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High Heating Value Bio-Chars from a Bio-Oil Upgrading Process

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Abstract : In today's world of rapid population growth and a changing climate, one way to mitigate various negative effects is via renewable energy solutions. Energy and power as basic requirements in almost all human endeavours are also the banes of the changing climate and the impacts thereof. Thus it is crucial to develop innovative and environmentally friendly energy options to ameliorate various negative repercussions. Upgrading of fast pyrolysis bio-oil via hydro-treatment offers such opportunities, as quality renewable liquid transportation fuels can be produced. The process, however, is typically accompanied by bio-char formation as a by-product. The goal of this work was to study the yield and some properties of bio-chars formed from a hydrotreatment process, with an overall aim to promote the valuable utilization of wastes or by-products from renewable energy technologies. It is assumed that bio-chars that have comparable energy contents with coals will be more desirable as solid energy materials due to renewability and environmental friendliness. Therefore, the analytical work in this study focused mainly on determining the higher heating value (HHV) of the chars. The method involved the reaction of bio-oil in an autoclave supplied by the Parr Instrument Company, IL, USA. Two main parameters (different temperatures and resident times) were investigated. The chars were characterized using a Thermo EA2000 CHNS analyser, then oxygen contents and HHVs computed based on the literature. From the results, these bio-chars can readily serve as feedstocks for the production of renewable solid fuels. Their HHVs ranged between 29.26-39.18 MJ/kg, affected by different temperatures and retention times. There was an inverse relationship between the oxygen content and the HHVs of the chars. It can, therefore, be concluded that it is possible to optimize the process efficiency of the hydrotreatment process used through the production of renewable energy materials from the 'waste' char by-products. Future work should consider developing a suitable balance between the primary objective of bio-oil upgrading processes (which is to improve the quality of the liquid fuels) and the conversion of its solid wastes into value-added products such as smokeless briquettes.

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