ABSTRAK

ANALISIS SISTEM TERMAL *BURNER* BIOMASSA TIPE *ROCKET* TERHADAP VARIASI LAJU UMPAN BAHAN BAKAR DAN VARIASI KECEPATAN UDARA PEMBAKARAN

(Bimo Pamungkas, 2026: 118 Halaman, 64 Tabel, 28 Gambar, 4 Lampiran)

Kebutuhan energi global yang terus meningkat masih didominasi oleh sumber energi fosil, sehingga mendorong pengembangan sumber energi alternatif yang lebih ramah lingkungan, salah satunya biomassa. Wood pellet merupakan bahan bakar biomassa terdensifikasi yang memiliki nilai kalor dan stabilitas pembakaran yang baik sehingga potensial diaplikasikan pada sistem burner biomassa tipe rocket. Penelitian ini bertujuan menganalisis pengaruh laju umpan bahan bakar dan kecepatan udara pembakaran terhadap karakteristik api, efisiensi termal, serta distribusi energi dan kehilangan panas pada burner biomassa tipe rocket berbahan bakar wood pellet. Penelitian dilakukan secara eksperimental dengan variasi laju umpan bahan bakar 5, 7, dan 9 kg/jam serta kecepatan udara pembakaran 6, 8, 10, 12, dan 14 m/s. Parameter yang diamati meliputi temperatur ruang bakar, temperatur nyala api (stack gas), temperatur udara pembakaran, konsentrasi gas CO dan CO_2, serta karakteristik visual nyala api. Efisiensi termal dihitung berdasarkan perbandingan panas stack gas terhadap panas masuk sistem. Hasil penelitian menunjukkan panjang nyala api tertinggi sebesar 60 cm pada laju umpan 9 kg/jam dan kecepatan udara 14 m/s, sedangkan temperatur nyala api tertinggi sebesar 1.189°C dicapai pada laju umpan 9 kg/jam dan kecepatan udara 10 m/s. Efisiensi termal tertinggi sebesar 74,14% diperoleh pada kombinasi laju umpan 9 kg/jam dan kecepatan udara 10 m/s, yang juga merupakan kondisi operasi optimal. Pada kondisi tersebut, 73,63% energi masuk tersalurkan sebagai panas berguna stack gas, sedangkan kehilangan panas dominan terjadi melalui konduksi (13,30%) dan konveksi (6,65%) dinding ruang bakar. Hasil ini mengindikasikan bahwa peningkatan efisiensi termal lebih lanjut dapat dicapai melalui penambahan material insulasi termal pada dinding ruang bakar.

Kata kunci: burner biomassa tipe rocket, wood pellet, kecepatan udara pembakaran, laju umpan bahan bakar, efisiensi termal

ABSTRACT

THERMAL SYSTEM ANALYSIS OF A ROCKET-TYPE BIOMASS BURNER ON VARIATIONS IN FUEL FEED RATE AND COMBUSTION AIR VELOCITY

(Bimo Pamungkas, 2026: 118 *Pages*, 64 *Tabels*, 28 *Pictures*, 4 *Attachments*)

Growing global energy demand remains dominated by fossil fuels, driving the development of more environmentally friendly alternative energy sources, one of which is biomass. Wood pellets are a densified biomass fuel with a favorable calorific value and stable combustion characteristics, making them suitable for application in rocket-type biomass burner systems. This study aims to analyze the effect of fuel feed rate and combustion air velocity on flame characteristics, thermal efficiency, and energy distribution and heat losses in a wood-pellet-fueled rocket-type biomass burner. The research was conducted experimentally with variations in fuel feed rate of 5, 7, and 9 kg/h and combustion air velocity of 6, 8, 10, 12, and 14 m/s. The observed parameters included combustion chamber temperature, flame (stack gas) temperature, combustion air temperature, CO and CO_2 gas concentrations, and visual flame characteristics. Thermal efficiency was calculated based on the ratio of stack gas heat to the system's heat input. The results showed that the highest flame length of 60 cm was obtained at a feed rate of 9 kg/h and an air velocity of 14 m/s, while the highest flame temperature of 1,189°C was achieved at a feed rate of 9 kg/h and an air velocity of 10 m/s. The highest thermal efficiency of 74.14% was obtained at the combination of a 9 kg/h feed rate and 10 m/s air velocity, which also represented the optimal operating condition. Under this condition, 73.63% of the input energy was converted into useful stack gas heat, while the dominant heat losses occurred through wall conduction (13.30%) and convection (6.65%). These findings indicate that further improvement in thermal efficiency can be achieved by adding thermal insulation to the combustion chamber wall.

Keywords: *rocket-type biomass burner, wood pellet, combustion air velocity, fuel feed rate, thermal efficiency*