IMPROVE THE CLASSIFICATION SYSTEM IN HYDRO ALUNORTE LINES 4/5

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Abstract

Precipitation was the main bottleneck in lines 4 and 5 and had a lower operating factor and yield than the other precipitation lines. The lower operating factor and yield was associated with the following issues: The original flowsheet required the precipitation circuit to be coarse in order to be able to send the produced hydrate to calcination and to limit the amount of fine seed to the Tertiary Thickener system. In addition the Primary Thickeners and Hytanks had frequent pluggages in the underflow and required frequent caustic cleaning. The old circuit limited the solids concentration in the circuit to about 420 gpl. This, together with coarse precipitation circuit and the low operating factor, were the reason for the low production of these lines. The main part of the proposed modifications was upgrade the existing Secondary cyclone system, add an additional Secondary cyclone battery and replace the Primary Thickener and Hydrate Tank with cyclones. In addition to resolving the operational and maintenance issues above, eliminated the precipitation bottleneck and guarantee the budget production expected for this two lines, also there are an expectation to increase production.

Introduction

Alunorte started operation in 1995 with a design production capacity of 1.1 Mtpy. Since then the plant was expanded three times and consists today of seven production lines with a total production capacity of close to 6.3 Mtpy. Expansion 2 included the process lines 4/5. The lines was commissioned in 2006 and have a design nominal production capacity of 1.8 Mtpy.

Precipitation is the main bottleneck in line D and E (4 and 5) and had a lower operating factor than the other precipitation lines with an average production of 105 t alumina/hr for each line. The lower operating factor is associated with the existing flowsheet requires the circuit to be coarse in order to be able to send the produced hydrate to calcination and to limit the amount of fine seed to the capacity of the Tertiary Thickener system. A finer circuit results in a concentration of the circuit (the production can not be removed via the Primary Thickener / Hytank system) and overloads the Tertiary Thickener resulting in high solids in the spent liquor and even in loss of a Tertiary Thickener if the flow is not reduced in time.

The present circuit limits the solids concentration in the circuit to about 420 gpl. This together with the required coarse circuit and the low operating factor, means that the production is lower than the rest of line D and E allows.

The main part of the proposed modifications will upgrade the existing Secondary cyclone system, add an additional Secondary cyclone battery and replace the Primary Thickener and Hydrate Tank with cyclones. In addition to resolving the operational and maintenance issues above, this will eliminate the precipitation bottleneck leading to an expected to increase in production.

Materials and Methods

Classification System Current

Lines DE has a variance and lower operating factor based on both production and flow compared to the other lines. This is mostly related to the classification section as described below. All the flow from the end of chain (FDC) enters the Primary Thickener. Product from the underflow is sent to the Hytank in the calcination area. Underflow from the Hydrate tank is sent to the product filters, overflow from the Hytanks returns to the precipitation train. The underflow from the Secondary Thickener is used as Coarse seed and goes to Cementator tank directly. The Overflow goes to Tertiary Thickener. The underflow from the Tertiary Thickener is used as Fine Seed and goes to the Agglomeration and to the Cementation tank. The overflow from the Tertiary Thickener is spent liquor which is sent to HID for heat recovery.

The existing flowsheet requires the circuit to be coarse (approx. 110 um at the FDC) in order to be able to send the produced hydrate to calcination and to limit the amount of fine seed to the capacity of the Tertiary Thickener system. A finer circuit results in a concentration of the circuit and overloads the Tertiary Thickener resulting in high solids in the spent liquor and even in loss of a Tertiary Thickener if the flow is not reduced in time.

In addition the Primary Thickeners and Hytanks have frequent pluggages in the underflow and require frequent caustic cleaning, which causes disturbances to the control of the precipitation circuit and to calcination. This also of-coarse reduces the time operations can use on other issues and reduces the amount of caustic available for precipitator or other cleaning purposes.

The present circuit also limits the solids concentration in the circuit to about 420 gpl. This together with the required coarse circuit and the low operating factor (average precipitation flow is approximately 91% of design), means that the production is lower than what it could be. Figure 1 is gravimetric classification circuit.

