

ABSTRAK

STUDI EKSPERIMENTAL PENGARUH VARIASI TEMPERATUR DAN WAKTU TINGGAL PADA PROSES TOREFAKSI *WOOD CHIP* MAHONI MENGGUNAKAN REAKTOR KONTINU TIPE TUBULAR DENGAN SISTEM PEMANAS *OIL JACKET*

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Penelitian ini mengkaji pengaruh variasi temperatur dan waktu tinggal pada proses torefaksi *wood chip* mahoni (*Swietenia macrophylla*) menggunakan reaktor kontinu tipe tubular dengan sistem pemanas oil jacket. Torefaksi dilakukan pada temperatur 250, 275, dan 300°C dengan waktu tinggal 10, 20, dan 30 menit untuk mengevaluasi perubahan kualitas bahan bakar padat melalui parameter nilai kalor, analisis proksimat (*moisture content, volatile matter, ash, fixed carbon*), *mass yield, energy yield*, serta ketahanan serap air (hidrofobisitas). Hasil menunjukkan bahwa peningkatan temperatur dan waktu tinggal meningkatkan derajat devolatilisasi dan deoksigenasi sehingga nilai kalor cenderung meningkat, terutama pada temperatur tinggi dan waktu tinggal lebih lama. Sebaliknya, *mass yield* menurun seiring meningkatnya keparahan proses akibat konversi fraksi volatil menjadi gas dan tar, penurunan paling besar terjadi pada temperatur 300 °C hingga mencapai kisaran sekitar 52% pada waktu tinggal 30 menit. *Energy yield* juga menurun dari kondisi awal, mencerminkan kompromi antara peningkatan densitas energi padatan dan kehilangan massa selama proses. Selain itu, torefaksi meningkatkan hidrofobisitas, ditunjukkan oleh penurunan *water uptake* pada sampel dengan temperatur dan waktu tinggal yang lebih tinggi. Secara keseluruhan, kombinasi temperatur–waktu tinggal pada rentang 250 - 300 °C berpotensi meningkatkan kualitas *wood chip* mahoni sebagai bahan bakar padat alternatif dengan mempertimbangkan antara peningkatan nilai kalor dan penurunan rendemen.

Kata Kunci: Torefaksi, *wood chip* mahoni, reaktor kontinu tubular, temperature, waktu tinggal, nilai kalor, analisis proksimat, *mass yield, energy yield*, hidrofobisitas.

ABSTRACT

EXPERIMENTAL STUDY ON THE EFFECT OF TEMPERATURE AND RESIDENCE TIME VARIATIONS IN THE TORREFACTION OF MAHOGANY WOOD CHIPS USING A CONTINUOUS TUBULAR REACTOR WITH AN OIL JACKET HEATING SYSTEM

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*This study investigates the effects of torrefaction temperature and residence time on mahogany wood chips (*Swietenia macrophylla*) using a continuous tubular reactor with an oil-jacket heating system. Torrefaction was conducted at 250, 275, and 300°C with residence times of 10, 20, and 30 minutes. Fuel quality was evaluated through calorific value, proximate analysis (moisture content, volatile matter, ash, fixed carbon), mass yield, energy yield, and water uptake (hydrophobicity). The results indicate that increasing temperature and residence time enhances devolatilization and deoxygenation, leading to a general increase in calorific value, particularly at higher severity conditions. In contrast, mass yield decreases with increasing severity due to progressive conversion of reactive components into permanent gases and condensable vapors; the most pronounced reduction occurred at 300 °C, reaching approximately 52% at 30 minutes. Energy yield also declines compared with the raw material, highlighting the trade-off between improved energy density of the solid product and overall energy retention as mass is lost. Torrefaction further improves hydrophobicity, evidenced by reduced water uptake at higher temperatures and longer residence times. Overall, operating within 250–300 °C provides an effective pathway to upgrade mahogany wood chips into a more coal-like solid fuel, while requiring optimization to balance calorific value enhancement against yield losses.*

Keyword: Torrefaction, mahogany wood chips, continuous tubular reactor, temperature, residence time, calorific value, proximate analysis, mass yield, energy yield, hydrophobicity.