Effect of idling on fuel consumption and emissions of a diesel engine fueled by Jatropha biodiesel blends


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ARTICLE INFO

Article history:
Received 28 October 2013
Received in revised form 2 January 2014
Accepted 12 January 2014
Available online 23 January 2014

Keywords:
Biodiesel
Jatropha curcas
Idling
Emissions
Fuel consumption

ABSTRACT

An engine running at low load and low rated speed is said to be subject to high idling conditions, a mode which represents one of the major problems currently the transport industry is facing. During this time, the engine can not work at peak operating temperature. This leads to incomplete combustion and emissions level increase due to having fuel residues in the exhaust. Also, idling results in increase in fuel consumption. The purpose of this study is to evaluate fuel consumption and emissions parameters under high idling conditions when diesel blended with Jatropha curcas biodiesel is used to operate a diesel engine. Although biodiesel–diesel blends decrease carbon monoxide and hydrocarbon emissions, they increase nitrogen oxides emissions in high idling modes. Compared to pure diesel fuel, fuel consumption also increases under all high idling conditions for biodiesel–diesel blends, with a further increase occurring as blend percentage rises.

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1. Introduction

Adaptability, reliability, higher combustion efficiency and handling facilities are the reasons behind wide acceptance of diesel fuel around the world (Ribeiro et al., 2007). In present, transport industry largely depends upon diesel fuel. But, currently this sector is facing some problems while using diesel fuel. It has been reported that, the major source of environmental pollution is the emissions from fossil fuel (Mofijur et al., 2013). These emissions may rise up to 39% by the end of 2030 if no stringent legislation is introduced to limit the emissions from diesel fuel (Mofijur et al., 2012). Many countries have imposed environmental taxes to control the emissions. Fig. 1 depicts environmental taxes as % of GDP for different countries of European Union whereas Fig. 2 shows environmental taxes by categories: Energy taxes, Transport taxes, Pollution and Resource taxes (Environmental tax statistics, 2011).

Diesel fuel is non-renewable, it is depleting rapidly, and hence the above situations accentuate research in a large scale to find out alternative renewable fuels which must be technically feasible, environmentally acceptable and domestically available. Also, they must be able to fulfill the large energy demand. Nowadays the tendency to use renewable fuels has been proliferated due to less production cost, rising fossil-fuel prices and carbon pricing.

Amongst many renewable fuels, biodiesel is rapidly becoming the best option to substitute diesel fuel. This is due to its potential to satiate the energy demand, abate global warming and greenhouse gasses (Shahabuddin et al., 2013). Throughout the world, the production of biodiesel has proliferated in the recent decade when the production was 19 thousand barrels per day in 2001, it increased up to 403 thousand barrels per day in 2011 to 403 thousand barrels per day, on the other hand, consumption raised to 414 thousand barrels per day from 17.5 thousand barrels per day in this same period of time (EIA). Biodiesel, also known as fatty acid methyl ester, can be produced from vegetable oils or animal fats by employing dilution, pyrolysis, trans-esterification and micro treatment (Singh and Singh, 2010). Biodiesel is non-flammable, biodegradable, non-toxic, renewable, and environmentally friendly (Basha and Raja Gopal, 2012; Jayed et al., 2011). Biodiesel has similar properties like diesel fuel properties (Jayed et al., 2009; Lin et al., 2011). The chief benefits of using biodiesel is that, it can be applied with diesel as biodiesel-diesel blend at any proportion (Jain and Sharma, 2011). Moreover, absence of deleterious substance and lesser amount of harmful emissions to the environment are reason behind biodiesels continuous growth in popularity.

