Egyptian Journal of Petroleum (2016) **25**, 91–95

HOSTED BY

Egyptian Petroleum Research Institute

Egyptian Journal of Petroleum

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www.sciencedirect.com

FULL LENGTH ARTICLE

Potential use of eucalyptus biodiesel in compressed ignition engine

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Received 20 January 2015; revised 10 March 2015; accepted 11 March 2015
Available online 9 December 2015

KEYWORDS

Biodiesel;
Engine;
Viscosity;
Transesterification

Abstract The increased population has resulted in extra use of conventional sources of fuels due to which there is risk of extinction of fossil fuels' resources especially petroleum diesel. Biodiesel is emerging as an excellent alternative choice across the world as a direct replacement for diesel fuel in vehicle engines. Biodiesel offers a great choice. It is mainly derived from vegetable oils, animal fats and algae. Hence in this paper effort has been made to find out feasibility of biodiesel obtained from eucalyptus oil and its impact on diesel engine. Higher viscosity is a major issue while using vegetable oil directly in engine which can be removed by converting it into biodiesel by the process of transesterification. Various fuel properties like calorific value, flash point and cetane value of biodiesel and biodiesel–diesel blends of different proportions were evaluated and found to be comparable with petroleum diesel. The result of investigation shows that Brake Specific Fuel Consumption (BSFC) for two different samples of B_{10} blend of eucalyptus biodiesel is 2.34% and 2.93% lower than that for diesel. Brake Thermal Efficiency (BTE) for B_{10} blends was found to be 0.52% and 0.94% lower than that for diesel. Emission characteristics show that Smoke Opacity improves for both samples, smoke is found to be 64.5% and 62.5% cleaner than that of diesel. Out of all blends B_{10} was found to be a suitable alternative to conventional diesel fuel to control air pollution without much significant effect on engine performance. On comparing both samples, biodiesel prepared from sample A of eucalyptus oil was found to be superior in all aspects of performance and emission.

1. Introduction

World's fossil fuel resources such as crude oil, natural gas and coal are decreasing at alarming rate due to the increasing demand for fossil fuels across the globe. As per Indian Energy Scenario, energy demand is expected to reach 166 MT by 2019 and presently 79% of crude oil is imported to meet the demand. Against the overall trend in growth of the Indian

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Peer review under responsibility of Egyptian Petroleum Research Institute.

http://dx.doi.org/10.1016/j.ejpe.2015.03.008

economy, the energy requirement continued to increase during this phase. The fuels of bio-origin can provide a feasible solution to this worldwide petroleum fuel crisis [1,2]. Gasoline and diesel-driven automobiles are the major sources of greenhouse gas (GHG) emission. Researchers around the world have explored several alternative energy resources having the potential to quench the ever-increasing energy thirst of today's population. Biodiesel from vegetable oils is emerging as a potential substitute for diesel to be used in IC engines [3–7]. The Ministry of Petroleum & Natural Gas, Govt. of India has taken several measures for enhancing exploration and exploitation of petroleum resources, apart from developing the distribution and marketing of petroleum products. There was an increase by 7.15% in production of total petroleum products, including fractionators, during 2012–13 compared to the year 2011–12. This calls to improve the alternative resources for continuous feed of demand of energy. Large-scale biodiesel production from edible oil is negatively impacting India due to competition with food crops creating economic imbalances. A possible solution to overcome this problem is to use non-edible oil. The main feedstocks for biodiesel production from non-edible oils are *Jatropha, Pongamia* and *Polanga* etc. Eucalyptus Oil is also one the non-edible oils which can be a potential source for biodiesel due to its large availability in India. The biodiesel from eucalyptus oil has a high cetane number and the absence of sulfur in biodiesel makes it a very good alternative to diesel. The pollutant component from exhaust are also decreased by using biodiesel [8,9]. The aim of this paper is to investigate the impact of eucalyptus biodiesel in engine performance and emission characteristics.

Figure 1 Eucalyptus seeds.

2. Cultivation of eucalyptus is India

Eucalyptus was first planted around 1790 by Tippu Sultan, the ruler of Mysore, in his palace garden on Nandi hills near Bangalore, India using seeds received from Australia and initially about 16 species were introduced. Subsequently in 1843, and later in 1856 regular plantations of *Eucalyptus globulus* were raised to meet the demands for firewood in Nilgiri, Tamil Nadu. There were several other attempts to introduce eucalypts at various parts of the country. The species identified during 1954–55 were *Eucalyptus camaldulensis, Eucalyptus citriodora, Eucalyptus crebra, Eupleres major, Eucalyptus intermedia, Eucalyptus polyanthemos, Eucalyptus robusta, Eucalyptus tereticornis, Eucalyptus tessellaris,* a hybrid of *E. robusta* x *E. tereticornis,* and a hybrid of *Eucalyptus botryoides* and *E. tereticornis*. Out of 170 species, varieties and provenances of eucalypt were tried in India, out of which the most outstanding and favored species is *E. tereticornis* known as Mysore gum.

Fig. 1 shows seeds of eucalyptus plant. Oil is extracted from seeds by a mechanical expeller. The oil content present in the seed is about 60% in the form of cineole content. It's main features include fast growing nature, capable of over topping weeds, coppices well, is fire hardy, browse resistant and has the ability to adapt to a wide range of climatic conditions. Other species which are grown on plantation scale are *Eucalyptus grandis, E. citriodora, E. globulus,* and *E. camaldulensis*. Over 1,000,000 ha of eucalyptus plantations have been established, mostly by State Forest Departments and Forest Development Corporations with around 6000 million seedlings have been planted in private lands. There are several reasons for raising large scale eucalypt plantations in the country; some are common and some are specific to each State. The most important common reason is to use the denuded and barren plains and hilly areas and to replace low value natural forests [4]. Table 1 explains the scenario of plantation of eucalyptus in various states of India.

The eucalyptus shows great variations in the height and diameter. In agroforestry systems, eucalyptus grows to a height of about 12 m and 40–45 cm girth at the age of 3 years.

Table 1 Plantation statistics in various states of India [4,5].

State	Plantation	Maximum volume (m^3/ha)
Andhra Pradesh	*Eucalyptus* hybrid, *E. camaldulensis* and *E. tereticornis*	76.57
Bihar	*E.* hybrid	98.57
Goa, Daman & Deu	*Casuarina*	–
Haryana	*Eucalyptus* hybrid, *E. citriodora*, and *E. crebra.*	–
Kerala	*Eucalyptus grandis*	100.13
Maharashtra	*E.* hybrid and *E. camaldulensis* in the dry zone and in high rainfall areas *Eucalyptus grandis* followed by *E. robusta* and *Eucalyptus saligna.*	–
Punjab	*Eucalyptus* hybrid	–
Tamil Nadu	*Eucalyptus globulus* and *Eucalyptus* hybrid	325.23
Uttar Pradesh	*Eucalyptus* hybrid	228.7