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Ash characteristics and plant nutrients in some aquatic biomasses

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Aquatic biomasses are explored as potential fuel source for direct combustion because of their faster growth and no land requirement. The energy density and the ash characteristics of the aquatic biomasses are to be evaluated for their suitability for energy extraction. In the study, four aquatic plant samples namely Eichornia crassipes, Hydrilla verticilleta, Lemna minor, Spirogyra spp were collected from a pond in Digwadih Campus of Central Institute of Mining and Fuel Research, Dhanbad. The biomasses were air dried, powdered and ashed at different temperatures. Volatile C was relatively lower in Spirogyra and Hydrilla (53 %) than Eichornia (62.6 %) or Lemna (59.7 %), whereas fixed C was higher for Eichornia and Lemna (about 10 %) and lower for Hydrilla (1 %). Ultimate analysis showed that the carbon content was in the order Eichornia > Lemna > Spirogyra > Hydrilla. The IR spectra of each raw biomass is compared to their respective ashes obtained at different temperatures (500-900°C). With increase in ashing temperature from 500-900°C there is gradual breakdown of the cellulosic structure hence, peaks around 2900-2800cm-1 caused by aliphatic C-H vibration tends to disappear slowly in ash. More number of peaks appears at lower wavenumbers in ashes of all the biomass samples indicating towards increased percentage of inorganic ion species. Considerable enrichment of SiO_2 is validated with prominent peaks at 1100-900 cm-1 in all the ashes. Lemna and Spirogyra has a similar ash composition (Si > Al > Ca > K), whereas, Ca was higher in Hydrilla (Si > Ca > K > Al). Eichornia (Si > K > Ca > Al) has higher K and Ca than Al. SiO_2 and $Al2O_3$ were higher in Spirogyra, while SiO_2 and CaO in Eichornia and Hydrilla. K first increased from 500-700/800^{0}C, and then decreased from 800-900^{0}C. Cl is lost slowly in ash from 500-700/800^{0}C and then by a drastic reduction from 800-900^{0}C. S is enhanced in ash at all temperatures although the change is quite small. Most of the Cl is released at 800 ºC. The salgging tendencies based on both base: acid ratio and slagging factor, fouling probabilities based on fouling factors is in the order Hydrilla > Eichornia > Lemna > Spirogyra. Among the different heavy metals Zn, Pb, Cu, and Ni have concentration > 100 mg/kg; Cr and V content was > 50 mg/kg; Co, > 10 mg/kg. In general the heavy metal contents were higher in Spirogyra. Due to the volatile nature Cd and Pb decreases in ash with temperature and is lost continuously in flue gas. Plant nutrient content was relatively higher for Eichornia: K (8 – 12.8 %), P (5.7 – 7.3 %), Ca (9.2 – 10.8 %), Mg (2.8 – 3.6 %), S (1.9 – 2.9 %), Zn (0.033 – 0.045 %), Fe (3.3 – 4.7 %), Cu (0.009 – 0.013 %), Mn (0.8 -1.3%). Among the four biomasses we have studied, Eichornia could be a potential candidate for energy extraction in view of its C content and widespread availability in many parts of the globe, and fast multiplication associated with the eutrophication of water bodies.