Speciation Dynamics of Nutrients and Heavy Metals During Thermal and Hydro-Thermal Treatment of Sewage Sludge

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Reference: McDowell RJ, CA Pruitt, RA Bahn (eds.), *Proceedings of the 2015 Georgia Water Resources Conference*, April 28-29, 2015, University of Georgia, Athens.

Abstract. Because of the intrinsic high water content and the presence of a wide range of contaminants such as microorganisms, heavy metals and hazardous organic substances in sewage sludge from wastewater treatment plant, the management of sewage sludge has been a challenging task for the wastewater industry. Thermal and hydrothermal treatments are emerging as promising treatment alternatives since the contamination hazards can be mitigated and the sludge can be efficiently converted into valuable products. In the present study, we systematically investigated the migration and speciation dynamics of phosphorus (P) and heavy metals during the pyrolysis and hydrothermal treatment of sewage sludge collected from a local wastewater treatment plant in Atlanta, in order to evaluate the potential application of chars derived from the sludge as soil amendments. P in the chars and liquid extracts were characterized by ^{31}P solid-state and liquid nuclear magnetic resonance spectroscopy (NMR), respectively. Heavy metals (Zn and Cu) were characterized by synchrotron X-ray adsorption spectroscopy. Results showed that both P and the heavy metals in the chars were significantly altered depending on the treatment conditions, which was possibly responsible for the different acid extraction behaviors between chars. Results from the present study provide guidance for safe handling of the chars and technique selection for P reclamation, ultimately the development of sustainable management techniques for sewage sludge.