INTISARI

Pemanfaatan biomassa tempurung kelapa sebagai sumber energi alternatif memiliki potensi besar dalam mendukung transisi menuju energi baru terbarukan di Indonesia. Tempurung kelapa, sebagai limbah pertanian yang melimpah dan belum termanfaatkan secara optimal, mengandung nilai kalor tinggi sehingga layak digunakan sebagai bahan bakar padat pengganti batubara. Namun, proses pembakarannya masih menghadapi berbagai kendala, terutama emisi partikulat dan ketidakefisienan pembakaran akibat distribusi udara yang tidak seimbang. Emisi partikulat dari pembakaran biomassa berpotensi mencemari udara, menurunkan kualitas lingkungan, dan berdampak negatif terhadap kesehatan. Oleh karena itu, diperlukan penelitian lebih lanjut untuk memahami pengaruh rasio udara berlebih (*excess air*) dan penerapan konverter katalitik dalam menekan emisi tanpa mengorbankan tempertatur termal sistem pembakaran.

Penelitian dilakukan secara eksperimental dengan variasi *excess air* sebesar 50%, 75%, dan 100%, menggunakan distribusi udara primer dan sekunder 50:50. Parameter yang diamati meliputi temperatur ruang bakar dan cerobong, konsentrasi CO_2 dan O_2, serta kadar partikulat (PM) sebelum dan sesudah konverter katalitik. Pengambilan data dilakukan menggunakan *thermocouple* tipe K, *gas analyzer* KANE 457, sensor O_2 DFRobot, dan sensor partikulat SPS30.

Hasil penelitian menunjukkan bahwa pada kondisi *excess air* 50% diperoleh performa pembakaran terbaik, dengan temperatur ruang bakar tertinggi sebesar 842°C, kadar CO_2 maksimum 10,8%, dan O_2 minimum 8,6%. Konsentrasi partikulat setelah konverter katalitik menurun signifikan hingga 35–45% dibandingkan sebelum katalitik. Peningkatan *excess air* di atas 75% menyebabkan penurunan temperatur dan efisiensi pembakaran, disertai kenaikan kadar partikulat akibat pendinginan ruang bakar. Dengan demikian, kondisi *excess air* 50% dengan konverter katalitik merupakan kombinasi paling optimal untuk menurunkan emisi partikulat sekaligus menjaga efisiensi pembakaran biomassa tempurung kelapa.

Kata kunci: biomassa, tempurung kelapa, *excess air, catalytic converter*, emisi, partikulat

ABSTRACT

The utilization of coconut shell biomass as an alternative energy source holds great potential in supporting Indonesia's transition toward renewable energy. Coconut shells, an abundant agricultural by-product, possess a high calorific value, making them a promising solid fuel substitute for coal. However, their combustion process still faces challenges such as high particulate emissions, incomplete combustion, and fluctuating thermal efficiency caused by uneven air distribution. Particulate emissions from biomass combustion contribute significantly to air pollution, environmental degradation, and adverse health effects. Therefore, further investigation is needed to optimize combustion performance by examining the influence of excess air variation and the use of a catalytic converter in reducing emissions while maintaining temperature.

The experiment was conducted with excess air variations of 50%, 75%, and 100%, using an equal distribution of primary and secondary air (50:50). Observed parameters included combustion chamber and chimney temperature, CO_2 and O_2 concentrations, and particulate matter (PM) levels before and after the catalytic converter. Measurements were carried out using a K-type thermocouple, KANE 457 gas analyzer, DFRobot O_2 sensor, and SPS30 particulate sensor.

The results showed that at 50% excess air, the combustion exhibited the best performance, with the highest combustion chamber temperature of 842°C, maximum CO_2 concentration of 10.8%, and minimum O_2 concentration of 8.6%. The catalytic converter effectively reduced particulate emissions by 35–45% compared to conditions before the catalyst. Increasing excess air above 75% resulted in lower combustion temperatures and efficiency, accompanied by higher particulate concentrations due to cooling effects in the furnace. Therefore, 50% excess air combined with a catalytic converter is identified as the optimal condition to minimize particulate emissions while maintaining efficient biomass combustion of coconut shells..

Keywords: biomass, coconut shell, excess air, catalytic converter, emissions, particulate matter