FACT SHEET

Automation for Optimization of Thickening and Dewatering

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Introduction

Water resource recovery facilities (WRRFs) face increasingly stringent regulations and pressure to reduce costs. In this environment, WRRFs of all sizes can benefit from targeted and proven automation that can be used to optimize process efficiency. This can simultaneously provide "real-time" information while freeing plant staff from time-consuming sampling and analysis. Dewatering represents significant operational costs for most WRRFs because of the associated hauling and chemical costs. Some thickening processes also utilize chemical conditioning, and therefore represent operating costs. The proportional costs related to dewatering and thickening relative to overall WRRF operating costs are included in Figure 1 under solids transport and disposal and portions of the chemical, electricity, and labor values. **Targeted sensors and control systems that can optimize thickened solids concentration or dewatered cake dryness and polymer dose can save WRRFs substantial operational costs.**

With specific instrumentation and controls, operators can utilize process information to run thickening/dewatering equipment more efficiently. When understood and used properly, data from instrumentation can be leveraged to increase cake dryness, improve clarity of return streams (e.g. centrate/filtrate), reduce downtime, free operators for other activities, and reduce polymer costs. Seasonal trends and the impacts of changes in solids characteristics can be automatically tracked and monitored. Control algorithms at SCADA or in automation packages can then use the data to optimize the thickening or dewatering process, and its ancillary systems.

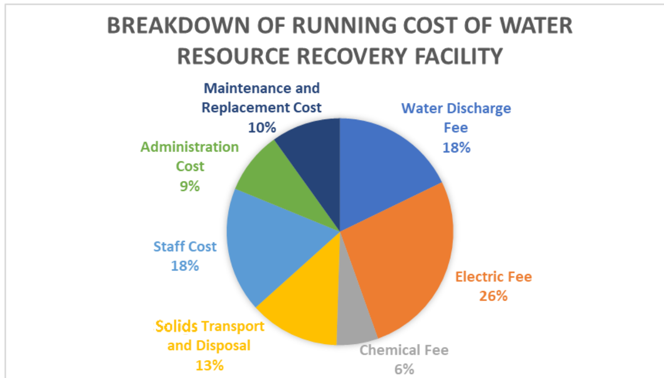

Figure 1: Sample Breakdown of WRRF Operating Costs (Data from costwater.com)

What Can be Done with Automation?

Automation through instrumentation and controls can be used for thickening or dewatering processes to:

- Monitor solids concentration in feed to thickening/ dewatering equipment
- Monitor solids in centrate/filtrate
- Monitor thickened solids concentration or dewatered cake dryness
- Pace polymer dosage to solids loading (mass) rate using flow meters and total solids analyzers

Process monitoring and control options can be leveraged individually for incremental improvements in process efficiency and cost reduction. Some complex automation packages aim to monitor and use multiple parameters simultaneously to optimize the overall thickening

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or dewatering process. These packages include multiple sensors, algorithms, and a control system.

Potential Benefits

Proven, calibrated, and properly maintained automation systems can yield multiple benefits:

- Efficient polymer usage for potential 20-50% cost savings
- Overall process optimization, including:
    - Greater process sustainability
    - 24/7 real-time data collection to minimize the need for operator sampling and laboratory analysis
- Lower energy consumption, lower maintenance costs and extended life of thickening/ dewatering equipment.
- Better control of dewatered cake quality for downstream solids processing or disposal/reuse.
- Real-time solids concentration and flow rate measurements that can be used in mass balance calculations for solids processes.
- Increase in data accuracy and improvements in subsequent operational changes through real-time measurements. Many plants take infrequent grab samples of various process streams and make process changes based on those few samples. As shown in Figure 2, there can be substantial variability in some solids processes so non-representative sample results can lead operators to make process changes that may not be optimal.

At the Tampere WWTP in Finland, reduction in hauling costs through automation-based process optimization and increased cake dryness exceeded $100,000 a year. Similarly, annual savings in polymer dosing corresponded to 20% of annual polymer costs that resulted from the use of real time data analytics and subsequent process optimization.

