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Optimization of diesel engine performance and emissions with biodiesel-diesel blends and EGR using response surface methodology (RSM)

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Abstract

The rising price of conventional liquid fuels and increasing pollution drive research into alternate bio-fuels. In the present study, waste cooking soybean oil (WSCO) was collected from local restaurants and food processing industries. The 92% biodiesel yield was obtained by using a homogeneous transesterification process. A detailed experimental and analytical study of the engine performance and emissions with binary fuel blends of WSCO biodiesel and ultra-low sulfur diesel (ULSD) has been performed using response surface methodology. Binary blends were prepared by adding 20–35 v.% of WSCO to ULSD; experiments were carried out at 0–15% EGR. To analyze the effects of input variables on BSFC, BTE, smoke, NO_x, CO, and HC, regression models were developed and confirmed to be statistically significant. The binary blend of B35 with 15% EGR (B35EGR15) showed the maximum desirability (0.928). The model's adequacy was validated by a confirmation test with an error in prediction below 6%. For blend B35EGR15, BSFC was increased by 6.61% and BTE was reduced by 5.30% for B35EGR15 as compared to ULSDEGR0 (ULSD at 0% EGR). Smoke and NO_x emissions were decreased by 19.09% and 59.04%, while CO and HC emissions were increased by 17.54% and 11.76%, as compared to ULSDEGR0. The economic analysis showed that the operation cost was reduced by 23.34% for B35EGR15 as compared to ULSDEGR0. The B35EGR15 blend can be used in existing diesel engines with no engine modifications.

Previous Next

Keywords

Waste cooking soybean oil biodiesel; EGR; RSM; Desirability approach; Exhaust emissions

Nomenclature

WSCO biodiesel
Waste soybean cooking oil biodiesel