FLOWROX

Pump Selection

How to choose the best pump for thickener underflow.

Thickener or Clarifier Pumping

Clarifiers and thickeners are both means of separating liquids and solids. Thickeners are used to concentrate solids, whereas clarifiers are designed to purify liquids. Effective thickening or clarifying is typically done with the aid of flocculants or reagents. These flocculants often have long polymer chains that are like the tentacles of an octopus. If the wrong type of pump is used to pump these flocculants to the clarifier or thickener, then the flocculants may be damaged by the pumping process. One would want to utilize a low shear pump in this application. Some typical low shear pumps would be diaphragm, progressive cavity or peristaltic. High shear pumps would be centrifugal, gear, or rotary lobe pumps. If a high shear pump is utilized the thickener or clarifier may require significantly increased volume of expensive flocculant.

Thickeners or Clarifiers can be gravity flow devices but in most cases, especially when there is high solid content out of the bottom thickener, it will require a pump to deliver the medium to its desired location. Many times, the thickened solids are fed to pressure filters of various types to dewater the solids. In some cases, the solids may be valuable product and other cases the solids may be simply a waste product. How well the thickener controls the density of the thickened solids can determine how profitable or productive the process may be. If the filtration is filtering a valuable mineral or metal, then the effectiveness for the both the thickener and filtration process may be critical. How the thickener and filtration process work together may result in significant higher costs of filtration or vice versa. If the thickener only supplies 30% solids thickened slurry to filter, then the filter may require additional fill time and pressing time. This slows the process and production. However, if the thickener delivers 65% thickened solids concentration consistently, then both fill time and pressing can be reduced. Thus, providing increased production and cost effectiveness.

Choosing the Best Pump for Thickener Underflow

Typically, there are three types of pumps that are often found on thickener pumping. Those pumps in many cases are centrifugal, progressive cavity or peristaltic pumps. All three types have their strengths and weaknesses. Some of the weaknesses of the various designs are found below.

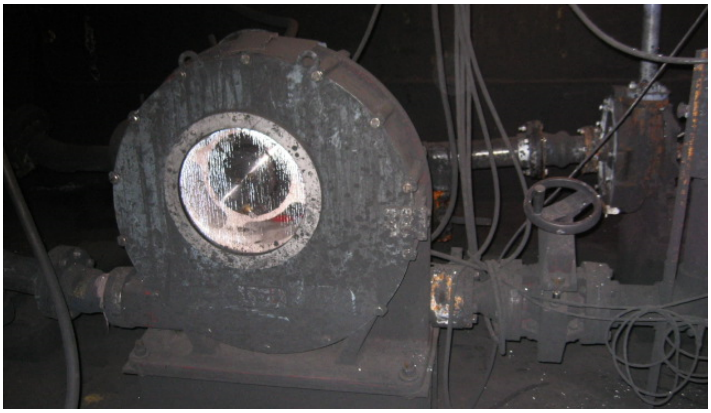
	Peristaltic- Eccentric Single Roller	Centrifugal	Progressive Cavity
Gland Water	No	Yes	Yes
Risk of Cavitation	No	Yes	Yes
Siphoning When Pump is Stopped	No	Yes	Yes
Self-Priming	Yes	No	No
Dry Run Capable	Yes	No	No
Fixed Volume	Yes	No	Yes
Reversible	Yes	No	No
Shearing of Medium	No	Yes	No
Frequency of Repair	Low	High	High
Cost of Repair	Low	High	High
Suction Lift	Yes	No	No
Flow Capacity	Moderate	High	High - Moderate

As the percent solids is increased both the progressive cavity and centrifugal pumps require more frequent costly repairs. The number of components requiring repair on both the progressive cavity pump and centrifugal are significant and carry a significant repair cost. The peristaltic pump typically only requires a new hose and a small amount of glycerin. The cost of repairs on an eccentric single rolling design peristaltic pump can be a fraction of what it takes to maintain both the centrifugal and progressive cavity pumps.

