"Value-Added Fertilizer Products from Municipal Biosolids"

Jeffrey C. Burnham, Ph.D.
VitAG Corporation
Beech Island, SC

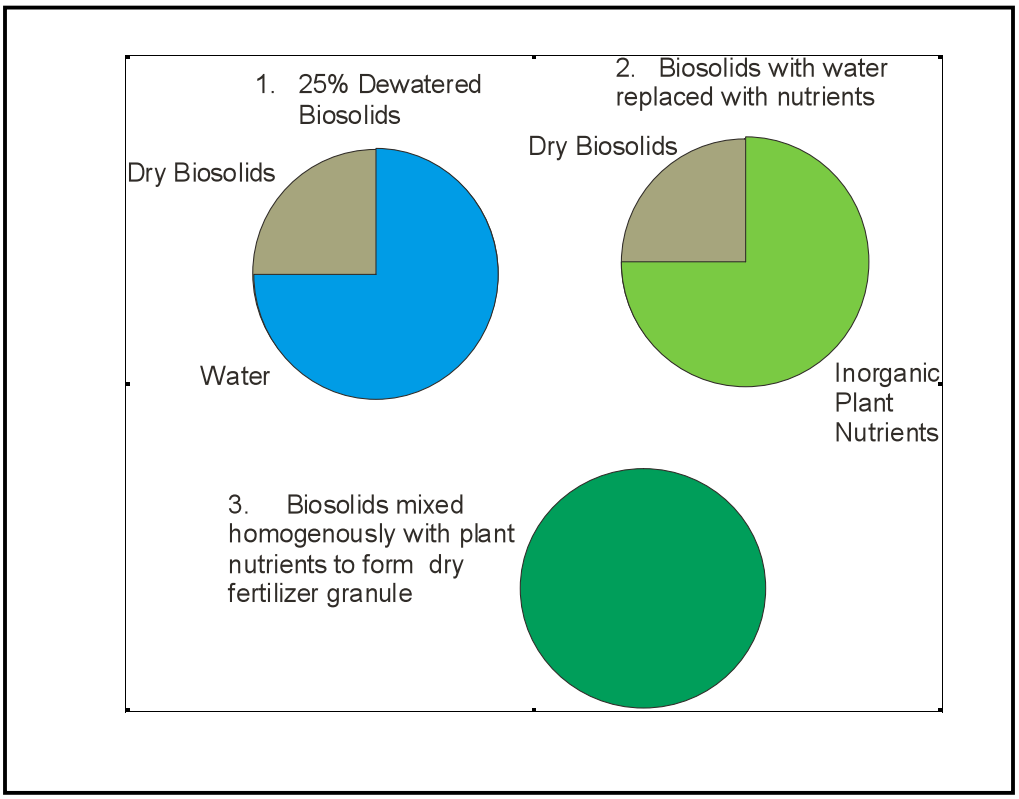
The concept of using biosolids as fertilizer has been around for a long time. This presentation goes beyond the concept of these materials as fertilizers themselves as, for example, with land application or heat-dried pellet strategies. It will primarily address the high value-high nitrogen fertilizers that result from the bringing together of two large and mature industries, i.e., municipal biosolids processing and commercial fertilizer manufacturing. The combination of their technological and business approaches has resulted in the production of new products for the betterment of each.

The traditional problem with biosolids-as-fertilizers is that the level of nutrient present in biosolids, especially nitrogen, even in dewatered biosolids, is too low to support a market price that permits an independent company to be profitable. Add in the fact that many of these biosolids-as-fertilizers approaches have products that contain significant water. Given the cost of transportation in today's energy market, it is even easier to understand this economic squeeze. This can be overcome with newer technologies that utilize manufacturing methodologies developed in the traditional fertilizer industry that permit the level of plant nutrients, especially nitrogen, to reach common commercial fertilizer levels.

One of the reasons why the manufacture of value-added fertilizers containing biosolids has not become common is that it is an expensive process to add the amount of nitrogen and phosphorus and other nutrients needed to reach commercial levels of plant nutrients, especially with today's soaring market pricing of natural gas—the origin of most nitrogen-containing fertilizers. Therefore, effective, competitive and sustainable biosolids processes need economic chemical inputs coupled with effective manufacturing strategies to compete with the real world economics of the existing massive commercial fertilizer industry. Making a high value fertilizer is a more viable option today because of increasing tip fees paid by municipally operated wastewater treatment plants to dispose of their biosolids, especially medium to large municipalities. With the amount of municipal biosolids needing processing increasing and the increasing recognition of an inherent value to biosolids, there is an encouraging movement towards more beneficial use of biosolids coupled to an increasing demand for Class A biosolids products. The value of making a "product" is also being recognized, for example, in the State of Florida, there is a Class "AA" standard to indicate that the product is not only meeting the USEPA Class "A" standard but that the end result of the treatment technology is actually a saleable product.

