FACT SHEET

Solids Capture in Dewatering Processes

By: Dan Fronhofer

Importance of Solids Capture in Dewatering

Optimizing dewatering equipment involves monitoring a handful of important parameters. For most applications, those parameters include ***Solids Loading (lb/hr)***, ***Hydraulic Loading (gpm)***, ***Chemical Dosage (lb active / dry ton)***, ***Discharge Cake Solids (% solids)***, and ***Solids Capture (%)***. The typical focus often seems to be on cake solids, and operators are asked to find ways to produce drier cake. Next, the spotlight falls on hydraulic loading and chemical dosage, to both reduce operating times, and reduce costs, respectively. The challenge is that all of these parameters are intricately linked. It is not possible to adjust for one without affecting the others. Optimizing the system becomes a balancing act where all parameters must be acknowledged **(Figure 1)**.

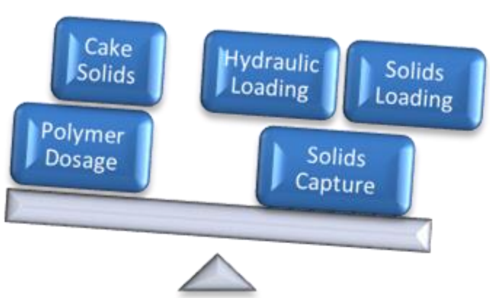

Figure 1: Optimization is a Balancing Act

An important parameter on which to focus is often the last one on people's list. The overlooked parameter of the group is often Solids Capture. Technically, it represents the percentage of solids in the feed slurry that make it to the discharge point of the machine as a dewatered "cake." In practice, it is an indication of how "clean" the dewatering equipment is running. The industry standard for solids capture on dewatering equipment is 95%. This number has gone up over recent years as technologies and polymers have improved. Some wastewater treatment facilities with poor dewatering performance are capturing only 80% of the solids, and it is not unheard of to have solids capture values as low as 60%. Centrate/Filtrate is often returned to the head of the plant. Dewatering equipment does not leave the centrate/filtrate clean enough for discharge as effluent; it is laden with suspended solids, nutrients, and biochemical oxygen demand (BOD) and requires further treatment. But the point of dewatering equipment is to remove the solids from the plant. Problems arise when too many solids are being returned to the head of the plant in the centrate/filtrate. Solids end up getting recycled through the entire treatment process – often multiple times! Below is a generic diagram of the solids path through a treatment facility **(Figure 2)**. If a large portion of the solids are not removed (low solids capture), then the path turns into a loop **(Figure 3)**. These solids move through the entire process again, being pumped, requiring energy for re-treatment, causing wear, and often causing other performance, and operation and maintenance issues within the plant. Getting the solids removed efficiently the first time around can save money and headaches throughout the facility.

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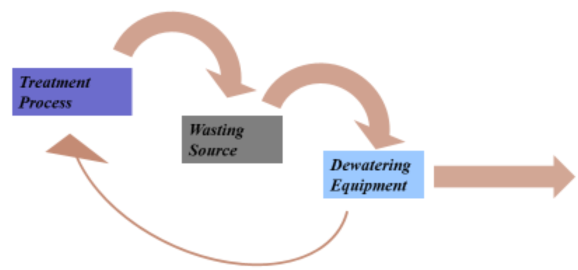

Figure 2: Good Solids Capture

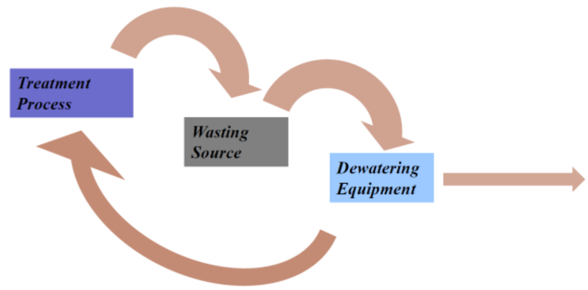

Figure 3: Poor Solids Capture

A focus on improving this parameter will pay dividends, not only in the dewatering building, but in the entire plant. A blind focus on polymer usage, for example, can lead to adverse effects on the rest of the operation. Simply turning down the polymer without consideration of the other monitoring points will often lead to lower cake solids, lower solids loading capability, and lower solids capture. When dewatering equipment is optimized, polymer usage can often be reduced. However, it is usually by focusing on the other parameters that this chemical savings is achieved. Likewise, an attempt to increase cake solids simply by turning up the torque or pressure on the cake will often yield detrimental effects on solids capture and maintenance costs.

Maintenance costs: A huge part of this equation that has not yet been mentioned, but one that ties in directly with the optimization parameters, is the cost associated with operating and maintaining the dewatering equipment. Although not a typical "parameter" to be monitored, maintenance costs are directly and dramatically affected by adjustments to these other parameters. The labor time and energy required to change out wear parts, not to mention the increased cleaning time for a machine that is operating with poor capture, is a significant cost component for a treatment plant. There is also a cost to pumping and moving solids through the plant.

