Characterization of Bio-oil Produced by HTL of Binary Mixture of Phenylalanine and Glucose

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Abstract

Hydrothermal liquefaction (HTL) is an effective technique to obtain bio-oil from advanced biomass without any drying step. However, bio-oil produced from HTL cannot be used directly as a liquid transportation fuel due to its significant nitrogen content that makes this material immiscible with conventional petroleum fuel and cause NOx emissions. To overcome this problem it is necessary to study the chemical behavior of nitrogen containing compounds during HTL in order to adjust the severity of hydrotreating process. Doubtless, for optimization and selection of appropriate upgrading strategy the chemical characterization of heteroatom and functionality distribution in bio-oil is crucial. Therefore, in the present study phenylalanine and glucose were employed as representative biomass model compounds of protein and carbohydrate macromolecules. Their interaction behavior during the HTL process was investigated considering the molecular level characterization of the nitrogen-containing species in bio-oil by means of positive electrospray high resolution mass spectrometry (FTICR –MS).
Based on results obtained, N2 is the most abundant heteroatom class, followed by O1N1, N1, and O1N2 classes in bio-oil. According to the abundance-contoured plots (Fig 1) of DBE versus carbon number for N2 compounds, a broad distribution of species which range from Cn=15-50 and DBE 10-30 was determined. Major N2class compounds in the bio-oil are related to Cn=32 and DBE 19, Cn=39 and DBE=23, Cn=46 and DBE=27 with the difference of benzene or alkylated benzene rings (DBE≥ 4) and these species could be assigned as pyrazinic compounds formed from Maillard reaction with the addition of alkylbenzene rings. High values of DBE for N1, N2, O1N1 classes indicate high unsaturation of nitrogen-containing compounds in the bio-oil. It is known that N1 compounds are more hydrotreatment-resistant than compounds with additional nitrogen (N2 class) and oxygen (O1N1) heteroatom. Using the data obtained might be essential for the improvement in the HTL bio-oil production and subsequent upgrading process.

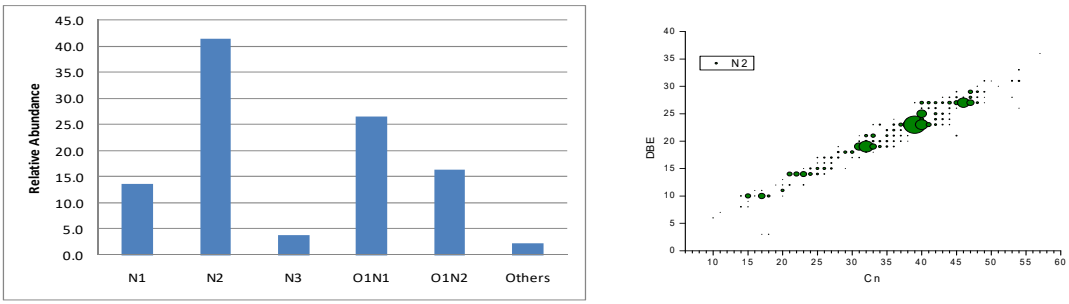

Fig.1. Abundance-contoured plot of DBE versus carbon number for N2 class