ABSTRACT

Now a day, depleting fossil fuel resources and environmental issues are the major area of interest for researchers. To overcome the above issues, in this research work, orange peel biodiesel (OPB) and sal oil biodiesel (SOB) were prepared, and investigations on diesel engine performance and emission parameters were performed with 10%, 20%, and 30% (v/v) of biodiesel blending. The blending of biodiesel in diesel fuel led to reduction in HC, CO, and smoke emissions, and a slight increase in NO emissions. The limitation of biodiesel blending, i.e., NO emissions growth, is reduced by using water in diesel emulsion (WiDE) fuel. In this research work, WiDE fuels were prepared by emulsifying 5%, 10%, and 15% (v/v) water in diesel fuel, and investigations were performed. The incorporation of nano additive further reduces the NO emissions as well as the smoke and CO emissions. The engine performance and emissions analysis were also performed by incorporating Al_2O_3, and CNT nano additive with water-emulsified biodiesel blended fuel. The engine performance and emission parameters optimization was also performed using the Taguchi-Grey relational method for each set of experiments. The Taguchi method was used for experimental design and optimizing individual performance and emission parameters through the signal-to-noise ratio analysis. The Grey optimization techniques were used to convert the multi optimum response into a single optimum response.

This experimental investigation analysed the impact of engine power, engine speed, and percentage blends on exergy, energy, and emission parameters for the variable speed engines. The energy parameters like brake specific fuel consumption (BSFC), brake thermal efficiency (BTE), exhaust gas temperature (EGT), exergy parameters, i.e., exergy efficiency, engine sustainability, exergy destruction rate (EDR), entropy generation rate, and emission parameters,

i.e., HC, NO, CO, CO_2, and smoke emissions were investigated for percentage of orange peel biodiesel and sal seed biodiesel fuel blends. Experimental results revealed that the BTE and exergy efficiency of the engine with biodiesel- diesel blend fuels are lower than diesel fuel at each engine power and speed condition. The HC, CO, and smoke emission were observed reduced, and NO, and CO_2 emission enhanced with biodiesel-diesel blends fuel at each engine power and speed. The signal-to-noise ratio (S/N) curve of grey relational grade (GRG) for SOB and OPB blended fuel declared that the engine load was the most affecting parameter, with a contributing factor of more than 45% for each performance parameter. The performance and emission parameters with OPB20 and SOB20 fuels were comparable with diesel fuel.

In this research work, the impact of percentage emulsification for water in diesel fuel on exergy, energy, and emission parameters for diesel-based samples (5–15% v/v.) water emulsification were also analysed on variable speed engines. The engine BSFC and CO_2 emissions were observed enhanced with water-emulsified fuel compared to diesel fuel. The engine BTE, exergy efficiency, and sustainability index were observed to enhance up to 5% of water emulsification in water emulsified fuel. The engine HC, CO, NO, and smoke emissions were reduced with water-emulsified fuel at each engine power and speed. The S/N curve of GRG of water emulsified fuel declared that the performance and emission parameters with WiDE fuels were better than diesel fuel and the engine load was the most affecting parameter, with a contributing factor of more than 50% for each performance parameter.

Finally, the investigation was performed by incorporating Al_2O_3, and CNT nano additive in the optimum water-emulsified biodiesel blended fuel level. The engine BSFC and EGT were observed to be reduced, and BTE, exergy efficiency, EDR, sustainability index, and entropy generation rate were observed to be enhanced with the

incorporation of Al_2O_3 and CNT nano additive. The effect of incorporation of CNT nano additive on engine exergy and energy performances has been observed to be higher than Al_2O_3 nano additive. The engine CO_2 was enhanced, and HC, CO, NO, and smoke emissions were reduced by incorporating Al_2O_3 and CNT nano additive. The S/N curve analysis of GRG revealed that the result obtained with CNT nano additive incorporated water emulsified biodiesel blended fuel was comparable to diesel fuel.

The optimization of engine performance and emission parameters was also performed with SOB-based CNT fuel and OPB-based CNT fuel using the mixed level of Taguchi experimental design method. The S/N curve of GRG of CNT incorporated 5% water emulsified OPB20, and SOB20 fuel revealed that 14 N-m engine torque, 1400 rpm engine speed, and CNT incorporated 5% water emulsified SOB20 fuel was optimum engine setting for overall optimum performance and emission parameters. The engine load was observed most affecting input parameters with more than 45% contribution factor for each output response except smoke emission. For smoke emission, the fuel type was observed most concerning input parameters.

Furthermore, with an engine load of 14 N-m, 1400 rpm engine speed, and with CNT incorporated 5% water emulsified SOB20 fuel, the engine BTE, exergy efficiency, EDR, EGT, entropy generation rate, NO, and CO_2 emission have been observed with 1.66%, 1.30%, 7.50%, 1.0%, 7.54%, 4.26%, and 27% higher than the diesel fuel. However, BSFC, CO, HC, and smoke emissions have been observed at 1.81%, 1.05%, 67.64%, and 50% lower than diesel fuel. The experimental result revealed that CNT incorporated 5% water emulsified SOB20 can be used as a fuel for diesel engines for better engine performance and emission characteristics without any engine modifications.

(This page is left intentionally)