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A study on influences of torrefaction to enhance the chemical characteristics of pyrolytic liquids from fast pyrolysis of palm kernel shells

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Palm Kernel Shells (PKS) is a residue product from palm oil production and is today mainly used as a fuel for production of heat and power. Pyrolysis of PKS is an alternative way to increase the amount of oil produced from the material (both for fuels and chemicals) at the same time as producing a solid and gaseous fuel. Compared to conventional biomass types used in today's pyrolysis processes PKS has a higher lignin content of 51% relative to 18-35% in lignocellulosic biomass and 10-30% in agricultural residues, i.e. enhanced production of phenolic compounds. Further on, the high oxygen content of approximately 1/3 of elemental composition in PKS tends to reduce the heating value of pyrolytic liquids as well as its thermodynamic stability, which is mainly caused by compounds derived from hemicellulose, e.g. water and reactive carbonyl compounds. Torrefaction is today used to increase the energy density of biomass to facilitate logistic issues. Also, the volatile fraction of biomass released during torrefaction temperatures includes acids, carbonyls and other oxygenated compounds that are involved in aging reactions in pyrolytic liquids as well as reducing its fuel properties. By controlling the torrefaction process either with temperature, and/or residence time, it is possible to produce more stable pyrolysis oil by removing these limiting compounds during the torrefaction process for downstream fast pyrolysis. The objective of this study is to investigate torrefaction as a pretreatment method of PKS in order to produce more thermodynamically stable pyrolysis oil. In this work, PKS is torrefied at different temperatures (200-300°C) followed by pyrolysis at 550°C. Experiments are performed in a fixed bed batch pyrolyzer followed by analysis of pyrolytic liquids by GC/MS and gases by micro-GC. Preliminary results show that pyrolytic liquid from raw PKS exist in aqueous and bio-oil separated phases, i.e. water production is relatively high. Figure 1 shows the comparison of bio-oil between raw and torrefied PKS. It is found that the concentration of phenolic compounds is significantly higher in bio-oils derived from torrefied PKS at 250°C compared with that derived from raw PKS. Concentration of acids and aldehydes were reduced in the aqueous phase for torrefied PKS, at the same time as sugar concentration was increased. Pyrolytic gases of torrefied biomass show enhanced potential as a gaseous fuel, with a reduced fraction of non-combustible gases

Biography

Henry Persson is a PhD Candidate and holds his expertise in Chemical Engineering with focus on biomass pyrolysis processes for production of bio-oils. He holds a MSc degree in Chemical Engineering from KTH Royal Institute of Technology, with Diploma work in catalytic process development for gaseous systems. His current research is focusing on pretreatment of biomass combined with fast pyrolysis systems. At KTH, Royal Institute of Technology, the research group is working on pyrolysis processes for different feedstocks by investigating different process conditions in order to optimize energy and material recycling. Besides research, he is also teaching and supervising Master's students in risk analysis projects and diploma works.

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