Effects of waste frying oil based methyl and ethyl ester biodiesel fuels on the performance, combustion and emission characteristics of a DI diesel engine

H. Sanli a,c, M. Canakci b,c,⇑, E. Alptekin b,c, A. Turkcan b,c, A.N. Ozsezen b,c

a Golcuk Vocational School, Kocaeli University, 41650 Golcuk, Turkey
b Department of Automotive Engineering, Faculty of Technology, Kocaeli University, 41380 Izmit, Turkey
c Alternative Fuels R&D Center, Kocaeli University, 41275 Izmit, Turkey

HIGHLIGHTS

• A complete biological origin biodiesel fuel was produced using bioethanol.
• Brake specific fuel consumption and thermal efficiencies of ester fuels were higher than petro-diesel.
• Ester fuels emitted less CO and THC emissions, but higher NOx and CO2 than petro-diesel.
• Ethyl ester had slightly better engine performance than methyl ester.
• Ethyl ester had superior exhaust emissions over methyl ester.

ARTICLE INFO

Article history:
Received 4 January 2015
Received in revised form 22 June 2015
Accepted 24 June 2015
Available online 29 June 2015

Keywords:
Waste frying oil
Methyl ester
Ethyl ester
Engine performance
Emissions

ABSTRACT

In this study, fuel quality biodiesels produced from waste frying oil using methanol and ethanol were tested as pure and 20% (v/v) blend with petroleum-based diesel fuel (PBDF) in a direct injection (DI) diesel engine running at 600 Nm and three different engine speeds (1100, 1400 and 1700 rpm). The results showed that the brake specific fuel consumptions (BSFC) of ester fuels were higher than those of petrodiesel. The BSFC of ethyl ester biodiesel was slightly lower as compared with methyl ester biodiesel. The thermal efficiencies of the ester fuels were higher than those of PBDF. Ethyl ester biodiesel had slightly better thermal efficiency than methyl ester biodiesel. In comparison to PBDF, ester fuels emitted less CO and THC emissions but they caused to produce more NOx. CO2 emissions were very close to each other. In general, ethyl ester biodiesel released relatively less emissions than methyl ester biodiesel.

1. Introduction

Since biodiesel has increasing usage ratio among the alternative fuel sources, the most important issue for the sustainability of biodiesel is the feedstock type which is used in its production. In addition to its technical effects, the selection of feedstock type has also great influence on the economic growth of biodiesel industry of the country. From the point of view of reducing the dependence on foreign sources, biodiesel production from food-grade vegetable oils is not reasonable for the countries importing their vegetable oil needs. However, using waste vegetable oils as a biodiesel feedstock may be a solution for these types of countries. Turkey has considerable amounts of waste frying oil [1]. For commercialization of biodiesel, the cost price of biodiesel can be reduced by using waste frying oils and animal fats as feedstock. In addition to its economic benefit, this application helps to solve some serious environmental problems caused by the disposal of these types of waste oils [2,3].

As known from the literature, biodiesel fuel has chemical bonds from the alcohol used in transesterification reaction affecting the fuel properties [4–8] and these properties make some impact on the performance, combustion and emissions of the diesel engines [9–12]. When considering the related literature, it is seen that the alcohol used in biodiesel production is mainly methanol and the number of studies in which biodiesel fuels are produced via ethanol usage is insufficient and restricted only in laboratory scale as compared with methanol usage. At the same time, the methanol