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Outline of Doctoral Dissertation

Name : Flabianus Hardi

Title : Consecutive Hydrothermal Liquefaction and Gasification of Lignocellulosic Biomass for Biofuel Generation

Date : March 2018

Chapter 1. Introduction

- Background and motivation for producing biofuel
- Biomass conversion technology, particularly the recent status of hydrothermal liquefaction (HTL) and gasification
- Black liquor gasification technology
- Fundamental of experimental design and response surface methodology
- Proposal of consecutive HTL and gasification to improve gasification performance

Chapter 2. Effect of reaction parameters on non-catalytic hydrothermal liquefaction of pine sawdust

- Effect of reaction temperature, sawdust concentration and reaction time on biomass conversion, aqueous product yield, heavy oil yield, gas yield, higher heating value of products and pH of slurry after HTL
- Developing the mass and carbon balances model predictions
- Identifying the statistically significant terms (linear, interaction and quadratic) for each model prediction and analysis of variance (ANOVA)
- Qualitative analysis of the aqueous product using GC-MS analysis and plausible mechanism of pine sawdust decomposition
- Higher heating value models for solid residue and heavy oil products

Chapter 3. Comparison between non-catalytic and K_2CO_3-catalytic hydrothermal liquefaction of pine sawdust

- Comparison between non-catalytic HTL and K_2CO_3-catalytic HTL on the biomass conversion, aqueous product yield and gas yield
- Plausible reaction mechanism during K_2CO_3-catalytic HTL

- Effect of sawdust particle size during non-catalytic HTL and K_2CO_3-catalytic HTL on biomass conversion, aqueous product yield and gas yield

Chapter 4. Catalytic hydrothermal liquefaction of pine sawdust with K_2CO_3 for production of gasification feedstock

- Mass and carbon distributions of the K_2CO_3-catalytic HTL products
- Estimation of produced water using hydrogen balance
- Total carbon recovery and corrected total mass recovery
- Quantification of the effect of reaction parameters on biomass conversion and HTL products using multiple linear regression
- Model prediction for biomass conversion, aqueous product yield and gas yield in mass and carbon basis and ANOVA of the models
- Further investigation on the effect of the biomass/water and biomass/ K_2CO_3 ratios on conversion and aqueous products.

Chapter 5. Gasification of chars derived from catalytic hydrothermal liquefaction products under CO_2 atmosphere using thermogravimetric analyzer

- Converting four selected HTL products, black liquor and virgin pine sawdust samples into chars by fast pyrolysis in a fixed bed glass tube
- Non-isothermal CO_2 char gasification characteristics
- Reactivity of the chars during CO_2 gasification and the feasibility of using HTL product as gasification feedstock
- Kinetic analysis: Calculation of the activation energies of the chars iso-conversionally using Flynn-Wall-Ozawa, Kissinger-Akahira-Sunose and Starink appromiantions

Chapter 6. Conclusions and recommendations

- Summary of the important findings and conclusions of each previous chapter
- Recommendations for future research