ENHANCED PASTE PLANT CONTROL WITH ACT THICKENER OPTIMIZER AT YARA SIILINJÄRVI

New ACT Thickener Optimizer system at Yara is well integrated with plant DCS, maintaining process stability despite highly challenging variables.

The Yara Siilinjärvi plant is located in Finland and is owned by Yara International ASA, a Norwegian fertilizer company.

Siilinjärvi is Western Europe’s only apatite mine. It produces apatite concentrate mainly for its Siilinjärvi phosphoric acid plant. Part of the concentrate is also dried and shipped to other Yara fertilizer plants. About one million tons of apatite concentrate are produced annually, creating approximately 10 million tons of tailings per year.

Background of the project
In 2015 Yara awarded Outotec the contract for a full-scale paste tailings plant at Siilinjärvi as an Engineering, CHALLENGES

- Mineralogy varies significantly on a daily basis
- High content of coarse mica
- Variable stockpile and ore types, fluctuating paste plant mass flow
- 6.6km from main concentrator plant

SOLUTION

- ACT Thickener Optimizer system, cost-effective and highly integrated with customer DCS system

BENEFITS

- Consistent performance, maintaining target underflow solids of 66-68%
- Operators with full access to user interface, alarms, interlockings, history data, and documentation from DCS
- Minimised flocculant use, 10-20% savings
- Paste plant availability >97% and trouble-free high-density pumping
Procurement and Construction (EPC) project. This paste plant delivered by Outotec increases tailings solids content, improves tailings beaching properties and extends the capacity and lifetime of the existing tailings storage facility. The paste plant has been operational since February 2017. Further details of this EPC project can be found separately in another Outotec case study on Yara.

As part of the overall project, Outotec also designed and delivered an optimizing control system for the two paste thickeners at the tailings plant. This case study discusses the control application, its challenges and results following implementation at Yara.

The new plant’s objective was to achieve a 68–70% solids underflow and at least two degree (3.5%) beach slopes, extending the tailings pond lifespan from 2020 to 2035. Factors such as the plant’s changing mineralogy and tailings feed fluctuations make it challenging to reach these solids underflow and beach slopes targets. It was determined that many of these challenges could be overcome with adequate process instrumentation and state-of-the-art control techniques.

Challenges for process control

1. **Varying mineralogy** Siilinjärvi’s tailings sand rheology varies significantly on a daily basis. The overall tailings sand mineralogical composition is apatite (1%, variation 0.7-10%), calcite and dolomite (20%, 10-35% variation), phlogopite mica (74%, 60-85% variation) and other silicates (5%, 1-10% variation). In particular, the high content of coarse, flake-like mica strongly influences both thickening and pumping performance.

2. **Milling circuits** The mills operate with 24-hour homogenisation stockpiles, where the incoming ore type varies from one pile to another. In addition, each milling section has to be shut down for 1–2 hour periods each week to charge the new rods. This reduces the paste plant input mass flow remarkably, causing feed disturbances.

3. **Paste plant location** The paste plant is 6.6km from the main concentrator plant. Currently, the paste plant is partly manned, but the target is to operate and maintain it from the main plant. The paste plant must therefore be fully controllable remotely, so that automated process sequences and efficient process controls are critical in varying situations.

**Multivariable control algorithm**

The thickener control application uses the Model Predictive Control (MPC) algorithm. MPC is an advanced process control method which is considered a standard method for control processes with a multivariable character and complex response dynamics. MPC control is based on the process response models, which are typically obtained by performing process trials or simulating the process responses.

**System structure**

The new system implemented at Yara, the ACT Thickener Optimizer, is based on Outotec’s proven Advanced Control Tools (ACT) platform. This platform is a dedicated environment developed especially for advanced process control solutions.

In the Yara paste plant project, a high level of system integration was desired. The controller user interface, alarms, interlockings, history data and documentation were therefore all implemented into the customer DCS, giving operators full functionality from the interface also used for plant control. The ACT Thickener Optimizer system also included a remote connection to the Outotec network, so that the controller performance monitoring, tuning, and support could also be performed remotely.

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Yara Siilinjärvi paste plant process layout.
Controller setup
The controlled variables in the optimizing system are, underflow density [kg/m³], overflow solids content [%], bed mass [%], bed level [m] and rake torque [%]. Underflow density was selected as a primary control variable, which has a precise target value and the highest priority during normal operation. Overflow solids is the second most important variable. Overall, the system should run with minimal flocculant dosage to minimize plant operating costs.

Operational results
The ACT Thickener Optimizer has been in use at the Yara paste plant since May 2017. Experiences have been good, and operators have adopted the controls well in their daily toolkit. Since start-up, the controls have been in continuous use. It is only during exceptional situations such as underflow line flushing or maintenance work that manual operations are needed. Overall, the controls usage rates have been over 92%.

The basic operating principle is to run the system with the highest possible density that still ensures trouble-free pumping. In practice, this means the operator adjusts the density target value in accordance with the observed pumping behavior and the discharged slurry visuals. As the paste plant is operating very close to the corner point in the solids content vs. yield stress curve, even a very small 10-20kg/m³ change in density makes a remarkable difference in pumping resistance.

One of the Yara paste key targets was continuous operation with 68-70% underflow solids content. As seen from site trend lines (June-Aug 2017), the actual operating window of both thickeners is 66–68%. Actual operating values are slightly lower than original targets due to the fact the targeted beach slopes are exceeded already with this operating range, so no requirement for higher solids content.

Solids content variability (measured value is green, target value is blue). Actual Jun-Aug 2017.
A major long-term target for Yara is remote paste plant operation from the main concentrator plant. Currently, the plant is partly manned, and it operates autonomously during night shifts and it is operated remotely from the main plant. The next step is to gradually move to fully remote operation.

**Conclusion**

With the Outotec ACT Thickener Optimizer, the paste thickeners can consistently run with high and stable underflow solids content of 66–68%, regardless of challenging mineralogy and tailings feed rate variation. This results in average beach slope angles of 3.5 degrees (6.1%) in the tailings disposal area. Additionally, the control pushes the system towards the minimum use of flocculant, delivering 10-20% savings in flocculant costs. The optimizing controller also helps in underflow pumping, as it keeps the process in its operation window, with fewer manual operations required.

To watch a video on Yara’s Paste plant click here