EFFECT OF TORREFACTION ON BIOMASS CHEMISTRY AND HYDROCARBONS PRODUCTION FROM FAST PYROLYSIS

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Abstract

Torrefaction has shown to improve the chemical composition of bio-oil produced from fast pyrolysis by lowering its oxygen content and enhancing aromatic yield. The objective of the present study was to develop fundamental understanding on chemical and structural transformation of biomass components during torrefaction and how that will impact on hydrocarbons production from non-catalytic and catalytic pyrolysis. Py-GC/MS study was employed to investigate the effect of torrefaction temperatures (225, 250 and 275 ^{o}C) and residence times (15, 30 and 45 min) on product distribution from non-catalytic and H^{+}ZSM-5 catalyzed pyrolysis of pinewood. During torrefaction, structural transformations in biomass constitutive polymers: hemicellulose, cellulose and lignin took place, which were evaluated using component analysis, solid state CP/MAS ^{13}C NMR and XRD techniques. Torrefaction caused deacetylation and decomposition of hemicellulose, cleavage of aryl ether linkages and demethoxylation of lignin, degradation of cellulose and overall increase in aromaticity of biomass, all of which affected the product yield from pyrolysis of torrefied biomass. For non-catalytic pyrolysis, selectivity of phenolic compounds increased with increase in torrefaction severity while that of furan compounds decreased. In case of catalytic pyrolysis, sample torrefied at 225^{o}C-30min and 250^{o}C-15min resulted in significant increase in aromatic HC and also total carbon yield (approx. 1.6 times higher) as compared to catalytic pyrolysis of non-torrefied pine. Cleavage of aryl ether linkages and demethoxylation in lignin due to torrefaction caused increased yield of phenolic compounds, which in presence of catalyst were dehydrated to from aromatic HC.