The use of biodiesel in diesel engine as blend has great impact on engine performance and emissions. Many researches have been carried out to appraise the engine performance and emissions using biodiesel and their blends (Atabani et al., 2013; Hussan et al., 2014). These emissions occurring as blend percentage rises.
Researchers’ results showed that, diesel engine operated with biodiesel—diesel blends emit lesser amount of CO and HC emissions, whereas it increases NO\textsubscript{x} emissions (Alam et al., 2006; Ozsezen et al., 2009; Wu et al., 2009). Engine performance is highly affected by the quality of biodiesel. Poor quality of biodiesel will result in deposits, corrosion, and excessive engine wear which ultimately accumulates to engine breakdown (Bhale et al., 2009). Deposits and clogging due to use of biodiesel are major problems for diesel engine (Knothe, 2006; Lapuerta et al., 2008a,b). Deposits on injectors due to the use of biodiesel will affect the fuel spray pattern, deposits in injector pump will affect the engine performance (Çetinkaya et al., 2005). Biodiesel may dilute lubrication on, which may lead to rising oil levels, loss of oil pressure and worn bearings. As biodiesel is a very effective solvent for some materials used in engine, fuel leakage can become a vital problem. To avoid these problems, it is important to make sure that the quality of the biodiesel is excellent and the engine is “rated for biodiesel use” (Agarwal et al., 2003; Bhale et al., 2009). Roy et al. (2013) investigated engine performance and emissions during high idling conditions. High idling is a critical problem for the transport industry. The high idling operational condition is defined as a condition in which the engine runs at low load and at low rated speed. After driving for a certain period, as it is imperative for drivers to take a repose they keep the engine running idle to maintain amenities, such as refrigerators, heating, microwave and air conditioning, and to provide power to the cab. Several studies reported an average 6—16 h idling per day for long-haul trucks. Engine idling results in high fuel consumption. During this time, the engine can not work at peak operating temperature. This leads to incomplete combustion and emissions level increase due to having fuel residues in the exhaust. Heretofore, many researches have conducted to evaluate the engine performance and emissions using only diesel fuel at idling condition. Researchers found that, during engine idling NO\textsubscript{x} emissions was 1.5 times higher than vehicle running on road (Lambert et al., 2002). Also, NO\textsubscript{x} increase with increasing load during idling (Khan et al., 2006; Zietsman et al., 2005). During idling fuel consumption can be as high as 1.65 gal/h (Lim, 2002), CO emissions can be as high as 295 g/h (Storey et al., 2003), and HC emissions can be as high as 86.4 g/h (Brodrick et al., 2002). Compared to driving cycle emissions HC emissions during idling is reported to be 1 to 5 times more than that of driving cycle and idling CO emissions were 5—75% of driving emissions (McCormick et al., 2000). The study of Roy et al. (2013) was based upon biodiesel produced from Canola oil. But since canola oil is an edible oil, so using biodiesel produced from canola oil will be a menace to food security. As the world confronts a reported food shortage and rising fuel prices, researchers are looking for feedstock that would not affect food security. It is becoming increasingly apparent that the demand for biodiesel is going to increase in near future. Albeit many edible oils might be the inexpensive feedstock for biodiesel production, but most of them are not a sustainable source to meet this increasing demand. This substantiates the necessity to use non-edible oil feedstock for biodiesel production. In this perspective, Jatropha oil is a promising non-edible feedstock. It will not pose a threat to food security. As the world confronts a reported food shortage and rising fuel prices, researchers are looking for feedstock that would not affect food security. It is becoming increasingly apparent that the demand for biodiesel is going to increase in near future. Albeit many edible oils might be the inexpensive feedstock for biodiesel production, but most of them are not a sustainable source to meet this increasing demand. This substantiates the necessity to use non-edible oil feedstock for biodiesel production. In this perspective, Jatropha oil is a promising non-edible feedstock. It will not pose a threat to food security. Thus, it has gained popularity as a prospective substitute of diesel fuel and many studies have been conducted to evaluate engine performance using Jatropha biodiesel blends in a diesel engine (Ong et al., 2013; Palash et al., 2014; Rahman et al., 2014; Sanjid et al., 2014). However, no study was done to evaluate its performance during idling. So, the main objectives of this study are—

a) Characterization of Jatropha biodiesel properties in order to compare with ASTM standards
b) Study of effect of Jatropha biodiesel blends on fuel consumption at high idling conditions
c) Study of effect of Jatropha biodiesel blends on engine emissions conditions at high idling conditions

![Environmental Tax as % of GDP](image-url)

**Fig. 1.** Environmental taxes as % of GDP and as % of total taxes and social contributions.
2. Biodiesel property test

Jatropha biodiesel (JB100) properties were measured in the Energy Laboratory and the Engine Tribology Laboratory, Department of Mechanical Engineering, University of Malaya. Property testing equipment and method are listed in Table 1 and the measured fuel properties are given in Table 2.

3. Engine test

The engine test was done with an in-line four cylinder CI engine which was coupled with an eddy current dynamometer. Three idling conditions (1000 RPM 10% load, 1200 RPM 12% load and 1500 RPM 15% load) were considered in this investigation. 10% and 20% (JB10 and JB20) blends of Jatropha along with diesel fuel have been used to run the engine. Also, to depict the effect of idling, engine was run at 100% load at 2000 RPM and measured data were compared with the idling data. Schematic diagram of the engine setup is given in Fig. 3. Tables 3 and 4 shows engine specification and test equipment respectively. For combustion analysis a pressure sensor and a crank angle encoder (RIE-360) have been used. These two sensors together provides the in-cylinder pressure variation with crank angle. Digital data have been recorded in a computer using a software name DEWESoft Combustion Analyzer.

