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# An experimental study on performance and exhaust emissions of a diesel engine fuelled with tobacco seed oil methyl ester

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**Abstract**

Tobacco seeds are a by product of tobacco leaves production. To the author's best knowledge, unlike tobacco leaves, tobacco seeds are not collected from fields and are not commercial products. However, tobacco seeds contain significant amounts of oil. Although tobacco seed oil is a non-edible vegetable oil, it can be utilized for biodiesel production as a new renewable alternative diesel engine fuel. In this study, an experimental study on the performance and exhaust emissions of a turbocharged indirect injection diesel engine fuelled with tobacco seed oil methyl ester was performed at full and partial loads. The results showed that the addition of tobacco seed oil methyl ester to the diesel fuel reduced CO and $SO_2$ emissions while causing slightly higher $NO_x$ emissions. Meanwhile, it was found that the power and the efficiency increased slightly with the addition of tobacco seed oil methyl ester.


*Keywords:* Tobacco seed oil; Biodiesel; Diesel engine; Performance; Emission

## 1. Introduction

Biodiesel produced from vegetable oils is considered as a renewable alternative diesel engine fuel. In general, prices of edible vegetable oils are higher than that of diesel fuel no. 2. Therefore,

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waste vegetable oils [1–6] and non-edible crude vegetable oils [7–9] have been considered as potential raw materials for biodiesel production. Different techniques have been developed to produce biodiesel from vegetable oils, and the quality of a biodiesel depends on the vegetable oil and the production process [7,10–14].

Tobacco seed oil is a non-edible crude oil extracted from tobacco seeds. Unlike tobacco leaves, tobacco seeds are not commercial products and are not collected from fields. Giannelos et al. [15] examined tobacco seed oil and pointed out that tobacco seed oil may be an appropriate substitute for diesel fuel. However, no study has been found in the literature on production and testing of a biodiesel from tobacco seed oil.

To the author's best knowledge, the first study on tobacco seed oil methyl ester as a biodiesel was performed by the author. Detailed information about tobacco seed oil, its potential in the world, oil extraction from tobacco seed, the esterification process and a summary of engine test results are presented in another paper [16]. It has been found that tobacco seed oil is fairly suitable for biodiesel production, and there are huge amounts of unused tobacco seeds in the world.

In general, it is expected that the specifications of a new biodiesel should be within the limits of ASTM 6751 or EN 14214 standards. A research in our laboratory is being conducted on tobacco seed oil methyl ester to bring all its specifications within the limits of the standards. Furthermore, a new biodiesel should also be tested in a diesel engine to determine its effects on the performance and the emissions. Favorable test results will encourage its use in diesel engines.

In this study, detailed experimental results are given on the performance and the emissions of a turbocharged indirect injection diesel engine fuelled with tobacco seed oil methyl ester. All the experiments were performed without any modification on the engine. Tobacco seed oil methyl ester and diesel fuel no. 2 are referred to by TSOME and D, respectively, throughout the paper.

## 2. Tobacco seed oil methyl ester (TSOME)

Detailed information about the TSOME used in the experiments can be found in Ref. [16]. The lower heating value, density (at 15 °C) and kinematic viscosity (at 40 °C) of TSOME were determined as 39 811 kJ/kg, 886.8 kg/m$^3$ and 3.98 mm$^2$/s, respectively. Although the heating value of TSOME is approximately 10.8% less than that of diesel fuel no. 2, its density is approximately 5.4% greater than that of diesel fuel no. 2. The viscosity of TSOME at 40 °C is in the range of ASTM D975.

The change of viscosity with temperature is also very important for a biodiesel. Therefore, dynamic viscosity values of TSOME and the diesel fuel were determined at different temperatures. The variations of the dynamic viscosities of TSOME and the diesel fuel are compared in the range of 5–45 °C (Fig. 1). It is shown in the figure that although the difference increases with decreasing temperature, the variation of TSOME viscosity is very similar to that of diesel fuel. An equation was derived for the viscosity of TSOME as a function of temperature. The derived equation is

$$\mu = e^{\left(\frac{2570.2}{T} - 6.945\right)} \tag{1}$$

where $\mu$ is the dynamic viscosity in mPa s and $T$ is the absolute temperature in K. It is thought that this kind of equation may be very useful to compare the viscosities of different biodiesel fuels [17].