

Fig5.Variation of CO_2 with BP

Carbon Monoxide (CO):
Fig. 6 shows the plots of carbon monoxide (CO) emissions of the diesel fuel, biodiesel fuel and theirs blends operation at the rated engine speed of 1500 rpm at various load conditions. The CO emissions are found to be increasing with increase in load since the air–fuel ratio decreases with increase in load such as all typical internal combustion engines. The engine emits less CO using neat biodiesel and its blends with diesel as compared to that of diesel fuel under all loading conditions. With increasing biodiesel percentage, CO emission level decreases for the reason that amount of oxygen content in biodiesel helps for the complete combustion.

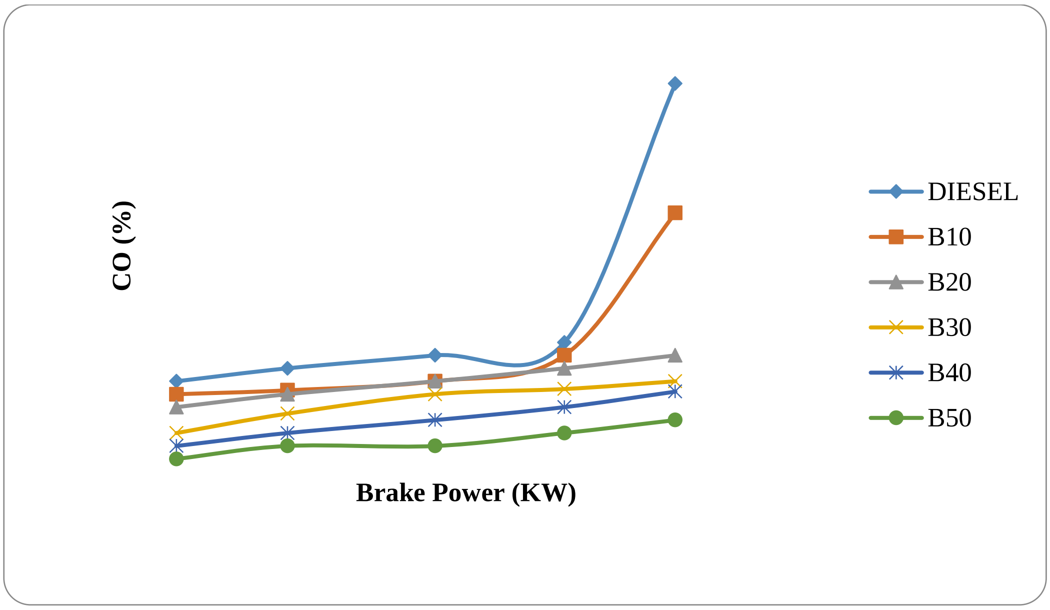

Fig6. Variation CO with BP

Hydro-Carbons:
The variation of hydrocarbon (HC) emission with load for different fuels tested is plotted in Fig. 7. The HC emissions increase with increasing in load. HC emissions decreases with increasing biodiesel percentage in the

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blend and reaches minimum value when used pure biodiesel as fuel. This decreasing may be explained with the oxygen content in biodiesel improve the quality of combustion.

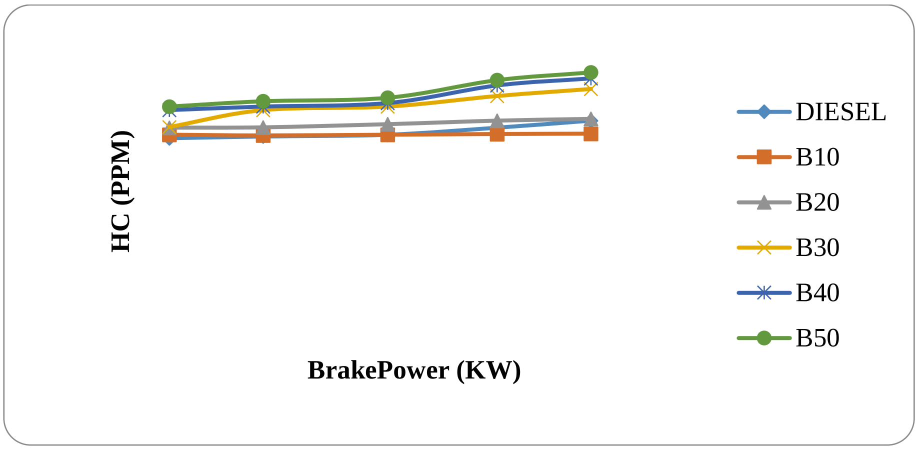

Fig8.Variation of HC with respect to BP

Nitrogen oxides (NO_x):