4. Results

Fig. 4 shows CO emissions at different idling conditions for diesel and Jatropha biodiesel blends. The lowest CO emissions are achieved for JB20 at all the operating conditions. Also, in every condition diesel fuel produced maximum emissions. As blend percentage of biodiesel in diesel increased emissions decreased.

Fig. 5 represents HC emissions at different idling conditions for diesel and Jatropha biodiesel. It can be seen that, diesel fuel emits highest amount of HC at all conditions and 20% Jatropha biodiesel blends emits lowest.

Furthermore, it is seen that increase in idling speed decreases HC emissions for all tested fuel.

Fig. 6 demonstrates NOX emissions at different idling conditions for diesel and Jatropha biodiesel blends. Diesel fuel exhibited lowest emissions at all condition. As blend percentages of biodiesel increases emissions increases. JB20 emitted highest NOX emissions.

Also it is evident that increase in idling speed reduces NOX emissions.

Fig. 7 shows the fuel consumption at different idling conditions for diesel and Jatropha biodiesel blends. At all conditions diesel fuel consumption rate was lowest, and as blend percentages increased fuel consumption increased. JB20 biodiesel blends fuel consumption were highest at all conditions.

Fig. 8 depicts in-cylinder pressure at various crank angle of Jatropha biodiesels at all idling modes. From the figures it can be seen that, maximum in-cylinder pressure for diesel fuel at all idling modes are lowest compared to Jatropha biodiesel–diesel blends. With increase in blend percentages of Jatropha biodiesel in diesel, cylinder pressure increases for all the idling modes.

5. Discussion

During this time, the engine can not work at peak operating temperature. This leads to incomplete combustion and emissions level increase due to having fuel residues in the exhaust. Also, idling results in increase in fuel consumption. One of the main factor of
increase in HC emissions is at light idle and load is over mixing, especially for engines of a relatively small size at high speed. Incomplete oxidation product of fuel carbon results in Carbon Monoxide (CO) emissions. Generally CO formation is resulted from incomplete combustion. Incomplete combustion occurs when flame front approaches to crevice volume and relatively cool cylinder liner.

From Fig. 4, increase in percentage of biodiesel in blend, decreased CO emission. These may be due to the higher concentration of O\textsubscript{2} in the air-fuel mixture which ensured improved combustion and hence reduction in CO emissions at idling conditions. Also, due to these reason, HC emissions decreases with increase in blend percentages which can be seen from Fig. 5. Decrease in HC emission with increase in idling speed is due to the reason that increase in speed ensures better mixing of air and fuel. CO emission at idling mode 1 for diesel, JB10 and JB20 was 22.43 g/h, 18.80 g/h and 16.55 g/h respectively. The reduction of CO emission due to use of biodiesel was 16.18\% and 26.2\% respectively for JB10 and JB20. CO emission at idling mode 2 for diesel, JB10 and JB20 was 19.77 g/h, 17.03 g/h and 15.36 g/h respectively. The reduction of CO emission due to use of biodiesel was 13.9\% and 22.3\% respectively for JB10 and JB20. CO emission at idling mode 3 for diesel, JB10 and JB20 was 17.29 g/h, 14.49 g/h and 10.12 g/h respectively. The reduction of CO emission due to use of biodiesel was 16.7\% and 41.46\% respectively for JB10 and JB20. The reduction of HC emissions due to use of biodiesel was at idling mode 1–4\% and 36.36\%, at idling mode 2–11.11\% and 42\%, at idling mode 3–2.37\% and 44\% respectively for JB10 and JB20. As increase in blend percentages also means additional oxygen content of the biodiesel facilitate better combustion. Similar trends were observed in the study of Roy et al. (2013), where the author reported that canola oil biodiesel blends decreased CO emissions compared to diesel fuel at high idling conditions. Canola biodiesel–diesel blends exhibited similar reduction of HC, however, achieved lower CO emissions reduction compared to Jatropha biodiesel blends used in this study. Reduction of CO and HC emissions also supported by other researchers (Lakshmi Narayana Rao et al., 2007; Narayana Reddy and Ramesh, 2006). Compared to engine running at 100\% load and 2000 RPM, CO emissions for diesel, JB10 and JB20 at three idling modes were 39.29–50.97\%, 36.84–47.8\% and 27.59–45.12\% respectively. Compared to engine running at 100\% load and 2000 RPM, HC emissions for diesel, JB10 and JB20 at three idling modes were 44.55–53.67\%, 44.48–52.67\% and 31–42.7\% respectively.

