







Soft computing-based modeling and emission control/reduction of a diesel engine fueled with carbon nanoparticle-dosed water/diesel emulsion fuel

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Abstract

This study was set up to model and optimize the performance and emission characteristics of a diesel engine fueled with carbon nanoparticle-dosed water/diesel emulsion fuel using a combination of soft computing techniques. Adaptive neuro-fuzzy inference system tuned by particle swarm algorithm was used for modeling the performance and emission parameters of the engine, while optimization of the engine operating parameters and the fuel composition was conducted via multiple-objective particle swarm algorithm. The model input variables were: injection timing (35–41° CA BTDC), engine load (0–100%), nanoparticle dosage (0–150 μM), and water content (0–3 wt%). The model output variables included: brake specific fuel consumption, brake thermal efficiency, as well as carbon monoxide, carbon dioxide, nitrogen oxides, and unburned hydrocarbons emission concentrations. The training and testing of the modeling system were performed on the basis of 60 data patterns obtained from the experimental trials. The effects of input variables on the performance and emission characteristics of the engine were thoroughly analyzed and comprehensively discussed as well. According to the experimental results, injection timing and engine load could significantly affect all the investigated performance and emission parameters. Water and nanoparticle addition to diesel could markedly affect some performance and emission parameters. The modeling system could predict the output parameters with an $R^2 > 0.93$, $MSE < 5.70 \times 10^{-3}$, $RMSE < 7.55 \times 10^{-2}$, and $MAPE < 3.86 \times 10^{-2}$. The optimum conditions were: injection timing of 39° CA BTDC, engine load of 74%, nanoparticle dosage of 112 μM, and water content of 2.49 wt%. The carbon dioxide, carbon monoxide, nitrogen oxides, and unburned hydrocarbon emission concentrations were found to be 7.26 vol%, 0.46 vol%, 95.7 ppm, and 36.2 ppm, respectively, under the selected optimal operating conditions while the quantity of brake thermal efficiency was found at an acceptable level (34.0%). In general, the applied soft computing combination appears to be a promising approach to model and optimize operating parameters and fuel composition of diesel engines.