Best Case Scenario of Better Pump Selection

Figure 1. A Baltimore chemical factory was utilizing two progressive cavity pumps for thickener underflow pumping. Now you see two Flowrox peristaltic pumps that replaced those pumps. The progressive cavity pumps required repair every 6 months at a cost of $17K per pump or $34K. The plant purchased two Flowrox eccentric rolling design peristaltic pumps. The Flowrox pumps ran continuously for more than 1.5 years before the first hose changes were required. The cost of the two hoses was less than $3.5K.

Thickeners and clarifiers are utilized in numerous industries from water and waste water, mining, chemical, steel making and others. There are numerous inputs and outputs of a typical thickener or clarifier that if all is working well will produce the desired outcome. The inputs are the influent flow rate, flocculent delivery, rake speed, bed layer, overflow, underflow density and underflow pumping. When all is working, the underflow density and underflow pumping rate is at its optimal level. Upsets can occur that cost money and lost production.



(Left) Figure 2. Six Flowrox 2.5” pumps with variable frequency drives were selected for thickener underflow pumping at a Chicago steel mill. The pumps replaced centrifugal pumps to deliver thickened sludge to plate and frame filter presses. The Flowrox peristaltic pump was selected due to its ability to handle abrasive materials with higher solids concentration levels. The thickened mill sludge contained coarse carbon particles which rendered the centrifugal pumps a poor selection due to intense wear and repair costs. The steel mill was using many man hours replacing impellers, seals and casings. The estimated annual cost reduction was $177K. Notice the isolation valve to the pump was a Flowrox 2.5” slurry pinch valve. These valves are long-lasting valves for the world’s most abrasive slurries.

(Right) Figure 3. A Mexico mining operation determined that increasing thickened slurry from 7–10% to 30% to the filter presses would result in a 20% increase in tonnage. This increased production and profitability. The specific gravity of the medium was 1.546. The customer ordered 5 pumps: two 3” and three 1.5” Flowrox eccentric single rolling design pumps. Frictional sliding shoe peristaltic pumps were not an option because the temperature of the process was 197°F. Exotic alloy centrifugal pumps were used prior to the Flowrox pumps. The process was hot and had acids present, so the centrifugal pumps were manufactured out of exotic alloys at a considerable cost. The maintenance savings on these five pump replacements was more than $250K annually. Gland seal water was eliminated by changing to the Flowrox peristaltic pumps. This region of Mexico has a high cost of consumed water. There were two sets of pumps. The two 3” pumps were pumping jarosite and the three 1.5” pumps were pumping lead and silver slurry.

IIoT Monitoring, Cost Savings and Process Optimization

The industrial internet of things (IIoT) is bringing substantial opportunities to processing facilities. Process facilities of all types do not have to invest millions to begin reaping rewards. Simple processes can be optimized, maintenance cost and downtime reduced and maintenance can evolve from reactive to proactive by receiving advanced warnings of equipment fatigue. Minor repairs such as early bearing vibration can be detected and fixed prior to more extensive and costly repairs. Machine learning is employed to determine normal performance and when anomalies are detected warnings can be sent to key personnel. Some companies fully employing IIoT monitoring and aggressive proactive maintenance strategies claim they are gaining one additional month of production per year.

Flowrox developed its IIoT solution named Malibu™ over the past several years. Virtually any asset, process or complete facility monitoring can be employed. In recent years instrumentation and sensors costs have decreased substantially. Instrumentation can be added to provide valuable insight and monitoring. It is estimated that in the next few years there will be 4–5 sensors for every human on the planet. Connected assets are exploding and utilizing intelligent and cost-effective monitoring is ready right now from companies that can provide solutions to nagging problems. Assets that require constant repair and have significant downtime are excellent targets. Compliance or safety are also excellent targets for IIoT monitoring.