From Fig. 6, compared to diesel fuel, biodiesel blends produced higher NO\textsubscript{x} emissions. NO\textsubscript{x} emission at idling mode 1 for diesel, JB10 and JB20 was 1.54 g/h, 1.72 g/h and 1.869 g/h respectively. The increase of NO\textsubscript{x} emission due to use of biodiesel was 11.7\% and 21.36\% respectively for JB10 and JB20. NO\textsubscript{x} emission at idling mode 2 for diesel, JB10 and JB20 was 1.464 g/h, 1.64 g/h and 1.807 g/h respectively. The increase of NO\textsubscript{x} emission due to use of biodiesel was 12.02\% and 23.42\% respectively for JB10 and JB20. NO\textsubscript{x} emission at idling mode 3 for diesel, JB10 and JB20 was 1.185 g/h, 1.339 g/h and 1.573 g/h respectively. The increase of NO\textsubscript{x} emission due to use of biodiesel was 13\% and 32.74\% respectively for JB10 and JB20. So, it is clearly evident that, increase in biodiesel percentages significantly increases NO\textsubscript{x} emissions, these trends are supported by Lapuerta et al. (2008a,b). Biodiesels have higher cetane number and thus lower ignition delay (Robbins et al., 2009). A shorter ignition delay could allow the fuel mixture and initial combustion products to have a longer residence time at elevated temperature, thereby increasing thermal NO\textsubscript{x} formation. Biodiesel reduces soot concentration. Soot particles reduces chamber temperature through radiative heat transfer. Thus decreasing soot particles results in higher combustion chamber temperature thus increases NO\textsubscript{x} emissions (Hoekman and Robbins, 2012; Mueller et al., 2009). However, it is observed that, the higher the speed, the lower the NO\textsubscript{x} emissions. This may be attributed to the shorter residence time/ignition delay available for NO\textsubscript{x} formation at higher speeds (Lin and Li, 2009). Also, increase in NO\textsubscript{x} emissions with increase of percentages of biodiesel in blends is due to the reason that biodiesel have higher oxygen contents compare to diesel fuel (Hansen et al., 2006; Ozsezen et al., 2009). Roy et al. (2013) reported that,
lower percentages of canola biodiesel in blends exhibited almost negligible increase in NO\textsubscript{x} emission compared to diesel fuel, however as blend percentage increased emissions increase significantly, 20% Canola biodiesel blend, emitted almost 30–50% more NO\textsubscript{x} compared to diesel fuel at all condition. Similar trend is also seen in this study. Also, increase in NO\textsubscript{x} emissions due to use of Jatropha biodiesel is supported by Lakshmi Narayana Rao et al. (2007). Compared to engine running at 100% load and 2000 RPM, NO\textsubscript{x} emissions for diesel, JB10 and JB20 at three idling modes were 41.34–53.73%, 45–58% and 51.73–61.5% respectively.

Biodiesel have lower heating value compared to diesel fuel. From Table 2, it is seen that Jatropha biodiesel have lower calorific value of 39.8 MJ/kg whereas Diesel fuel have 44.664 MJ/kg. Compared to diesel fuel, which is almost 11% less. Due to this reason, Jatropha biodiesel blends have less calorific value. Thus fuel consumption increases. Fuel consumption also increased with rising idling speed. According to Lim, when an engine is idling at a faster speed, fuel consumption will be higher due to an increase in the fuel injection rate per second (Lim, 2002). Increase in fuel consumption for JB10 and JB20 for idling mode 1 was 21.05% and 26.3%, for idling mode 2 was 17.4% and 26.1% and for idling mode 3 was 3.33% and 6.66% respectively. So, it is clearly evident that, increase in idling speed results in somewhat better combustion thus, increase in fuel consumption is significantly reducing with speed due to use of Jatropha biodiesel blends. Compared to engine running at 100% load and 2000 RPM, fuel consumption for diesel, JB10 and JB20 at three idling modes were 35–44%, 38.5–48% and 41.2–51.4% respectively.