The concept for manufacturing high value-added fertilizers is simple. Figure 1 illustrates the basic scheme:

Figure 1

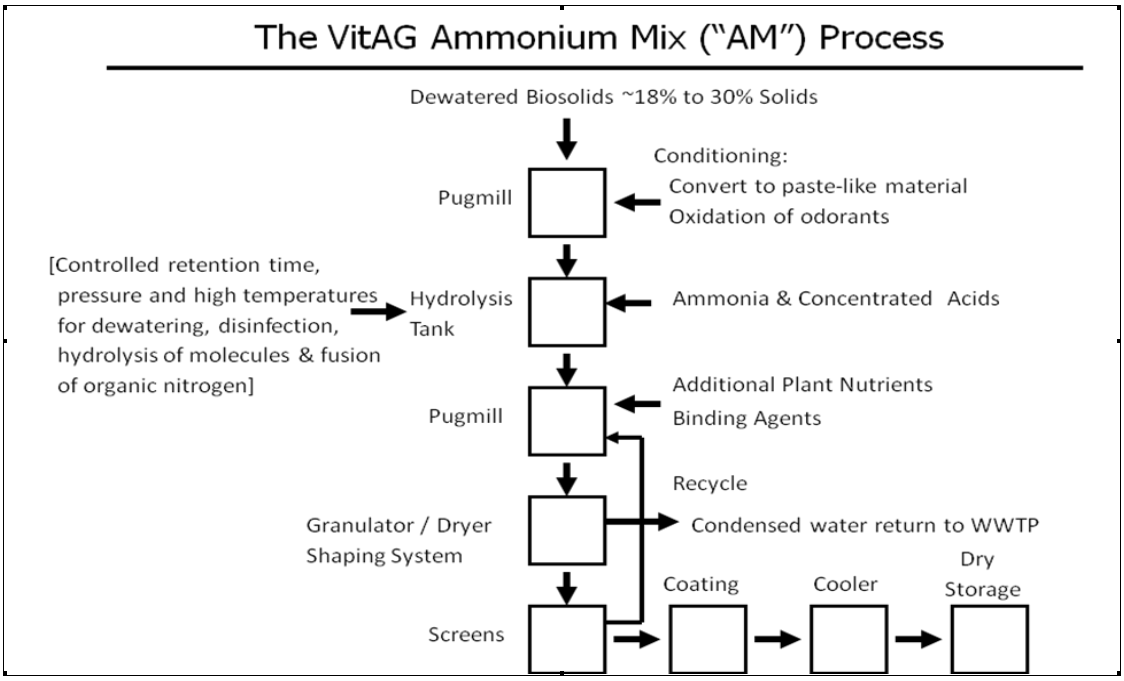


The concept is simple, i.e., the fertilizer manufacturing process basically replaces the water in dewatered biosolids with plant nutrients, e.g., the biosolids at the beginning of the process illustrated in Fig. 1 were dewatered to 25% solids leaving 75% of the mass of the biosolids as water. During processing the dewatered biosolids are mixed with a variety of types of nutrient containing material (this differs with different companies and patented processes) and then the mixture is dried by various means, producing a material, preferably granules, which now have the dry biosolids components now homogenously combined with the plant nutrients. The more intimate the association of the biosolids organic molecules with the inorganic plant nutrients, the better and more valuable the final fertilizer granule becomes. This is because, for example, the organics present in the biosolids will associate with the inorganics and reduce their solubility thereby making the finished fertilizer product function as a natural slow-release fertilizer. The analogy in the traditional fertilizer world would be using the highly soluble fertilizer, urea, as compared to the organic-associated urea, e.g., methylene urea.

VitAG carries out this process with a little different twist from other companies practicing this business.

The diagram in Fig. 2 shows the general schematic of how the VitAG process takes place.

Figure 2



The conditioning process is important to prepare the biosolids for reaction with the fertilizer components. In VitAG's technology the biosolids-fertilizer mix is conducted under carefully controlled temperature, pressure and time parameters. Once the mix is properly reacted the remainder of the process, i.e., the shaping, drying and further processing are utilizing "off-the-shelf" standard fertilizer processing equipment.