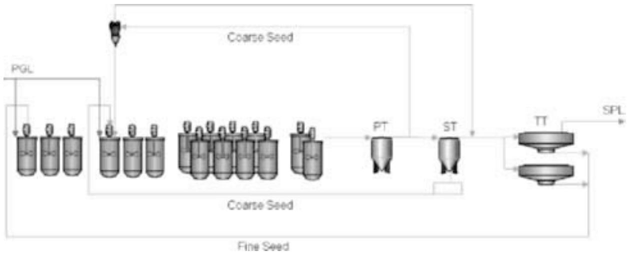

Figure 1. Gravimetric Classification Circuit

Precipation Firm-up of Lines 4 & 5: Proposed Cyclones

The precipitation firm-up of lines 4 & 5 consists of:

1. Replacing the Primary Thickener and Hydrate tank with cyclone classification fed from the lower part of the last precipitator.
2. Upgrading the existing Secondary cyclone battery system to allow increased feed flow, higher pressure drop over the cyclones and higher solids concentration in the underflow. Move the feed point from the Primary Thickener to the upper part of the last precipitator.
3. Installing an additional Secondary cyclone battery fed from the upper part of the last precipitator.

The Figure 2 is new circuit of cyclone classification.

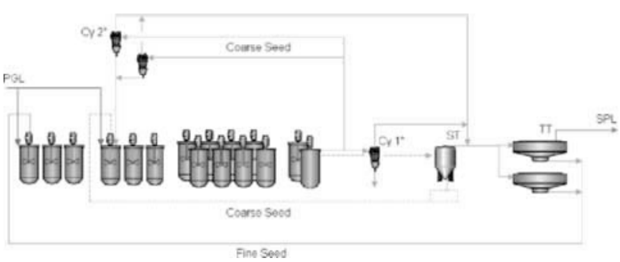

Figure 2. Gravimetric Classification Circuit

Three new Primary Cyclone Batteries are required, one for each line and one reserve. These will fed from the lower part of the last precipitator. This material will be somewhat coarser than the feed to the precipitator since some classification occurs in the precipitator.

The underflow from the cyclones will injected with wash water from the product filter 1. washing stage in order to control density and allow pumping of the material directly to the product filter. The overflow from the cyclones (containing fine seed material) will normally go to the Tertiary Thickener, but an option to discharge to the Secondary Thickener will also be required.

The cyclones will be designed to produce product quality material in the underflow (less than 2% <44 um) at a highest possible solids concentration.
The existing cyclones are limited in feed flow and in pressure drop. To the upgrade of existing secondary cyclones, the existing feed pumps needed to be upgraded or replaced. The underflow and overflow will go to the same location as to-day and to the Tertiary Classifier.

The new Secondary cyclone battery is designed for a flow above 1000 m3/hr. The flow required depends on the solids concentration requirement of the cyclones. The cyclone battery system is design for maximum solids concentration in the underflow (higher than 900 gpl) and high solids recovery (better than 90%). The battery is allow good operability and control and is allow for safe removal of cyclones for maintenance while the battery is in operation.

Results and Discussion

A software that simulates precipitation was calibrated to a relatively stable period in July 2009. This calibrated model was then used to establish the base condition and the proposed modified line with Primary and Secondary cyclones.

Table 1 below shows historical production and quality data for lines 4 and 5 and compares this with the expected average as well as the results after modification .

Table 1. Production and Quality Data after modifications.

	2010	2011 (1^{st} Six month)	2011* (2^{nd} Six month)	Expected Average With Firm up project	Results after Firm up (2012)**
Plant					
Availability (%)	94.4	87.4	87.4	> 94	94.2
Plant productivity (kg/m^3)	83.2	82.0	86.9	85.0	88.2
Product					
Alumina Prod. (t/hr/line)	99.8	99,2	101	103	105.5
Occl. Soda (%)	0.34	0.37	0.36	0.37	0.34
AI (%)	16.5	14.1	16.5	< 17	17
<44 um (%)	7.4	5.0	7.7	6.2	7.6
Precipitation					
EOC Solids (gpl)	404	399	450	447	482
EOC Median (Um)	111	113	106		
EOC <44 um (%)	2.9	2.7	3.5	4.7	3.6

EOC: End Of Chain
**period where ocurred improvements in the precipitation control.*

The results indicate an increase in productivity in the precipitation of the order of 0.91% and 7,8% in the availability over the year 2011 (2nd Six month). For the simulations, the estimated production gain is 2.6 t/hr per line or 5.2 t/hr/line for the two lines (46 kt/yr). With the firm up precitation, production is above 2.66 t/hr/line of estimated and 4.5 t/hr/line of period July – December/2011.

The chart 1 presents the production until september projected to full year.