When the engine is running at low load, residual gas temperature and wall temperature are low. Therefore, injection charge temperatures are also significantly low, which in turns increases injection delay period. Thus for diesel fuel combustion starts later compared to biodiesel and its blends, and thus have a lower peak pressure compared to biodiesel blends. Consequently, for diesel fuel, the peak cylinder pressure reaches a lesser value further away from the top dead center in the expansion stroke. Again, for biodiesel and its blends peak cylinder pressure take place earlier. These trends are observed in Fig. 8. For idling mode 1, peak cylinder pressure for diesel, JB10 and JB20 were 53.7 bar 55.9 bar and 56.8 bar respectively, whereas, for idling mode 2, they were 60.7 bar, 61.1 bar and 62.5 bar respectively. And, for idling mode 3, the values were 62.9 bar, 63.1 bar and 64.8 bar for diesel, JB10 and JB20 respectively.

Also, all the results found from this study is within the range reported in several literature (Brodrick et al., 2002; Lim, 2002; Storey et al., 2003).
6. Recommendation—alternatives of idling

The use of some technical applications (such as vehicle’s battery, Direct fire heater etc.) offer substitutes to engine idling (Frey et al., 2001; Pfaff et al., 2011). The vehicle’s battery power could be presented as the first alternate, but they might become stressed through protracted use. Another option is direct fire heaters (DFHs), which maintain a supply of heat to the cabin and consume a smaller amount of fuel for heating the cab/sleeper. However, DFHs do not provide power to any other accessories. Thermal storage systems (TSSs) use the thermal energy conveyed from the engine or air conditioner during the vehicle’s operation. This energy is stored in a phase-change material. TSSs can supply both cooling and heating of the cabin. Auxiliary power units (APUs) are the internal-combustion engine, which also consists of heat recovery and a generator to provide heat and electricity (Baratto et al., 2005). APUs do not replace the original engine but complement it by offering low emissions, high comforts, and low fuel consumption while idling. There are many types of APUs, such as diesel internal-combustion engine (Hoekman et al., 2012). APUs, battery electric APUs, diesel fuel cell APUs, etc. Diesel ICE and battery electric APUs can be great substitutes to idling. The one major drawback of battery APUs is that they are not able to store and deliver the equivalent power that is available from diesel ICE APUs. When the truck is parked, compared with diesel ICE and battery APUs, the diesel fuel cell APUs can provide auxiliary power at higher efficiency. In addition, the efficiency of the APU compared with the combination of the diesel engine and the alternator, is much higher. These systems can also supply the vehicle with auxiliary power when running, which means that the energy efficiency will increase overall (Soberanes et al., 2012). Among the various fuel cells available, only solid oxide fuel cells (SOFCs) and proton exchange membrane fuel cells (PEMFCs) are most suited as on-board APUs (Agnolucci, 2007; Lawrence and Boltze, 2006). For fuel cell APUs, 30% fuel efficiency has been reported in the literature (Lawrence and Boltze, 2006). Fuel cell APUs can reduce both the fuel consumption of trucks and the emissions of pollutants substantially. A completely different approach is seen in the scenario of truck stop electrification (TSE). To power the non-propulsion requirements at a truck-stop, the trucks are simply “plugged in” to the outlets. This allows operation of on-board systems, such as sleeper cab cooling, heating, microwave ovens, televisions, refrigerators, and other small appliances when parked without the need for idling (Jain et al., 2006; Zietsman et al., 2005). If truck stop electrification is utilized properly, it can reduce fuel consumption during idling substantially or eventually, eliminate it altogether. An inverter converts the truck’s 12 V battery direct current (DC) power into 120 V alternative power for cab appliances and accessories. However, the main problem with inverters is that they can not supply high-power-draw devices, such as an air conditioner or heater for an extended period of time (Perrot et al., 2004). Noise, additional maintenance, and deterioration of the engine are the major disadvantages of APUs. The disadvantages of DFHs are their inability to provide cooling and the amount of use required of the trucks’ battery, while the disadvantages of fuel cells are the absence of appropriate fuels, higher production expenses of the units, and the integration of the units with other on-board truck systems. TSE also has significant disadvantages, which comprise the cost of the...
equipment and accessibility, because the use of the system is restricted to truck stops (Hafiz et al., 2007).

