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Prediction of engine performance for an alternative fuel using artificial neural network

Yusuf Çay [a,*], Adem Çiçek [b], Fuat Kara [c], Selami Sağiroğlu [a]

[a] University of Karabük, Faculty of Engineering, Department of Mechanical Engineering, Balıklarkayası Mevkii, 78050, Karabük, Turkey
[b] University of Düzce, Faculty of Technology, Department of Manufacturing Engineering, Konuralp Yerleşkesi, 81620, Düzce, Turkey
[c] University of Düzce, Faculty of Technical Education, Department of Mechanical Education, Konuralp Yerleşkesi, 81620, Düzce, Turkey

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This study deals with artificial neural network (ANN) modeling to predict the brake specific fuel consumption, effective power and average effective pressure and exhaust gas temperature of the methanol engine. To obtain training and testing data, a number of experiments were performed with a four-cylinder, four-stroke test engine operated at different engine speeds and torques. Using some of the experimental data for training, an ANN model based on standard back propagation algorithm was developed. Then, the performance of the ANN predictions was measured by comparing the predictions with the experimental results. Engine speed, engine torque, fuel flow, intake manifold mean temperature and cooling water entrance temperature have been used as the input layer, while brake specific fuel consumption, effective power, average effective pressure and exhaust gas temperature have also been used separately as the output layer. After training, it was found that the R^2 values are close to 1 for both training and testing data. RMS values are smaller than 0.015 and mean errors are smaller than 3.8% for the testing data. This shows that the developed ANN model is a powerful one for predicting the brake specific fuel consumption, effective power and average effective pressure and exhaust gas temperature of internal combustion engines.

1. Introduction

The requirement of energy increases due to industrialization and continuously growing population in the world. Therefore, developing and newly developing countries tend to the new energy sources to compensate their energy necessity. Currently, the main energy source of the motor vehicles is petroleum products. It is expected that the petroleum reserves will be consumed away in the near future. In addition, one of the main causes of air pollution in the cities is harmful emissions of the motor vehicles which are operated with petroleum products. As a result, a lot of researchers have started to search for cheap, renewable and environmentally friendly alternative fuels such as ethanol, methanol, hydrogen, and liquefied petroleum gas (LPG), liquefied natural gas (LNG), compressed natural gas (CNG), electric and vegetable oil based fuels [1]. Calisir and Gümüs [2] analyzed the usage of mixture of methanol and gasoline in spark-ignited engine and studied the effects of methanol ratio on engine performance in different ignition advances. The best performance at standard ignition advance value of engine is acquired by mixture of 15% methanol and 85% petroleum. Celik et al. [3] investigated the effects of use of pure methanol as fuel at high compression ratio in a single cylinder gasoline engine on engine power, brake thermal efficiency and emissions. By increasing the compression ratio from 6/1 to 10/1, the engine power and brake thermal efficiency increased by up to 14% and 36%, respectively. Moreover, CO, CO_2 and NO_x emissions were reduced by about 37%, 30% and 22%, respectively. Li et al. [4] experimentally investigated the effects of injection time and ignition stroke on engine performance and emissions through a methanol engine with high pressure, direct injection and spark ignition. It was found that both injection time and ignition stroke have significant effects on methanol engine performance, combustion process and exhaust emissions. The best compromise values between thermal effectiveness and exhaust emissions were acquired at the determined optimal injection time and ignition stroke. Sayin [5] investigated the effects of mixtures of methanol-diesel (M5-M10) and ethanol-diesel (E5-E10) on engine performance and exhaust emissions. For the experiments, an ordinary diesel engine with single cylinder and four-cycle was used. The results showed that break specific fuel consumption and nitrogen

* Corresponding author. Tel.: +90 370 4332021; fax: +90 380 5421134.
E-mail address: yusufcay@karabuk.edu.tr (Y. Çay).

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