Simulation Modeling of a Dual Fuel (Natural Gas-Diesel) Engine Using Early Direct Injection Technique of Natural Gas

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Abstract:

The research for alternative fuels increased rapidly to mitigate the pollution problems resulting from using conventional fuels in internal combustion engines. Natural gas (NG) appears the most promising alternative due to its low prices and availability around the world. In this paper, a two-zone, zero-dimensional (0-D) model for the simulation of dual fuel NG-diesel engine is developed to study the performance of the engine with a proposed technique of NG early direct injection. The model is composed of several sub-models that are based on semi-empirical formulas. NG is modeled as being directly injected at the beginning of the compression stroke. The model is applied to study the performance of HELWAN M-114 diesel engine using dual fuel of NG and diesel fuels as a case study. The results indicate that using NG early direct injection technique (EDI) results in increasing the volumetric efficiency and hence the brake power of the engine compared to the intake manifold induction (IMI) of NG with air through the intake manifold. The percentage increase in brake power is 8.7% at NG mass ratio in the total fuel (the supplement ratio (SR)) of 90% at full load. To evaluate the proposed technique, results obtained by varying the engine load and the SR. Results indicate that the slow burning rate of NG results in decrease in the brake thermal efficiency by 3.5% and increases in brake specific fuel consumption with a percentage of 10.2% at 90% SR and full load. However, a great advantage of increasing the SR is the reduction in NOx and soot emissions particularly at high engine loads where they were reduced with percentages of 28.6% and 86%, respectively at 90% SR and full load condition.

Keywords:

dual fuel engine, direct injection, natural gas, supplement ratio

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