7. Conclusions

An experimental investigation has been carried out to figure out the fuel consumption and emissions parameters at high idling conditions. The most important conclusions derived are summarized as follows:

- **Fuel consumption** — At high idling conditions brake specific fuel consumption for Jatropha biodiesel blends increased compared to diesel fuel. As blend percentages of biodiesel increased fuel consumption increased. Increase in fuel consumption for JB10 and JB20 for idling mode 1 were 21.05% and 26.3%, for idling mode 2 were 17.4% and 26.1% and for idling mode 3 were 3.33% and 6.66% respectively. Compared to engine running at 100% load and 2000 RPM, fuel consumption for diesel, JB10 and JB20 at three idling modes were 35—44%, 38.5—48% and 41.2—51.4% respectively.

- **CO emissions** — CO emissions decreased with increase in blend percentages and at all tested conditions they were lower than diesel fuel. CO emission at idling mode 1 for diesel, JB10 and JB20 was 22.43 g/h, 18.80 g/h and 16.55 g/h respectively. The reduction of CO emission due to use of biodiesel was 16.18% and 26.2% respectively for JB10 and JB20. CO emission at idling mode 2 for diesel, JB10 and JB20 was 19.77 g/h, 17.03 g/h and 15.36 g/h respectively. The reduction of CO emission due to use of biodiesel was 13.9% and 22.3% respectively for JB10 and JB20. CO emission at idling mode 3 for diesel, JB10 and JB20 was 17.29 g/h, 14.49 g/h and 10.12 g/h respectively. The reduction of CO emission due to use of biodiesel was 16.7% and 41.46% respectively for JB10 and JB20. Compared to engine running at 100% load and 2000 RPM, CO emissions for diesel, JB10 and JB20 at three idling modes were 39.29—50.97%, 36.84—47.8% and 27.59—45.12% respectively.

- **HC emissions** — HC emissions decreased with increase in blend percentages and at all tested conditions they were lower than diesel fuel. The reduction of HC emissions due to use of biodiesel was at idling mode 1—4% and 36.36%, at idling mode 2—11.1% and 42%, at idling mode 3—2.37% and 44% respectively for JB10 and JB20. Compared to engine running at 100% load and 2000 RPM, HC emissions for diesel, JB10 and JB20 at three idling modes were 44.55—53.67%, 44.48—52.67% and 31—42.7% respectively.

- **NOx emissions** — NOx emission at idling mode 1 for diesel, JB10 and JB20 was 1.54 g/h, 1.72 g/h and 1.869 g/h respectively. The increase of NOx emission due to use of biodiesel was 11.7% and 21.36% respectively for JB10 and JB20. NOx emission at idling mode 2 for diesel, JB10 and JB20 was 1.464 g/h, 1.64 g/h and 1.807 g/h respectively. The increase of NOx emission due to use of biodiesel was 12.02% and 23.42% respectively for JB10 and JB20. NOx emission at idling mode 3 for diesel, JB10 and JB20 was 1.185 g/h, 1.339 g/h and 1.573 g/h respectively. The increase of NOx emission due to use of biodiesel was 13% and 32.74% respectively for JB10 and JB20. As blend percentages increased to NOx emissions increased significantly. Also, with increase in idling speed NOx emissions decreased, due to shorter residence time/ignition delay available for NOx formation at higher speeds. Compared to engine running at 100% load and 2000 RPM, NOx emissions for diesel, JB10 and JB20 at three idling modes were 41.34—53.73%, 45—58% and 51.73—61.5% respectively.

The increasing motorization throughout the world has intensified the demand of fossil fuel which has led clean environment in peril. The harmful exhaust emissions from the engines, rapid increase in the prices of petroleum products, and uncertainties of their supply have jointly created renewed interest among the researchers to search for suitable alternative fuels. Most of the oils used for the production of biodiesel by various researchers were soybean, sunflower, safflower, cotton, and rapeseed. These oils are essentially edible oil. Using edible oils to produce biodiesel may result a dearth of food. Thus, biodiesel produced from non–edible oil is currently gaining momentum throughout the world. Jatropha curcas is one such kind of non–edible feedstock. Thus, this can be used to produce biodiesel. From this study, it has been explicit that, during idling condition, use of Jatropha biodiesel–diesel blends makes a conspicuous improvement CO and HC emissions. However, fuel consumption and NOx emissions marginally degenerates during idling. Thus, it can be recommended that Jatropha biodiesel–diesel blend can slightly improve engines performance during idling thus can be used to operate a diesel engine.

Acknowledgments

The authors would like to appreciate University of Malaya for financial support through High Impact Research grant titled: Clean Diesel Technology for Military and Civilian Transport Vehicles having grant number UM/C/HIR/MOE/ENG/07.

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