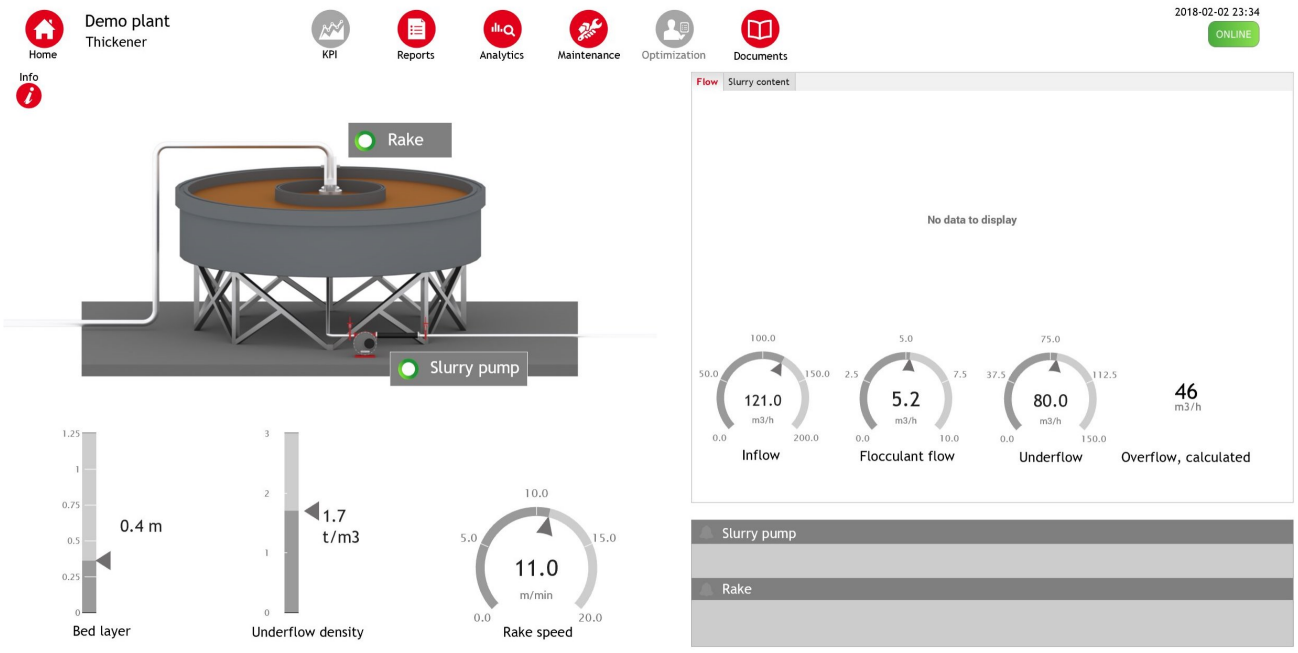


Figure 4. Depicted above is a typical thickener process monitored by Flowrox's Malibu™. The various inputs are monitored for proper delivery of the optimal density and slurry concentration to be delivered to the filtration process. As mentioned earlier in this white paper, there are significant gains in production and improved profitability.

