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Characterization of black carbon and organic contaminants in wood ash from different feedstocks and types of furnaces

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Due to their important concentration of nutrient and charcoal, wood ash from biomass power plants (WA) can be used as a fertilizer and organic amendment in intensively managed soils. Unlike biochar produced in under anoxic conditions, the nature of the organic compounds present in wood ash has been scarcely studied. Due to the incomplete combustion, wood ash may contain a wide range of organic compounds, from charred to highly condensed refractory biomass, which determines the possibilities of WA as an organic amendment. In addition, the possible environmental risk of this practice must be assessed by determining the content of water-soluble and insoluble organic contaminants. due to the incomplete combustion of organic matter, organic pollutants, such as Polycyclic Aromatic Hydrocarbons (PAHs), can be formed and can remain in the combustion residue. Also, the four alkyl benzene volatile organic compounds (benzene, toluene, ethylbenzene, and the ortho, para, and meta xylenes) can be formed, depending on certain conditions during combustion.

For this study 15 biomass power stations in Spain were selected. In all of them the feedstock is pine or eucalyptus branches and bark. Nine of them were bottom wood ash generated from wood fires furnaces, obtained from grate-fired or water-tube boilers. Whereas four of them were fly ash, obtained in cyclone separators. The samples were collected following a common procedure to ensure the representiveness of the sampling. Bottom ash samples were fraccionated in three fractions: < 2mm, 2-5 mm and > 5mm. Each fraction was characterized for organic matter and BTEX, styrene and total petroleum hydrocarbons Polycyclic Aromatic Hydrocarbons. For each analyzes, three replicates were analyzed per sample.

Mixes wood ash shows higher amounts of charred material than fly ash. The 13 C CPMAS NMR, DSC/TG and FTIR analysis showed the loss of carbohydrates and aliphatic constituents and revealed the formation of aromatic compounds. The atomic H/C ratios, NMR spectra, DSC and FTIR confirmed the presence of condensed structures, specially in the coarse particles. However, the different wood ash showed an important range of properties revealing the presence from charred material to charcoal containing condensed structures (H/C ratios lower than 0.6; aromaticity higher than 80 % and T50-DSC higher than 500 ºC). Typical organic pollutants including those water-soluble such as BTEX plus styrene, but also those water-insoluble such as polycyclic aromatic hydrocarbons (PAHs), together with aliphatic hydrocarbons, were examined in the ash. Their contents were related to degree of combustion of the biomass, determined through the content and composition of the organic matter in the wood ash. The sum of BTEX plus styrene varied from non-detected to 30 mg/kg, and the total amounts of PAHs (total PAHs) ranged between non-detected and 422 μg/kg, not exceeding the regulated limits. This research provides basic information for the evaluation of the environmental risk and potential uses of WW incinerator bottom ash
The results demonstrate the important variability in the charred material properties of the different power plants and size-particles. The organic compounds contents are also variable, but in all cases were levels of pollutants in all the samples were below the limits for both soil and industrial use (Environmental Protection Agency in the European Union and the USA.