State of Practice: Biosolids Energy and Resource Recovery

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Wastewater biosolids have been used for centuries as source of renewable fertilizer in agriculture; however, with the advent of commercial fertilizers and increasing urbanization of the world population, the inherent value of biosolids have been overlooked and it is typically handled as an unwanted byproduct of the wastewater treatment process. However, with increasing fuel costs and decreasing natural resources, the renewable or "green" aspects of biosolids are engendering significant interest.

Biosolids typically contain approximately 4 percent nitrogen, 2 percent phosphorus, and small quantities of potassium and micronutrients, all of which are necessary for optimum crop production. While commercial fertilizers can be blended to generate desired ratios of these nutrients, the cost of the nutrients drops by approximately 75 percent if they are obtained through use of biosolids, rather than through purchase of commercial fertilizer. Reducing the cost of food production can also result in lower food prices, which is vital to sustaining the increasing global population. In addition to the nutrient value of biosolids, their organic content improves the quality of the soil matrix and water retention, increasing crop yield. Advanced treatment methods, such as those that generate a "Class A" or high quality biosolids, protect public health regardless of the application practices.

Technologies are also available that can recover phosphorus from biosolids. These treatment processes are typically applied to digestate return streams and generate struvite (magnesium ammonium phosphate). There are a number of benefits associated with struvite recovery. Struvite, which is a crystalline material, is easy to transport and store and can be used as a slow-release fertilizer. Struvite recovery from the return stream also decreases the ammonia and phosphorus load on the wastewater treatment plant liquid stream process, which can reduce air requirements, and thus energy, necessary for treatment, as well as chemical requirements for chemical phosphorus removal.

As an added benefit, the use of nutrients recovered from biosolids reduces global greenhouse gas emissions. Commercial fertilizer production is a fossil-fuel intensive operation. Consequently, practices that reduce the need for fertilizer manufacture can reduce fossil fuel use and associated emissions. In addition, most biosolids treatment methods that are used to meet pathogen and vector attraction requirements also decrease the quantity of greenhouse gas emissions from the biosolids themselves.

The energy inherently available in biosolids can also be recovered. The digestion process produces methane, which has historically been used as a source of energy for the treatment process. However, utilities are increasingly using the methane as a source of energy for power production equipment, such as engine generators, microturbines, and fuel cells. Improvements in gas cleaning technologies and increasing power costs have made this practice more cost effective. In addition, processes that improve digestion or increase gas production, such as co-digestion of high energy substrates or digester pre-treatment, are being widely implemented.

The energy in the solids, either raw or digested, can be recovered through combustion processes as well. Well established processes include incineration with waste heat recovery and subsequent power generation and co-burning of the biosolids in power generating facilities or cement kilns, in place of fossil fuels. Not only do these practices reduce the use of non-renewable fossil fuels and greenhouse gas emissions, but in many cases also result in reduced costs for the users. A number of “emerging” technologies, such as supercritical water oxidation, pyrolysis, and gasification of biosolids, while technically feasible, are being investigated to determine cost effectiveness.

This paper will discuss the current state of the practice for biosolids treatment and use, with respect to energy and resource recovery.