The optimal value-added fertilizer contains lots of nitrogen as most of the value in typical N-P-K fertilizers comes from the nitrogen component. In a 15-2-0-16-1-19 (N-P-K-S-Fe-Organics) product the nitrogen component, i.e., 15% of the dry weight of the finished fertilizer granule, is worth about 75% of the entire product value on a nutrient calculated basis and in today's agricultural fertilizer marketplace would have a wholesale value of over $400 per ton of fertilizer. Traditional fertilizers such as ammonium sulfate (21% nitrogen) and urea (46% nitrogen) sell on the basis of the nitrogen level in these products. The price of fertilizer nutrients and fertilizer products is carefully reported weekly in such trade publications as "Green Markets" as published by Pike and Fischer, Inc.

The key characteristics particularly important for fertilizers after nutrient level are the dryness (often less than 1% water), hardness and size of the finished fertilizer. Hardness is defined as crushing resistance and values above 5 pounds are considered most desirable. This degree of hardness protects the granule against dust creation during storage, transfers and shipment. Size is important as the finished fertilizer needs to be able to be quantitatively applied by standard farming equipment. Fertilizer in the granular form is most desirable as air-flow fertilizer distribution systems in both land and air tractors are very commonly used in large agronomically-operated farms as the amount of fertilizer applied per acre can be very carefully controlled on a per acre basis as these systems are often linked to GPS and computer control systems.

That leads to the observation that when fertilizer products containing biosolids are selling in the wholesale marketplace for more than $100 to $200 per ton, in the author's opinion, the best regulators in the business, are farmers themselves. At these prices, farmers are not going to purchase any more fertilizer than they absolutely need to for optimum crop production as the economic operation of their farm will not permit otherwise—note that is usually between 100 and 600 pounds of fertilizer per acre depending upon crop and soil conditions. While on the subject of regulations, these high value-added fertilizers always meet the USEPA's Class A standard for biosolids-containing products and the EQ standard with regard to metals.

It should also be pointed out that a significant component of the chemistry that makes these high value-added products distinct and agronomically effective is the organics contributed by the biosolids themselves. The organic components accomplish a variety of effects as shown in Fig. 2 below:

Figure 3. Roles for Organics in Inorganic Fertilizers

- provide nutrient for plants
- provide nutrient for soil microbes
- decrease nitrogen volatilization
- decrease nitrogen leaching
- increase crop resistance to drying
- affects soil physical-chemical environment

The combined effect of these organic influences is that crop production and grower/farmer economics are improved (Burnham and Dahms, 2003; and, Burnham and Jarrett, 2004).

High nitrogen fertilizers may be manufactured using several different technologies. The simplest employ the blending of high nitrogen fertilizer components into biosolids prior to shaping and drying. The more complex use concentrated acids mixed with either aqueous or anhydrous ammonia in modifications of ammonia granulation processes developed by the fertilizer industry for principally for the production of ammonium sulfate, mono-ammonium phosphate (MAP)and di-ammonium phosphate (DAP) fertilizer products.

Companies that produce organically-enhanced inorganic fertilizers are the ACE Ltd, Green Technologies, Inc., Harmony Products Inc., BER Systems, Inc., Unity Envirotech LLC and VitAG LLC.

In summary, because of the safety, efficacy, value and marketplace for such organically-augmented inorganic fertilizers it can be predicted that these "value-added" products will occupy an increasing sector for the disposition of municipal biosolids and animal residuals.

References.

1. Burnham, J,C. and G.L. Dahms. 2003. Municipal Wastewater To Real Fertilizer: The Unity Fertilizer Solution. Presented at the Fertilizer Industry Roundtable on October 29, 2003, Winston-Salem, NC.
2. Burnham, J.C. and B. R. Jarrett. 2004. The Effect of Organically-Enhanced Inorganic Fertilizer On Commodity Crop Production. Water Environment Federation Biosolids and Animal Residuals Conference held in Chicago, IL on June 30, 2004.
3. Green Markets. 2008. Fertilizer Market Intelligence Weekly—Prices-Politics-Economics-Transportation. Pike & Fischer Publications. Latest Volume 32. No. 7 (February, 18, 2008).; www.greenmarkets.pf.com
4. Burnham, J.C. 2008. "Specific Value-Added Products: Commercial Fertilizers" In: Value-Added Products from Municipal, Agricultural and Industrial Waste Residuals Workshop. Water Environment Federation, Philadelphia, PA. March 30.