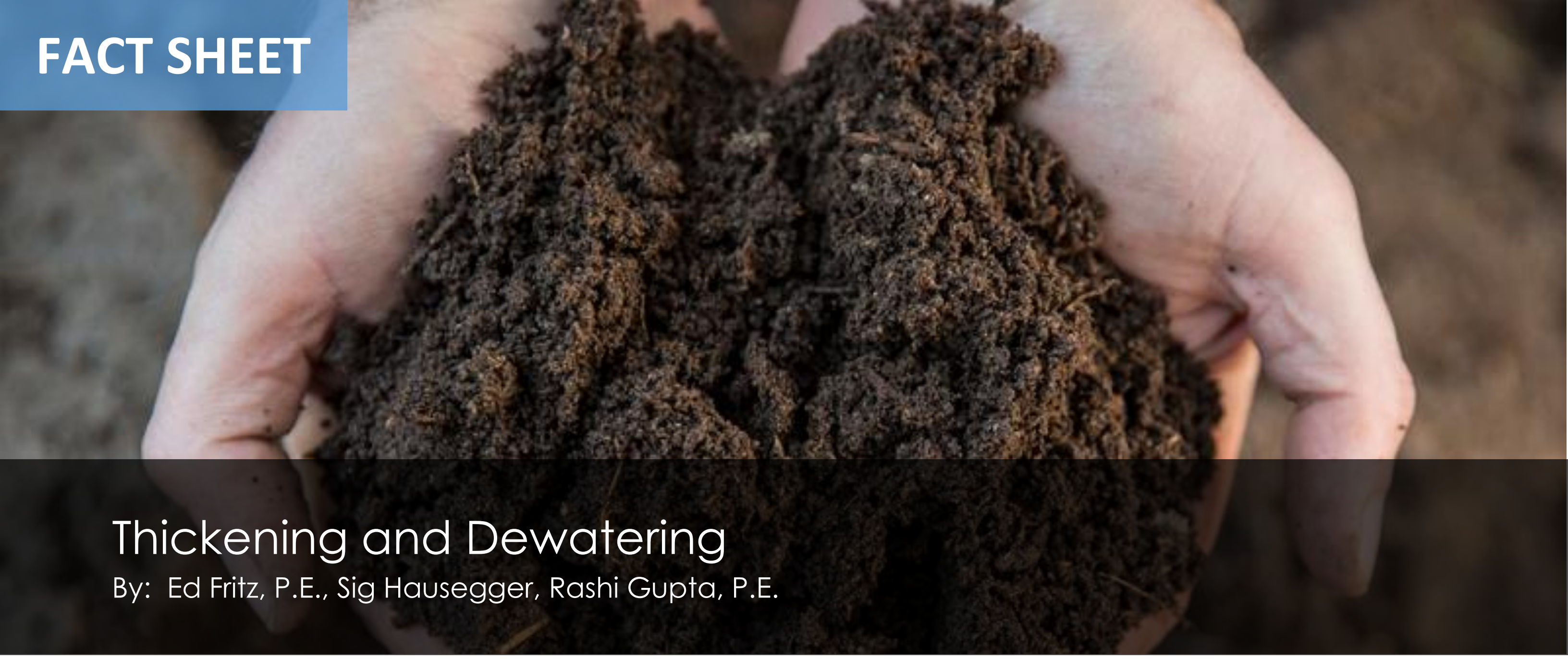

FACT SHEET

Thickening and Dewatering

By: Ed Fritz, P.E., Sig Hausegger, Rashi Gupta, P.E.

Introduction

The wastewater treatment process is generally separated into the "liquid" train and the "solids" train. Solids that are allowed to settle in primary and secondary clarifiers are conveyed to solids processing systems. These systems separate water from solids and increase the concentration of solids for subsequent stabilization or hauling offsite. Facilities may also provide some type of stabilization of the solids to reduce pathogens and vector attraction potential when the solids are intended for beneficial use. Solids management represents a critical part of the overall treatment process. While stabilization processes are discussed in other WEF documents, this fact sheet provides a basic overview of solids thickening and dewatering, as highlighted in Figure 1.

