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The influence of castor biodiesel blending ratio on engine performance including the determined diesel particulate matters composition

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ABSTRACT

There are world attentions to increase the share of renewable bioenergy in transportation sector to resolve problems of limited fuel reserve and polluted atmosphere. It is reasonable to produce biodiesel from non-edible vegetable oils to overcome any effect on food prices. Current study investigates the effect of castor methyl ester (CME) biodiesel blending ratio (BR) on the determined composition of diesel particulate matters (DPM). The main novelty of this study is to empirically predict the composition of DPM based on measurements of gaseous emissions and other engine parameters operated with biodiesel blends without necessity to follow expensive and time-consumed procedures. The base biodiesel is CME which is mainly mono-unsaturated fatty acids (≈87%) with 6% di-unsaturated and 7% saturated compounds. The empirical mathematical set of equation is used to estimate portions of elemental carbon (EC) and Organic carbon (OC) in DPM in addition to the total mass of emitted DPM based on measurements of gaseous emissions and engine mechanical parameters. Steady state experiments on single-cylinder engine according to ECE 96 five-mode test cycle were carried out. Results of experiments regarding effect of BR on engine performance reveled that (i) blend B10 provided best engine mechanical performance with insignificant efficiency increase, (ii) engine combustion analysis for B10 close to those for neat diesel fuel, (iii) blend B10 emit the lowest level of CO and HC emissions, while blend B30 emit the lowest exhaust opacity with slight change in NOx emissions, (iv) all blends provided DPM emissions lower than those for neat diesel fuel, (v) blend B10 provided the lowest DPM value among all other blends, and (vi) blend B30 provided the lowest EC in the emitted DPM. It can be concluded that (i) use of mathematical models to investigate the structure of DPM emissions is a useful tool, and (ii) even B10 provided the best economic and the lowest emissions with values close to those for B20, it will be more economic to increase the share of renewable energy sources and so to substitute diesel fuel with B20.

1. Introduction

Diesel engine fuel economy and thermal efficiency are main reasons for their widely usage in heavy-duty applications. However, diesel engines emit large quantity of toxic emissions; mainly diesel particulate matters (DPM) [1]. DPM emissions are considered the most critical anthropogenic emissions negatively affecting human and ecology with carcinogenic behavior. These effects depend on (i) drift-off between DPM and Nitrogen Oxides (NOx) emissions [2], (ii) engine operating conditions, (ii) DPM physical and chemical characteristics [3], and (iv) in-cylinder turbulence and reactions kinetics [4]. The parameters affecting DPM structure can be divided as engine-correlated and engine-

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