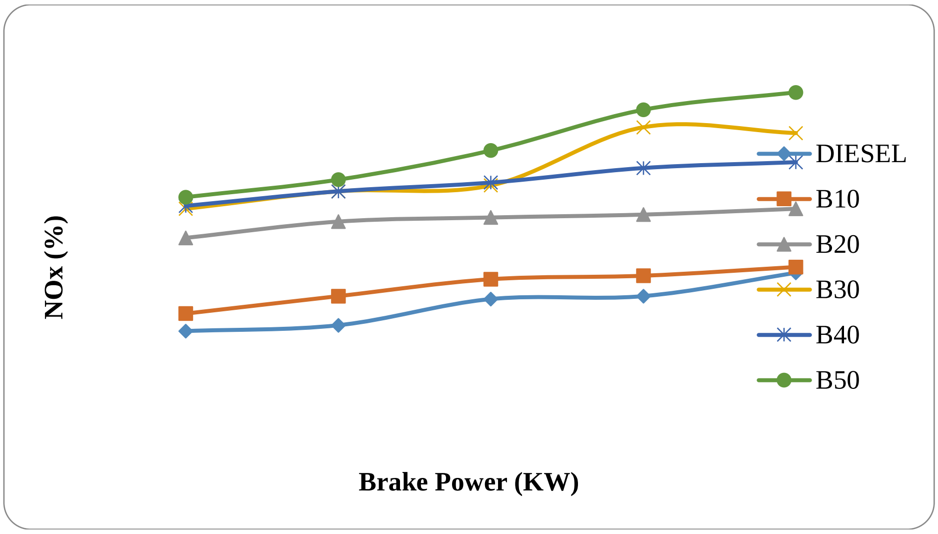

Fig9.Variation of Nitrogen Oxides with respect to BP

Fig. 8 shows the variation of Nitrogen oxides (NOx) with brake power. The NOx emission for biodiesel and its blends is higher than that of the diesel oil. The NOx emission increases with increasing of biodiesel include in the blends and reaches maximum value with using pure biodiesel as fuel. Nitrogen oxides are reported by several researchers to be increased with biodiesel. The emission of NOx is determined by oxygen concentration, peak pressure, combustion temperature and time. The availability of oxygen in biodiesel can explain the increase in the NOx emission, since additional oxygen for NOx formation may be provided by the fuel oxygen

CONCLUSIONS

In the present investigation, the ASKO, which was extracted from bitter apricot seed kernel, was considered as a potential alternative fuel for compression ignition engines. The ASKO was transesterified under optimum reaction condition and obtained the ASKOME. The important properties of ASKOME are quite close to that of diesel. The ASKOME and its different blends with diesel fuel were used as fuel in a compression ignition engine and its performance and emission characteristics were analyzed. Lower percent of ASKOME blends has equal BSFC as diesel. Furthermore they were found to improve exhaust emissions. Higher percent of ASKOME blend (B50) and neat ASKOME reduced CO, HC emission. But they increased slightly NOx emission and give lower performance characteristics than diesel fuel. Therefore, lower percent of ASKOME can be used as additive, which improves performance and exhaust emission in diesel fuel. Consequently ASKOME can effectively be used in diesel engines without any modification. Using of the ASKOME as diesel fuel can improve the agriculture economy and diminish indecision of fuel availability besides its environmental benefits.

REFERNCES

1. Internal Combustion Engines By V.Ganesan, The Mc Graw-Hill Companies.
2. Jinlin Xue, Tony E. Grift, Alan C.Hansen, Effect of biodiesel on engine performance and emissions, Elsevier Journal Renewable and Sustainable Energy Reviews,15(02),2011,1098-1116.
3. A course in internal combustion engines by M.L.Mathur and Sharma, Dhanpat Rai & sons publications.
4. A Review on Methods of Transesterification of Oils and Fats in Bio-diesel Formation. International Journal of ChemTech Research CODEN (USA): IJCRGG ISSN : 0974-4290 Vol.6, No.4, pp 2568-2576, July-Aug 2014
5. Base catalyzed transesterification of wild apricot kernel oil for biodiesel production African Journal of Biotechnology Vol. 8 (14), pp. 3289-3293, 20 July, 2009 Available online at http://www.academicjournals.org/AJB ISSN 1684–5315 © 2009 Academic Journals
6. Transesterification of vegetables oils in subcritical methanol conditions, 18 European Biomass conference and exhibition 3-7 may 2010, Lyon, France.
7. Use of vegetable oils as I.C. engine fuels—A review, A.S. Ramadhas _, S. Jayaraj, C. Muraleedharan Department of Mechanical Engineering, National Institute of Technology Calicut, Calicut REC P.O., Calicut 673601, India Received 28 April 2003; accepted 15 September 2.