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Abstract for NPS7

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Fast Pyrolysis of biomass: char/ash removal by in-situ filtering of pyrolysis vapors

Fast pyrolysis is a technology for the conversion of bulky solid biomass into liquid oil with an energy density of half that of fossil oil. Organic material is heated rapidly to 450 - 500 0C in the absence of oxygen under atmospheric pressure. At these conditions, biomass is converted to vapors, permanent gases and char. After char separation, the vapors are condensed to a dark brown liquid known as pyrolysis oil [1]. In conventional pyrolysis systems some fine char including ash (minerals) is inevitably entrained. The presence of char/ash makes pyrolysis oil unsuitable for direct combustion in oil/gas boilers and turbine operations. Char/ash is generally believed to contribute to secondary cracking reactions in the vapor phase thereby lowering the oil yield [2] as well as reactions in the liquid phase at ambient conditions thereby increasing viscosity [1]. Complete char/ash separation is therefore desirable.

The objective of this project is the development of a novel system to remove, in-situ, char/ash from hot pyrolysis vapors. For this, a fluidized bed with immersed filters for extracting pyrolysis vapors is proposed. It is anticipated that due to the sourcing action of the bed particles, the filters are cleaned continuously. In this way, reaction and separation are integrated in one apparatus. This approach will also prevent an increased residence time as observed with external filtering of pyrolysis oil vapors, thereby preventing secondary cracking reactions. In this study, tests were carried out in a continuous pilot plant including both a filter and a cyclone line (0.70 kg/h). Influence of the filters on the operability of the process, the quality of the oil and char formation reaction inside the vapor phase have been studied. Good process stability concerning temperature and pressure drop across the hot gas vapor filter was achieved during a two hour run. The filtered oil contained significantly less solids, alkali metals and ash as compared to cyclone oil, except for potassium. There were no significant differences in the elemental composition of the oil produced via the filter line and cyclone line. The molecular weight of the filtered oil obtained was lower. Results of the aging tests show that the reactivity of pyrolysis oil can already originate from the highly reactive components in pyrolysis oil itself and does not need the presence of char/ash. Furthermore, the results show the possibibility of char formation reactions in a particle free vapor stream.

References:

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[2] F.A. Agblevor, S. Besler, Inorganic compounds in biomass feedstocks 1. Effect on the quality of fast pyrolysis oils, Energy & Fuels, 1996, 10:p. 293-298