Exhaust emission profiling of fatty acid methyl esters and NOx control studies using selective synthetic and natural additives

ABSTRACT

The present study was focused on the optimized biodiesel production using Moringa oleifera (M. oleifera) and rice bran oils, characterization, and comparative evaluation of the exhaust emission profile using artificial and natural additives resulting from synthesized biodiesel. Furthermore, various biodiesel blends (B10, B20, B50, and B100) of Moringa oleifera (M. oleifera) and rice bran oils were studied in a four-cylinder, direct injection engine at different engine speeds (1800–3000 rpm). The optimal yields (%) for both the M. oleifera and rice bran oil-based biodiesel were found to be 87 ± 2.0 and 93 ± 2.6%, respectively, using sodium methoxide as the catalyst. The optimized reaction parameters involved in the transesterification of the M. oleifera and rice bran oils were revealed to be catalyst concentration (1.25%), methanol-to-oil molar ratio (9:1), reaction temperature (60 °C), and reaction time (90 min). The fuel properties of the M. oleifera and rice bran oil-based biodiesel were found to be in compliance with ASTM D6751 and EN 14214. The exhaust emission levels of the synthesized biodiesel and its blends with conventional diesel showed a significant reduction in the particulate matter and carbon monoxide levels comparative to the fossil fuel-based diesel combustion, whereas an increasing trend was observed in case of the oxides of nitrogen (NOx) emission. The results of the engine performance test indicated that the brake power in all of the samples had approximately similar values for each load and the enriched blends showed a distinct improvement in brake-specific fuel consumption. The effect of antioxidants on the NOx emission levels resulting from the combustion of the biodiesel and its blends showed that the synthetic additives (butylated hydroxyl anisole (BHA), butylated hydroxyl toluene (BHT), t-butyl hydroquinone (TBHQ), and propyl gallate (PG)) were more effective than the natural methanolic antioxidant extracts (extract of P. pinnata (EPPL), extract of A. lebbeck (EPPL), extract of P. guajava (EPG), and extract of M. azedarcah (EMA) for reduction in the NOx emission level.

Keyword: Biodiesel; Exhaust emissions

Additives

NOx control