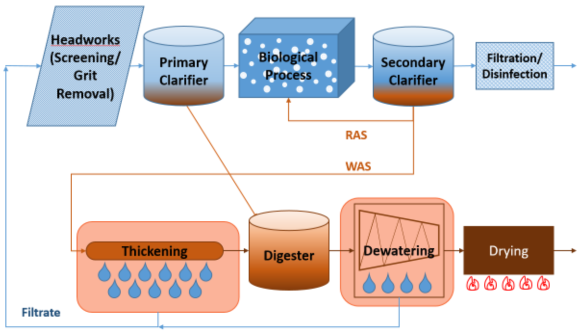

Figure 1. Typical Water Resource Recovery Facility Schematic highlighting the Thickening and Dewatering Processes

Thickening

What is thickening?

A process designed to increase the solids concentration in residuals by removing a portion of the liquid.[1] Feed solids generally range from 2,000 mg/L (0.2% solids) to 15,000 mg/L (1.5% solids). Thickening typically produces a thickened solids product of 2-8% solids concentration (Figure 2). The product is still flowable and handled as a liquid. The water separated from the solids is typically captured and returned for treatment in the liquid train. Depending on the thickening process, this returned water stream is called filtrate, overflow, underflow, centrate, or permeate. This stream is referred to as "filtrate" in this fact sheet.

Figure 2. Photograph of typical thickened waste activated sludge.

WSEC-2019-FS-001, RBC Solids Separation Subcommittee

Why thicken solids?

"…to increase the solids concentration of waste solids and reduce the hydraulic loading (total volume) to subsequent solids treatment processes…."[2]

The benefits of reduced hydraulic loading include:

- Smaller downstream basins and equipment;
- Increased storage or detention time of downstream basins;
- Reduced energy needs (i.e. heat) for processes such as anaerobic digestion

Where to thicken solids?

The thickening process is located within the treatment train depending on the desired effect. Often the thickening process is placed on the solids stream discharged from clarifiers, upstream of the digestion process or solids storage tanks, to reduce the volume required in these tanks. The most common municipal solids streams that are thickened include primary sludge and waste activated sludge (WAS).

What equipment is used for thickening?

- Gravity thickeners (or primary clarifiers if used for in-tank thickening)
- Dissolved air flotation thickeners
- Gravity belt thickeners
- Centrifuge thickeners
- Rotary drum/screw thickeners
- Membrane thickeners
- Disc thickeners
- Volute thickeners

The advantages and disadvantages of thickener types should be considered when selecting equipment. Table 1 gives an overview of the most common mechanical thickening devices and their relative operational parameters. (See note at end of fact sheet.)

Parameter	**Drum Thickener**	**Gravity Belt Thickener**	**Thickening Centrifuge**
Capacity	100-400 gpm	200-900 gpm	30-1,500 gpm
Washwater Requirement	25-60 gpm	20-60 gpm	N/A (required for clean-in-place cycle)
Odor Containment	Yes	No, unless enclosed	Yes
Power Consumption	≈0.005 kW/gpm	≈ 0.005 kW/gpm	≈ 0.2 kW/gpm

Table 1. Common thickeners and operating parameters

Determination of the number and size of units required should account for both hydraulic and solids loading limits.

What else do I need for thickening?

Some types of thickening processes require conditioning of the solids with chemicals (e.g. polymer) upstream of the thickening equipment. This helps flocculate the solids and aids in the thickening process by producing clearer "filtrate" and thicker solids. When chemicals are required, a chemical system that includes storage, blending, and make-down (for polymer), and chemical feed pumps are necessary. Mixing valves or static mixers may also be needed to promote mixing of the chemical with the solids stream, upstream of the thickening equipment. Monitoring and optimizing chemical dose is recommended to minimize operating costs.

Sludge pumps are often necessary to feed the thickeners and to convey thickened solids from the thickening system to downstream processes. While the feed solids are thin and able to be pumped by a variety of pump types, the thickened solids may reach concentrations that necessitate the use of positive displacement pumps.

Most thickening processes require wash water for elutriation or to keep the thickener screening elements clean and functional. Depending on the type of feed solids and odor sensitivity at the treatment plant, odor control systems may be necessary. Dissolved air flotation and membrane thickeners also require a pressurized air source.

It is also important to consider the impact of recycle streams, such as the "filtrate" stream, and the constituents of those streams on the facility's processes.

Dewatering

What is dewatering?

"Dewatering is the removal of water from wastewater treatment plant (WWTP) solids to achieve a volume reduction and to produce a material for further processing or disposal."[3]

Feed solid concentrations can range widely, depending on upstream treatment processes utilized. Some facilities directly dewater WAS, which is typically between 5,000 mg/L (0.5% solids) and 10,000 mg/L (1% solids). Facilities with digestion generate solids ranging from 1.5% to 3.5% solids. Dewatering typically produces a dewatered cake product of 15-40% solids concentration (Figure 3). This product is semi-solid and can be handled as a solid.

