FIELD OF STUDY

Chemical Engineering

DISSERTATION TOPIC

KINETICS OF BIOMASS FAST PYROLYSIS

EXAMINING COMMITTEE

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ABSTRACT

Lignocellulosic biomass is a domestic, environmental and sustainable source of organic carbon that has been selected as a near-term main renewable energy source. Thermochemical conversion, such as fast pyrolysis, is a versatile way to convert lignocellulosic biomass to heat, power, fuels, and useful chemicals. There is more than a century of scientific research in this area; however, it remains a vibrant topic in order to facilitate the commercialization of pyrolytic biofuels.

In biomass fast pyrolysis, the reactor is the performance-controlling process, and a variety of alternatives have been considered at all scales: laboratory, pilot and pre-commercial/commercial. In the majority of previous studies, there is a lack of specific experimental information about the effect of transport conditions on controlled geometry microscale feedstock. Factors including gas and condensed-phase residence time, type and amount of pyrolysis products and geometry of particle have not been clearly correlated. To close this gap, a novel laboratory-scale microsphere (~10µg) micro-reactor (MSMR) fast pyrolysis technique and associated technology for production of biomass microspheres was introduced.

The MSMR was introduced to study fast pyrolysis (at heating rates as high as 10,000 K/s) of whole biomass and cellulose at temperatures (between 500 and 900°C). A continuum-base model was also developed to investigate the kinetic and transport effects, e.g., temperature of the biomass microsphere and dynamics of real-time product formation for different-size particles (100-400 µm). A mechanism for the fast pyrolysis of cellulose was proposed from experimental observations, and the hypothesis was evaluated with the model. A series of experiments were also performed with manufactured microsphere particle to determine the uniformity and to correlate the extent of pyrolysis to gross morphological change (shrinkage). Finally, the effects of the size and type of biomass particle and the reactor temperature on the kinetics and heat of the reaction during fast pyrolysis were investigated.

BIOGRAPHICAL SKETCH

Ali Zolghadr was born in Neyriz, Iran, on September 11, 1986. He received his B.S. degree in petroleum engineering in 2009, and received his M.S. in chemical engineering from Shiraz University in 2012.There, he determined the optimum gas injection condition in the EOR process by interfacial tension investigation. After earning his M.S. degree, Ali worked as a research assistant at the Advanced Enhanced Oil Recovery Center at Shiraz University. In April 2014, he joined the chemical engineering program at Tennessee Tech University, and he completed all the requirements for his Doctor of Philosophy degree in September 2018.

EDUCATION

PhD, Engineering - Chemical Engineering, Tennessee Technological University, Tennessee, Cookeville, USA (2018).

M.Sc., Engineering - Chemical Engineering, Shiraz University, Shiraz, Iran (2012).

College of Engineering

TENNESSEE TECH

The Department of

Chemical Engineering

Announces the Dissertation Defense

Of

Ali Zolghadr

In Partial Fulfillment of the Requirements

For the degree of

Doctor of Philosophy

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