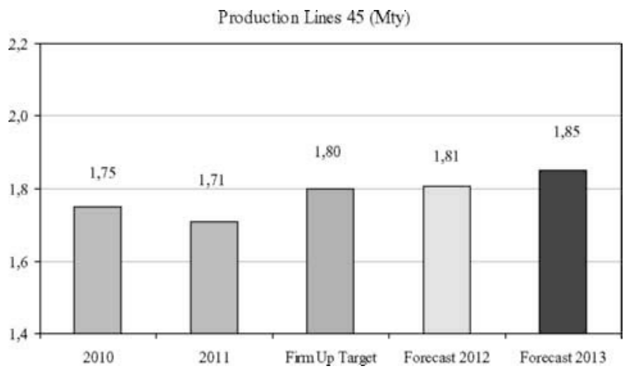

Chart 1. Production until September projected to full year.

The precipitation capability increase is due to increased average flow , higher solids concentration and reduced end of chain flow resulting in longer residence time and reduced precipitator bypass. The chats below presents the results of End OF Chain solids and ration in the years 2011 and 2012. In chart 2, we observe that in 2012 the EOC solids increased 13.5% and lower deviation.

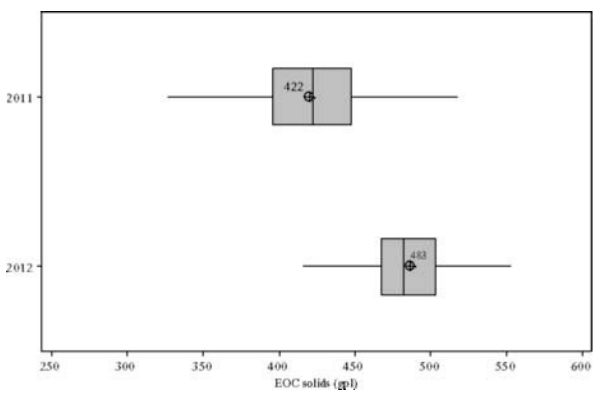

Chart 2. End OF Chain solids.

In chart 3, we observe that in 2012 the EOC ration reduced 0,411 to 0,402 and lower deviation.

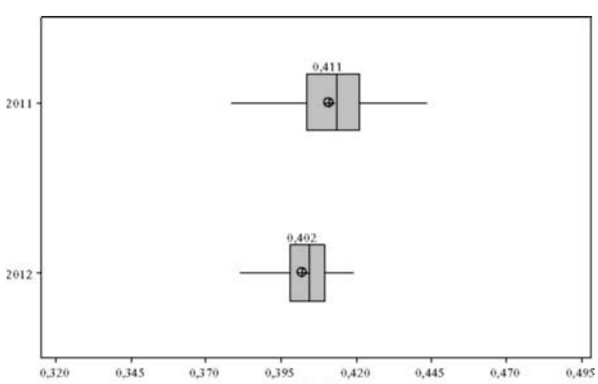

Chart 3. End OF Chain ration.

In product quality, the occluded soda (0,36 to 0,34) is more lower (chart 3) and attrition index sustained (< 17%) due to the finer circuit and less agglomeration requirements in the cementation section (lower first cementator temperature).

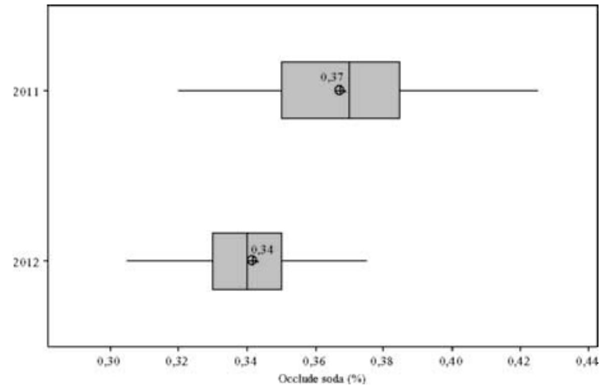

Chart 4. Occluded soda

Conclusion

The main results is:

- After precipitation firm up of lines 4 and 5, the precipitation productivity increase 0,91%, 7,8% increase availability, accounting for a production increase of 5,32 t/hr.

- The precipitation circuit is more stable and the results of solids concentration an ration present smaller variations due to good performance of cyclones.

- The product quality is better with the occluded soda reduced and attrition index sustained, but with expected od reduction to less than 17%.

References

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