FACT SHEET

Factors Affecting Municipal Biosolids Dewaterability

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Municipal Solids Dewatering

Dewatering at municipal water resource recovery facilities (WRRFs) is an operationally challenging and costly endeavor, due to the costs associated with chemical conditioning of the solids to improve their dewaterability [1] and hauling of the material for beneficial use or disposal. Operational goals for a utility include significant reduction in solids volume and the associated dewatering costs. Therefore, it is important to remove as much water as possible. Solids characteristics and process changes throughout a WRRF can impact the ability to effectively dewater. To improve the ability to remove water with minimal chemical addition, it is important to understand the many factors that can contribute to solids dewaterability. The information contained in this Fact Sheet describes ***factors that impact the dewaterability of solids*** generated at municipal WRRFs.

Factors Contributing to Dewaterability

Water Content and Type

The type of water content in a solids slurry will determine the extent of solids dewaterability because some types of water are easier to remove than others. Depending on the overall chemistry, the physical distribution of water within the slurry particles can vary. This water has typically been characterized as free water, interstitial water, vicinal water, intracellular water, and bound water (Figure 1) [2]–[5]. Free water is water that is floating in suspension not interacting with other constituents, and is easily removable via gravity filtration. Interstitial water is water that is trapped in the interstices of solids. Intracellular water is water that is present inside of microbial cells. Vicinal water is water that is bound to the surfaces of solids [6]. Bound waters refer to water that is chemically bound.

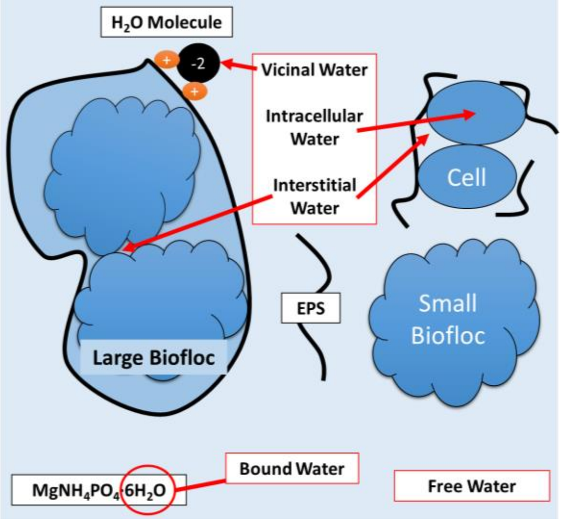

Figure 1. Physical distribution of water in a solids slurry. Mechanically removable water includes drainable and some interstitial water. Non-mechanically removable water includes interstitial, vicinal, intracellular, and waters of hydration.

Free water and some interstitial water can be removed mechanically. The term "bound water" is an operationally defined term that is dependent on the method of measurement, but may include interstitial water, vicinal water, and waters of hydration. This type of bound water is relatively difficult to remove through mechanical means. Ultimately, water that can be mechanically removed would be water that can be drained from a biosolids matrix (or "free water"), and the additional water that can be captured with energy input such as pressing or centrifugation. The limits of mechanical dewatering appear to be influenced by the amount of water in the biofloc (interstitial, intracellular, and vicinal), and chemically bound.

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Extracellular Polymeric Substances

Microbes that are present in wastewater solids produce extracellular polymeric substances (EPS). Activated solids produce much of the EPS, but additional EPS can come from microbial activity in sewers and primary clarifiers. EPS is produced internally within microbial cells (bound EPS), and then excreted into the bulk water (free or soluble EPS), forming larger microbial aggregates known as biofloc particles. EPS is typically present as free or soluble EPS. Bound EPS can be further fractionated into loosely bound EPS and tightly bound EPS (Figure 2) [7].

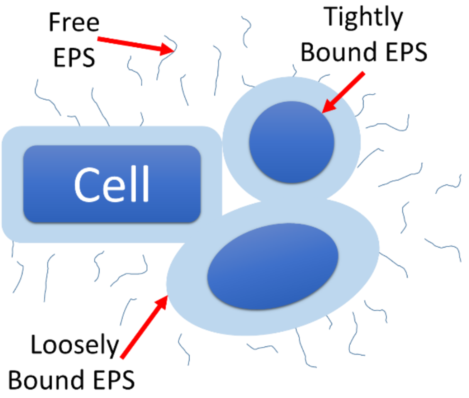

Figure 2. EPS distribution in sludges and biosolids.

