INTISARI

Sebagian besar kebutuhan energi dunia saat ini masih dipenuhi dari bahan bakar fosil, yang bersifat terbatas, tidak terbarukan dan tidak ramah lingkungan. Para ilmuwan telah memberikan perhatian serius terhadap biomassa yang memiliki sifat lebih baik daripada bahan bakar fosil, serta mencari teknologi proses untuk mengubahnya menjadi bahan bakar aplikatif. Selain teknologi biokimia, teknologi termokimia telah dikembangkan untuk mengubah biomassa menjadi energi, yaitu gasifikasi, pirolisis, dan likuifaksi. Kelebihan proses likuifaksi dibanding yang lain adalah dapat mengolah biomassa basah tanpa proses pengeringan terlebih dahulu, kuantitas bio-oil lebih banyak dan suhu operasi lebih rendah.

Likuifaksi termokimia biomassa menjadi bio-oil secara batch biasanya terjadi secara non-isotermal, khususnya pada awal proses, sehingga pengetahuan tentang kinetika pada proses ini perlu dipelajari. Pada penelitian ini, proses likuifaksi menggunakan medium larutan etanol-air dan katalis Na_2CO_3. Tujuan penelitan ini adalah untuk mempelajari kinetika likuifaksi termokimia tongkol jagung menjadi bio-oil secara batch dengan medium larutan etanol-air yang berlangsung secara non-isotermal, sekaligus mempelajari pengaruh konsentrasi etanol, katalis, dan biomassa. Dekomposisi biomassa dalam proses likuifaksi termokimia melibatkan banyak senyawa dan reaksi yang kompleks. Untuk penyederhanaan, disusun 14 model kinetika reaksi yang mungkin terjadi di antara komponen semu yang dipisahkan berdasarkan perbedaan fase pada kondisi ruangan, yaitu padatan, bio-oil, gas, dan volatil. Setiap model memiliki mekanisme reaksi dan persamaan kinetika yang berbeda dengan yang lain.

Percobaan likuifaksi tongkol jagung dalam larutan etanol-air dilakukan dalam reaktor autoklaf 150 mL yang dilengkapi dengan pengaduk magnetik. Proses pemanasan dimulai pada suhu kamar dan dihentikan pada waktu dan suhu tertentu untuk pengambilan sampel. Suhu tertinggi dibatasi hingga 280^{o}C. Produk reaksi diambil setelah reaktor mencapai suhu kamar kembali dengan pendinginan udara. Semua bahan dikeluarkan dari reaktor dan disaring dengan kertas saring untuk mendapatkan produk padatan. Filtrat dievaporasi hingga 90^{o}C dengan *rotary vacuum evaporator* untuk mendapatkan bio-oil.

Berdasarkan pertimbangan konsistensi dan akurasi, model yang dianjurkan adalah model 12. Menurut mekanisme reaksi model 12, mula-mula padatan biomassa terdekomposisi menjadi bio-oil, diikuti reaksi bio-oil menjadi volatil secara reversibel, dan dilanjutkan reaksi dekomposisi volatil menjadi gas. Penggunaan konsentrasi etanol hingga 40% dapat meningkatkan yield bio-oil hingga 54,93%. Penambahan katalis Na_2CO_3 hingga 10% berat biomassa dapat meningkatkan yield bio-oil hingga 53,54%. Namun, penggunaan larutan etanol 20% dan katalis 5% berat biomassa lebih disarankan karena lebih ekonomis. Konsentrasi biomassa tidak berpengaruh signifikan terhadap yield semua produk likuifaksi.

Kata kunci: kinetika, likuifaksi termokimia, bio-oil, biomassa, tongkol jagung, etanol

ABSTRACT

Most of the world's energy needs today are still met from fossil fuels, which are limited, non-renewable and environmentally unfriendly. Scientists have paid serious attention to biomass that has better properties than fossil fuels, as well as seeking process technology to turn it into an applicative fuel. In addition to biochemical technology, thermochemical technology has been developed to convert biomass into energy, namely gasification, pyrolysis, and liquefaction. The advantages of liquefaction process compared to the others are able to process wet biomass without drying process first, more bio-oil produced and lower operating temperature.

The thermochemical liquefaction of biomass into bio-oil in the batch process usually occurs non-isothermally, especially at the beginning of the process, so knowledge of kinetics in this process needs to be studied. In this study, the liquefaction process used ethanol-water solution and Na_2CO_3 catalyst. The objective of this research is to study the kinetics of thermochemical liquefaction of corncobs into bio-oil in the batch non-isothermally in the ethanol-water solution medium, as well as studying the effect of ethanol, catalyst, and biomass concentration. The decomposition of biomass in thermochemical liquefaction processes involves many complex compounds and reactions. For simplification, the 14 kinetics models of the possible reactions are arranged according to the group of compounds separated by phase differences in the room conditions, i.e. solids, bio-oil, gases, and volatiles. Each model has different reaction mechanism and kinetic equation from the others.

The experiments of corncobs liquefaction in ethanol-water solution were carried out in a 150 mL autoclave reactor equipped with a magnetic stirrer. The heating process started at room temperature and was stopped at a certain time and temperature for sampling. The highest temperature was limited to 280^oC. The reaction products were taken after the reactor reached room temperature again with air cooling. All materials were removed from the reactor and filtered by filter paper to obtain the solids product. The filtrate was evaporated up to 90^oC with rotary vacuum evaporator to obtain bio-oil.

Based on consistency and accuracy, the recommended model was model 12. According to the reaction mechanism of model 12, the biomass (corncobs) first decomposed into bio-oil, followed by decomposition of bio-oil into volatiles reversibly and, finally, volatiles decomposed into gaseous products. The use of ethanol concentration up to 40% was able to increase bio-oil yield up to 54.93%. The addition of Na_2CO_3 catalyst up to 10% by weight of biomass was able to increase bio-oil yield up to 53.54%. However, the use of 20% ethanol solution and Na_2CO_3 catalyst of 5% by weight of biomass was suggested for economic reasons. Biomass concentration had no significant effect on yield of all liquefaction products.

Keywords: kinetic, thermochemical liquefaction, bio-oil, biomass, corncob, ethanol