Studi Karakteristik Pembakaran Dual Fuel Engine Dimetil Eter dengan Campuran Bahan Bakar Gasoline-Ethanol-Methanol Berbasis Simulasi dan Eksperimen = Numerical and Experimental Combustion Characteristics Study of Dimethyl Ether Dual Fuel Engine with Gasoline-Ethanol-Methanol Fuel Blend

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Abstrak

Pertumbuhan jumlah kendaraan bermotor di Indonesia menyebabkan peningkatan signifikan terhadap emisi gas rumah kaca dan polutan udara. Studi ini bertujuan mengevaluasi karakteristik pembakaran sistem dual fuel engine yang menggunakan campuran Gasoline–Ethanol–Methanol (GEM) dengan penambahan Dimetil Eter (DME), melalui simulasi ANSYS Forte dan eksperimen pada mesin Yamaha Mio M3 125cc. Variasi komposisi bahan bakar meliputi GEM murni (100%), GEM 73% + DME 27%, GEM 71% + DME 29%, dan GEM 67% + DME 33%. Hasil penelitian menunjukkan bahwa penambahan DME 27% memberikan peningkatan daya optimal pada putaran menengah, sedangkan fraksi DME lebih tinggi menyebabkan penurunan daya akibat pembakaran yang terlalu cepat dan tidak selaras dengan langkah ekspansi piston. Kebisingan mesin menurun secara bertahap seiring kenaikan fraksi DME, dengan tingkat kebisingan terendah pada campuran DME 33%. Temperatur maksimum dalam silinder cenderung menurun karena latent heat DME yang tinggi, sementara temperatur gas buang meningkat pada fraksi DME tinggi sebagai indikasi pembakaran lebih sempurna. Emisi CO, CO, dan NOx berkurang signifikan, namun emisi UHC meningkat pada campuran DME 33% akibat pembakaran tidak sempurna. Temuan ini membuktikan bahwa penggunaan campuran GEM–DME berpotensi meningkatkan performa dan efisiensi mesin, namun memerlukan optimasi rasio campuran untuk meminimalkan emisi hidrokarbon tak terbakar.
.....The growth in the number of motor vehicles in Indonesia has significantly increased greenhouse gas emissions and air pollution. This study aims to evaluate the combustion characteristics of a dual-fuel engine using an alternative fuel blend of Gasoline–Ethanol–Methanol (GEM) with the addition of Dimethyl Ether (DME), through ANSYS Forte simulations and experiments on a Yamaha Mio M3 125cc engine. The fuel composition variations included pure GEM (100%), GEM 73% + DME 27%, GEM 71% + DME 29%, and GEM 67% + DME 33%. Results show that adding 27% DME provided optimal power improvement at medium engine speeds, while higher DME fractions led to reduced power due to overly rapid combustion that was not synchronized with the piston’s expansion stroke. Engine noise progressively decreased with increasing DME proportion, with the lowest noise recorded at 33% DME. The maximum in-cylinder temperature tended to decrease due to DME’s high latent heat, while exhaust gas temperature increased at higher DME levels, indicating more complete combustion. Emissions of CO, CO, and NOx were significantly reduced, while UHC emissions increased in the 33% DME blend due to incomplete combustion. These findings demonstrate that GEM–DME fuel blends have the potential to improve engine performance and efficiency but require optimized ratios to minimize unburned hydrocarbon emissions.