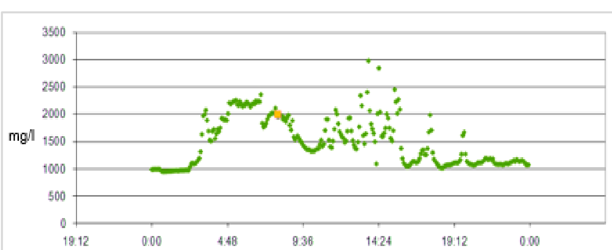

Figure 2: Example of Variability in Centrate TSS. Image by Valmet

Available Technology

Multiple types of sensors and systems are available on the market. Each type has a specific use and the intended goals of the process must be considered when determining which instrumentation and control systems to install. Instruments that measure total solids (TS) or total suspended solids (TSS) can be used in conjunction with flow meters to calculate and track real-time mass flow through solids handling systems. In most situations, magnetic flow meters are used for volumetric flow measurement. The types of sensors and systems that can measure TS or TSS include:

- Microwave "time-of-flight" flow-through devices to measure TS in the solid processing unit feed line, thickened solids outlet from thickeners, or dewatered cake
- Optical devices to measure TSS in filtrate/centrate/pressate
- Microwave resonance devices to collect, convey, and measure cake solids moisture content (dry solids, or DS) in dewatered cake

Microwave analyzers measure time of flight for a microwave to move across a pipe. That time of flight is correlated to solids concentration, using the dielectric constant of water as a baseline. Optical sensors measure turbidity (or total suspended solids concentrations) through a combined infrared absorption scattered light technique in which light is scattered sideways by particles and detected on photoreceptors.

<u>Microwave Flow-Through TS Meters</u>

- Enables continuous mass flow calculation when used with a volumetric flow meter
- Measurable concentration range of 0.5-40% Total Solids
- Can measure solids in typical solids streams across most applications except centrate
- Installed inline, similar to a magnetic flow meter
- Must be installed in pipe with good velocity profile similar to flow tubes or right at pump outlet
- Must be no air in process for sensor to accurately measure
- Must be kept clean through a maintenance program

- Options from certain manufacturers include glass lining, flushing rings, and high-pressure rated units

Multi-light Source Optics Centrate Analyzer

- Enables measurement of filtrate /centrate/pressate quality relative to suspended solids concentration. Can be used to vary polymer dose to maintain desired filtrate/centrate/pressate quality.
- Measurable concentration range of 0-5,000 mg/l TSS
- One manufacturer offers multiple optic channels through a measurement cell.
- Best for close-piped centrate.
- Some units include backflush loop to reduce clogging/interference
- Some units include components that allow correction for entrained air. Entrained air has typically proven problematic in past systems that aim to measure centrate suspended solids concentrations.
- Flow stream must be captured and conveyed to analyzers in a way that maintains a consistent, representative sample stream. Install sample ports directly into centrate piping system.
- Must be kept clean through a maintenance program

Insertion (in-line) optical probes

- Optical probes can measure turbidity or total suspended solids concentrations up to 4000 NTU or 500 mg/L.
- Measures TSS from light dispersion, absorption and similar technologies for turbidity.
- Typical applications are solids feed streams for thickening of dewatering units. Some manufacturers are also marketing these products for filtrate/centrate/pressate as part of optimization packages.
- Must be kept clean through a maintenance program
- Excessive grease, foam or color variations may interfere with signals.
- Some have optional self-cleaning elements (e.g. wipers) that are intended to prevent biological growth.

DS analyzers for cake solids

- One manufacturer offers a dry-solids microwave analyzer for conveyed dewatered cake
- Uses auger mechanism to carry cake falling from a dewatering device to send into a measurement chamber
- Measurable concentration range of 15-35% solids
- Install on cake chute to conveyor. Requires chute for mounting.

Summary

With a combination of flow meters and solids meters, it is possible to determine mass flow even when solids concentrations vary. This data can be used to maintain a setpoint polymer dose based on mass in the feed stream. Measuring TSS in filtrate/centrate/pressate allows determination of solids capture and can also be used to fine tune polymer dose. Some manufacturers offer total control packages that utilize various sensors described above and multi-variable programming to provide real-time optimization of the solids process. This can reduce polymer consumption, maintain desired solids capture, and/or maintain desired thickened or dewatered solids concentrations. As an example, adding a continuous centrate measurement to an existing feed solids measurement provides additional data points to optimize using both feedforward and feedback strategies,

Measuring solids or TSS in the streams discussed in this fact sheet can be an important way to reduce solids system processing costs and maintain process stability. However, as is true for all mechanical systems and control elements, the sensors must be installed correctly, maintained, and calibrated to yield accurate, useful data. It is recommended that interested facilities check maintenance requirements and installation details from other installations where these sensors and control systems have been successfully used.

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