When optimizing dewatering equipment, the focus should be on running "clean" first and producing a high solids capture rate, and then attempting to dial in the polymer dosage, solids loading, and cake solids. Often times, the act of achieving high solids capture first will automatically yield better results in the other areas. Larger plants that have previously been operating with poor solids capture for a while will experience this improvement over the course of a few months. It typically takes a relatively long period of time because the entire plant is literally being "cleaned" out. It is not that solids were not being removed from the plant before; it is that the ***correct*** solids were not being removed. When solids capture is poor, it is often certain types of solids that are the biggest culprit. It could be the "fines," or other specific particles that are not bound up well in the flocculated structure formed by the polymer. Either way, it is the solids that are difficult to capture that make it back to the head of the plant. Those same solids will be difficult to capture the second time they go through the dewatering equipment, and the third time around, and the fourth, and so on.

Centrate/Filtrate cleanliness and solids capture may be the next industry buzzwords as facilities become more aware of their sidestreams and how the sidestream flow affects the treatment process and effluent quality. Smaller treatment plants are not exempt from this concern. Centrate/Filtrate quality becomes very important at smaller plants where dewatering may only take place one or two days per week. In these cases, the centrate/filtrate returned to the head of the plant represents such a large percentage of the overall inflow that spikes can be seen in solids, BOD, and nutrient loading to the plant. So even the <1 MGD are not free to ignore the centrate/filtrate quality of their dewatering operation.

Calculating Solids Capture

To calculate an accurate solids capture percentage, the following data are required:

- Feed solids to the dewatering equipment (%TS by weight)
- Sludge flow rate to the dewatering equipment (gpm)
- Washwater (gpm)
- Polymer water flow rate (gpm)
- Discharge cake solids (%wt.)
- Centrate/filtrate solids (%wt., measured as mg/L of Total Suspended Solids and converted to %wt. by dividing by 10,000)

With these data, the following equation can be used to determine percent capture:

$$Percent\ Capture = \frac{C}{F} * \frac{F - (E * \frac{Q+S}{Q})}{C - (E * \frac{Q+S}{Q})} * 100$$

Where:

Q = Sludge Flow (gpm)
S = Washwater & Polymer Water Flow (gpm)
C = Discharge Cake (% solids by weight)
F = Feed Solids (% solids by weight)
E = Filtrate or Centrate Solids (% solids by weight)

Improving Solids Capture

How can solids capture be improved? Depending on the severity of the problem, it may be beneficial to start with jar testing of various polymers. When optimizing full scale dewatering, it is often best to take it step-by-step. Make a data table or a spreadsheet and write down all of the settings and parameters that are associated with the dewatering operation. It can be many set-points, but make sure to include the following: feed solids, flow rate, cake solids, polymer flow, and polymer concentration. Operating parameters associated with the particular dewatering equipment should be recorded for each set of results. For belt filter presses, this includes the belt speeds and belt tensions. For centrifuges, record bowl speed, G-force, differential speed, and backdrive torque. For screw presses, note screw speed, inlet pressure and cone pressure. The challenge is to only make one change at a time and to let that change reach steady-state operating conditions before sampling and taking measurements. It may seem unclear at first, but simply the act of recording all of the settings and results will often reveal a trend that points toward better optimization.

Consistency is key. The more consistent that the sludge feed and polymer flow rate can be, the more likely it is for the dewatering process to be optimized. Variations in feed flow, percent solids, or type of material can contribute to dewatering equipment running inefficiently. Adding a large blend tank for blended sludges, or a mixer for sludges that tend to settle can help maintain consistency in feed solids. If external materials, such as septage or grease, are added the best solution is to slowly meter that material in over a longer period instead of in surges. Once the certain feed characteristics are consistent, the proper chemistry can be applied to allow for the best performance. Polymers have improved recently, allowing the digested, difficult sludges to be flocculated and captured better in dewatering equipment. Polymers with higher cationic charges and molecular weights are now available, as well as branched and cross-linked products. When evaluating these newer polymers, it is important to find out the recommended mixing and conditioning tactics to improve flocculation and dewatering. This may include alternate polymer injection points to increase or decrease contact time. Setting up trials to run different polymer products on the full-scale dewatering operation will be more valuable to the operator compared to bench test that only tests a small feed sludge sample. More dramatic changes can be implemented if the above does not produce satisfactory results. For example, the loading rate to the dewatering equipment can be reduced. Or, mechanical changes can be evaluated, such as belt and screen selection on belt and screw presses, or adjustment to weir height on a centrifuge.

Spending a day or two every few months to focus on the dewatering operation, will typically pay off in the long run to optimize dewatering performance. It is recommended that equipment settings be recorded while testing different operating parameters to find optimal settings. It is recommended that operators start by figuring out how to run the dewatering equipment with clear centrate/filtrate and a "clean" machine, and then focus on other performance parameters for full dewatering performance optimization.

Acknowledgments

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Further Reading

1. Design of Water Resource Recovery Facilities, 6th ed; McGraw Hill, 2018.
2. Solids Process Design and Management, McGraw Hill, 2012.