INTISARI

Dual-fuel co-firing dengan hidrogen terbarukan merupakan alternatif transisi energi. Biodiesel mengurangi ketergantungan pada bahan bakar fosil, namun kandungan energinya yang rendah mengganggu keseimbangan keluaran mesin. Penelitian ini mensimulasikan pembangkitan listrik menggunakan mesin diesel dan generator yang dihubungkan menggunakan mekanisme *belt and pulley* yang disambungkan dengan sebuah *electronic load* sebagai pembebanan guna membandingkan unjuk kerja dan emisi serta menemukan *optimum energy share* antara biodiesel dan *co-firing* hidrogen.

Hasil eksperimen menunjukkan bahwa pada kondisi operasi nominal yakni 2200 rpm, persentase *co-firing* hidrogen 15% memberikan hasil optimal dengan peningkatan daya hingga 18% pada HVO, serta kenaikan BTE sebesar 15% pada HVO dan 11% pada B40. Pada kecepatan sedang dan rendah (1600 rpm dan 1000 rpm), persentase *co-firing* 5% terbukti paling efektif, menghasilkan peningkatan daya 10% pada B40 (1600 rpm) dan peningkatan BTE mencapai 30% pada B100 (1000 rpm). Dari aspek emisi, *co-firing* hidrogen 15% pada 2200 rpm secara signifikan mereduksi emisi CO, dengan mereduksi hingga 50% namun dengan kenaikan emisi NOx akibat suhu pembakaran yang tinggi. Pada kecepatan sedang (1600 rpm) dan rendah (1000 rpm), co-firing 5% menjadi titik optimal untuk mereduksi emisi, termasuk penurunan CO B40 hingga 98% dan penurunan SO_2 B40 hingga 87%.

Berdasarkan data yang diperoleh, disimpulkan bahwa *optimum energy share* berada pada 15% untuk putarann tinggi dan 5% untuk putarann sedang/rendah, dengan batasan maksimal 20% untuk menghindari risiko *pre-ignition*.

Kata Kunci: *dual-fuel, co-firing* hidrogen, biodiesel, unjuk kerja, emisi.

ABSTRACT

A dual-fuel co-firing setup with renewable energy has become a way to strategically approach energy transition problems. The use of biodiesel has effectively reduced our dependency towards the use of petroleum-based fuels. However, its lower energy density often results in a significant power deficit, disrupting the operational balance of internal combustion engines. This research investigates the integration of hydrogen co-firing to compensate for these energy losses. This experiment which uses a diesel engine that is coupled with a generator using a belt and pulley and an electronic load to simulate the operational environment of a gas-engine power plant, compares the performance and emission yet also find the optimum energy share of biodiesels with hydrogen co-firing in diesel engines.

Results show during nominal operating conditions (2200 rpm), a 15% hydrogen co-firing energy share provides optimal results, increasing power by up to 18% and improving BTE by 15% and BSFC by 11%. At medium and low speeds (1600 rpm and 1000 rpm), a 5% co-firing share proved more effective, achieving a 10% power increase for B40 (1600 rpm) and a peak BTE increase of 30% for B100 (1000 rpm). From an emissions perspective, hydrogen co-firing significantly reduced CO, reducing down until 50%. However, an increase in NOx emissions occurred due to high combustion temperatures. In lower speeds such as 1600 rpm and 1000 rpm, 5% hydrogen co-firing is optimal for emission reduction, achieving CO and SO_2 reduction upwards of 98% and 87% respectively.

In conclusion, the optimum energy share for high-speed operations is 15% and 5% for medium/low speeds, with a maximum threshold of 20% to avoid pre-ignition risks. This work provides an exemplar and scalable example of co-firing in diesel engines for broader use.

Keywords: *biodiesel, dual-fuel, hydrogen co-firing, performance, emissions*