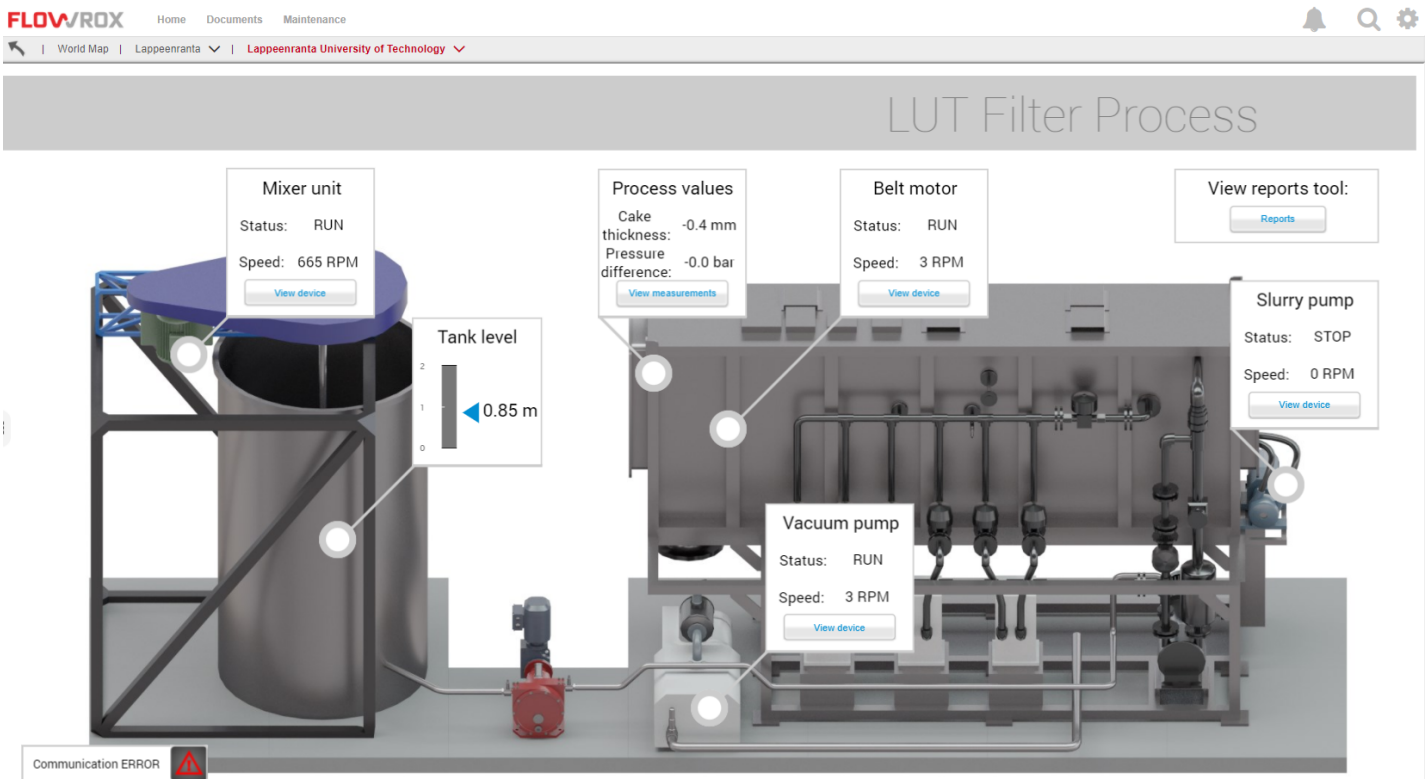


Figure 5. Depicted above is a vacuum filter that was connected to IIoT monitoring by Flowrox. By optimizing filter functions, Flowrox was able to reduce energy consumption on this machine by 50%.

Conclusions

Thickeners, Clarifiers and other abrasive high solids slurries are perfect opportunities for peristaltic pumps. With Flowrox's IIoT monitoring, an existing pump or other asset can be analyzed for effectiveness and cost. If a customer has two brands of pumps in a similar process, Flowrox can install instrumentation and a Smart Cube on both brands and help the customer to understand the full cost of ownership of each brand. The results will be clear for all to see. Flowrox can also imbed a document management system into its IIoT monitoring solution. All documentation such as drawings, manuals and even repair videos can be retrieved at a moment's notice from any smart phone, tablet or PC that has an internet connection. The interface also includes digital twin imagery of the equipment with dashboards that can be customized to the owners liking. Flowrox's Smart Solutions™ are typically used for monitoring only, so the plant PLC or DCS continues to control the operation of all equipment. The Smart Solutions™ security is TLS encryption which is the same utilized by the internet banking industry. Virtually any asset can be monitored. In many cases, information from existing instrumentation can be captured and analyzed to improve asset cost of ownership, reduce downtime and improve profitability.

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