

Studi Karakteristik Pembakaran Dual-Fuel Engine Liquefied Petroleum Gas dengan Campuran Bahan Bakar Gasoline-Ethanol-Methanol Berbasis Simulasi dan Eksperimen = Study of Combustion Characteristics of Dual-Fuel Engine Using Liquefied Petroleum Gas with a Gasoline- Ethanol-Methanol Fuel Blend Based on Simulation and Experiment

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Abstrak

Penelitian ini menganalisis pengaruh campuran Gasoline–Ethanol–Methanol (GEM) dan Liquefied Petroleum Gas (LPG) terhadap performa, konsumsi bahan bakar, temperatur ruang bakar, kebisingan, dan emisi gas buang mesin bensin 125 cc. Eksperimen dilakukan dengan variasi rasio LPG 27%, 29%, dan 33%, serta simulasi pembakaran menggunakan ANSYS Forte untuk memvalidasi tren hasil. Hasil menunjukkan campuran GEM murni menghasilkan daya maksimum tertinggi di seluruh putaran mesin, tetapi memproduksi emisi karbon monoksida (CO) dan unburned hydrocarbon (UHC) tertinggi. Penambahan LPG hingga 29% umumnya menurunkan konsumsi bahan bakar spesifik, emisi CO dan UHC, serta meningkatkan stabilitas pembakaran pada putaran tinggi. Rasio LPG 33% menunjukkan kenaikan daya pada 8000 rpm akibat distribusi campuran lebih homogen, meskipun disertai peningkatan emisi NOx dan konsumsi bahan bakar pada beban parsial. Temperatur ruang bakar lebih rendah pada rasio LPG tinggi, mengurangi risiko knocking tetapi memerlukan kontrol rasio udara–bahan bakar yang presisi. Selain itu, kebisingan mesin lebih tinggi pada GEM murni, sedangkan penggunaan LPG menurunkan lonjakan tekanan dan kebisingan akustik. Rasio LPG 29% dinilai sebagai kompromi terbaik antara performa, efisiensi, dan emisi.

.....This study analyzes the effects of Gasoline–Ethanol–Methanol (GEM) and Liquefied Petroleum Gas (LPG) blends on the performance, fuel consumption, combustion chamber temperature, noise, and exhaust emissions of a 125 cc gasoline engine. Experiments were conducted with LPG ratios of 27%, 29%, and 33%, and combustion simulations were performed using ANSYS Forte to validate the observed trends. Results showed that pure GEM produced the highest maximum power across all engine speeds but also generated the highest emissions of carbon monoxide (CO) and unburned hydrocarbons (UHC). Adding LPG up to 29% generally reduced specific fuel consumption, CO and UHC emissions, and improved combustion stability at higher engine speeds. The 33% LPG ratio exhibited an increase in power at 8000 rpm due to more homogeneous mixture distribution, although accompanied by higher NOx emissions and fuel consumption under partial loads. Combustion chamber temperatures were lower with higher LPG ratios, reducing knocking risk but requiring precise air–fuel ratio control. Additionally, engine noise was higher with pure GEM, while LPG usage decreased pressure spikes and acoustic noise. Overall, the 29% LPG ratio was considered the best compromise between performance, efficiency, and emissions.