Hydrolysis or cellular lysis will release intracellular EPS into the bulk water fraction. EPS is negatively charged, and the quantity of EPS present influences the amount of polymer required to condition the solids for dewatering. One reason primary solids are typically easier to dewater than secondary solids is because of the lower EPS present.

Cations

Cations have been reported to play an important role in the dewatering characteristics of solids and should be considered when assessing dewatering performance. Both monovalent (M) and divalent (D) cations have been observed to influence the dewaterability of secondary solids. D cations can form bridges between floc particles, cells, and EPS, thereby releasing some of the water associated with the floc particles and increasing cake solids concentration (Figure 3) [8]. A M:D Ratio of 2 or less was observed to be associated with higher cake solids and reduced polymer consumption in the dewatering of secondary solids [8], [9]. Biological treatment processes such as biological phosphorus removal (Bio P) and anaerobic digestion can impact cation content.

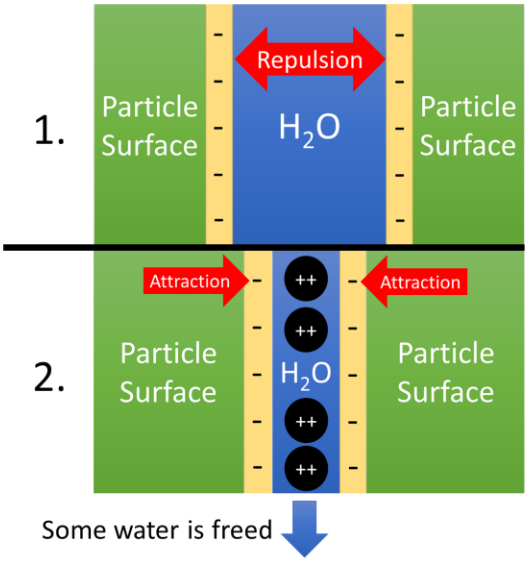

Figure 3. Divalent cations (black circles) form bridges between negatively charged surfaces, mostly composed of EPS (yellow), of cells (green) thus reducing the space between surfaces, which frees some water [8], [10] .

For anaerobically digested solids, one recent study found that the addition of M cations (potassium and sodium) to the digester feed led to higher final cake solids [11]. The theory that was proposed was that the addition of M cations frees up water that is bound to the negatively charged sites on EPS thus increasing the amount of recoverable water.

While the exact mechanisms are still unknown, cations have been observed to influence the dewatering characteristics of solids. Research in this area is ongoing.

Treatment Process Impacts on Dewaterability

Process changes can impact dewatering characteristics of solids. For example, facilities that use Biological phosphorus removal have reported increased chemical conditioning requirements to maintain target cake solids. Biological phosphorus removal has been shown to be correlated with a decline in the dewatering characteristics (lower dryness and increased polymer demand) of both secondary sludges and anaerobically digested biosolids [12], [13]. On the other hand, post-digestion phosphorus recovery has been observed to increase cake solids and reduce polymer consumption [14]. Sludge pre-treatment technologies such as thermal hydrolysis can also impact downstream dewatering characteristics, increasing cake dryness but with a relatively high polymer demand [15]. It is therefore critical to thoroughly consider the impact upstream process changes will have on final dewaterability.

Summary

Dewatering is a complex process that utilities are expected to effectively manage on a daily basis. Several constituents present in wastewater, some of which are uncontrollable, contribute to the ability to effectively dewater sludges and biosolids. Understanding these factors are vital for WRRFs troubleshooting and optimizing dewatering processes.

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Further Reading

- WEF Fact Sheet: *Bench Scale Dewaterability Assessments: Methods for Determining an Optimal Polymer Demand*
- WEF Fact Sheet: *Bench Scale Dewaterability Assessments: How Can We Determine Process Impacts on Cake Solids?*

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