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Similar to thickening, the dewatering process generates a filtrate, pressate, or centrate that is returned for upstream treatment in the liquid processes. As with thickening, this stream is referred to as “filtrate” in this fact sheet.

Figure 3. Photograph of dewatered cake.

Why dewater solids?

Volume reduction and to produce a material for further processing or disposal.

The benefits of volume reduction include:

- reduction in the size of downstream equipment and basins;
- reduction in volume of material to be transported and associated costs

Producing a material for further processing or reuse/disposal means that the dewatering process makes the downstream processes or reuse/disposal more efficient. Some processes that benefit from upstream dewatering include thermal hydrolysis; chemical conditioning and stabilization; drying; incineration; and composting.

Where to dewater solids?

The dewatering process is typically located downstream of all biological and digestion processes. Reuse/disposal, thermal hydrolysis, drying, or incineration processes typically follow dewatering.

What equipment is used for dewatering?

- Air drying beds
- Belt filter presses
- Recessed-plate (plate and frame) filter presses
- Recessed chamber and membrane filter presses
- Screw presses
- Volute presses
- Rotary fan presses
- Centrifuges
- Hydraulic piston presses

The advantages and disadvantages of dewatering systems should be considered when selecting equipment. Table 2 shows some of the most common dewatering devices and their relative operational parameters. (See note at end of fact sheet.)

Parameter	**Screw Press**	**Belt Filter Press**	**Dewatering Centrifuge**
Capacity	5-200 gpm	40-300 gpm	20-1,200 gpm
Washwater Requirement	25-45 gpm	20-60 gpm	N/A (required for clean-in-place cycle)
Odor Containment	Yes	No	Yes
Power Consumption	≈0.05 kW/gpm	≈ 0.05 kW/gpm	≈ 0.2 kW/gpm

Table 2. Common dewatering equipment and operating parameters

Determination of the number and size of mechanical units required should account for both hydraulic and solids loading limits.

Performance parameters for dewatering is dependent on the characteristics of the solids stream. Laboratory bench testing and onsite pilot testing are recommended to determine expected equipment performance based on a facility’s unique solids.

What else do I need for dewatering?

Many of the same types of ancillary processes required for thickening are also required for dewatering. Most mechanical dewatering processes require conditioning of the solids with chemicals (e.g. polymer) upstream of the equipment. This helps neutralize charge and flocculate the solids, ultimately aiding in the dewatering process by producing clearer "filtrate" and thicker solids. When chemicals are required, a chemical system that includes storage, blending, and make-down (for polymer) is necessary. Also, for some types of polymer, aging and chemical feed pumps are necessary. Mixing valves or static mixers may also be needed to promote mixing of the chemical with the solids upstream of the dewatering equipment. Monitoring and optimizing chemical dose is recommended to minimize operating costs.

Sludge pumps are necessary to feed the dewatering units. If the feed solids stream is relatively thin, then it is able to be pumped by a variety of pump types. Thicker feed solids may necessitate the use of positive displacement pumps. The dewatered cake requires the use of positive displacement cake pumps, hydraulic piston pumps, or conveyors.

Most dewatering processes require wash water to keep the components clean and functional. Depending on the type of feed solids and odor sensitivity at the treatment plant, odor control systems may be necessary.

Note

Operational parameters given in this fact sheet are generalized and not specific to any given facility. It is recommended to consult equipment manufacturers about particular equipment types operating under a specific facility's unique design conditions.

Acknowledgments

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References

1. Glossary of Water Resource Recovery Facility Design Terms; Water Environment Federation, 2018.
2. Design of Water Resource Recovery Facilities, 6th ed; McGraw Hill, 2018.
3. Solids Process Design and Management, McGraw Hill, 2012.

Additional Resources

- EPA Biosolids Technology Fact Sheets:
  - Belt Filter Press
  - Centrifuge Thickening and Dewatering
  - Gravity Thickening
  - Recessed Plate Filter Press.
- WEF Fact Sheets:
  - Bench Scale vs Pilot Scale Dewatering Testing
  - Polymer/Flocculants 101
  - Solids Capture in Dewatering Processes
  - Solids Pretreatment Methods to Enhance Dewatering Performance
  - Vivianite Impacts on Solids Processes

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