Pressure Decantation At Gramercy Alumina

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ABSTRACT

Gramercy Alumina restarted in July 2001, using a Double Digestion of Jamaican bauxite, employing Alcan pressure decantation technology. Low temperature digestion slurry is decanted in pressure vessels using synthetic flocculant to separate a clarified overflow and a consolidated mud underflow. The overflow reports to the digestion flash train. The underflow is pumped to high temperature desilicator/digesters.

Demand for throughputs and supersaturation levels above original design has challenged operation and process personnel since startup. Physical changes to the decanters piping and controls have improved underflow pumping capabilities to accommodate the above-design throughputs and significant bauxite quality changes. Optimizing flocculant injection placement and dosage level has reduced consumption to half the start-up levels.

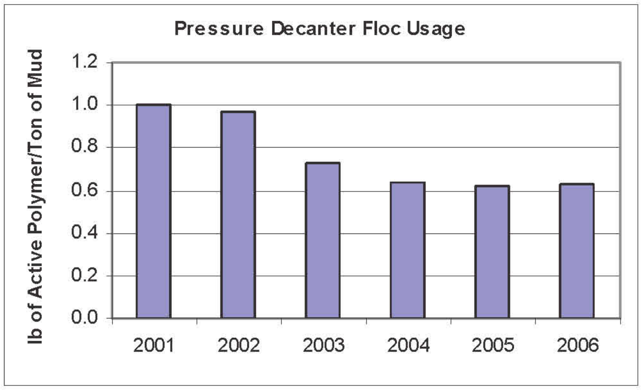
Despite advances that enabled operation above original design levels, relatively short decanter operating cycles and high scaling rates still pose significant operating and maintenance limitations. These improvements and the ongoing challenges are the subject of this presentation.

INTRODUCTION

Gramercy Alumina has operated a modified Bayer process incorporating a Double Digestion of Jamaican bauxite since 2001. Pressure decantation, an Alcan technology, is the heart of this Double Digestion process. The slurry stream exiting a low temperature digestion step is decanted using three of four pressure vessels to separate a clear overflow and a heavy mud solids underflow. The solids concentration in the overflow is typically below 1000 mg/L while the underflow contains 25-30% solids.

Much testing and optimization has been conducted regarding placement and dosage of flocculant injection. This optimization has led to a reduction in flocculant consumption from 1 pound of active polymer per ton of mud at start-up to the current rate of 0.6 pound of active polymer per ton of mud processed through the decanters.

Alcan estimated in their design that the flocculant consumption should be between 0.45 and 0.80 lb/ton of mud based on the bauxite evaluated at the time of the design.

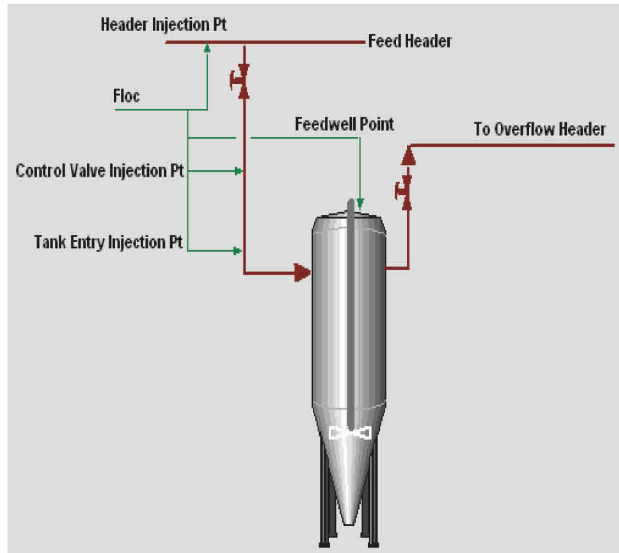


Flocculant has not been the only focus for decanter improvements. Key changes have been directed at improving underflow pumping capabilities to accommodate mud loads due to increasing mono-hydrate content of Jamaican bauxite.

Short operating cycles have also plagued the decanters. The original design approximated the life cycle of a pressure decanter to be 90 days. Currently, the life cycle is 65 days. Gramercy operates with one decanter on turnaround at all times.

Flocculant Optimization

1. The pressure decanters use a synthetic polyacrylate flocculant. There are a total of three flocculant injection locations on each decanter and one injection point on the feed line to the decanters called the "header" injection point. This is done in order to provide enough flexibility and take into account the fluid dynamic characteristics of each installation. Each injection point can be seen in the drawing below.



Alcan design stipulates that the flocculant be added to the feedwell of each decanter and to feed header. At the start-up of the decanters, the control valve and the header injection points were used with 75% of the flocculant being injected at the header and 25% being injected at the control valve. Due to the high flocculant consumption, it became apparent that this configuration was not optimal. Therefore, the amount of flocculant being fed to the header and to control valve points was interchanged, greatly reducing flocculant consumption. Optimization was done on the other two remaining injection points. It was found that the feedwell injection point yielded the best overflow clarity and the lowest flocculant consumption rate. It is believed the reason the feedwell injection point works so well is that it reduces the shear rate of the flocculant because it is injected so close to the vessel. This led to the discovery that the flocculant being injected into the feed header was being sheared so severely that it was doing very little mud settling.

The header flocculant injection point was abandoned in June of 2004.

In theory, dual floc addition continued to be the optimal approach to dosing flocculant. Testing was done using the tank entry and the feedwell injection points to reduce the shear rate of the flocculant. The data in the table below shows the results of a test run conducted on #4 decanter.

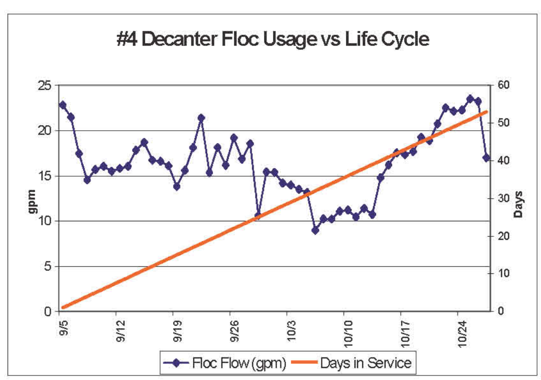
	Feedwell (gpm)	Tank Entry (gpm)	Clarity (mg/L)	Total Floc (gpm)
6/8/2004 11:00	8.4	2.3	439.8	10.7
6/8/2004 12:00	7.5	2	11015	9.5
6/8/2004 13:00	7.5	3	10342	10.5
6/8/2004 14:00	7.5	4	970	11.5
6/8/2004 15:00	7	4	10336	11
6/9/2004 11:00	7	5	13655	12
6/9/2004 12:00	7	6	12643	13
6/15/2004 7:00	8	2	690	10
6/15/2004 9:00	7	7	639	14
6/15/2004 10:00	6	7	457	13
6/15/04 13:00	5	7	548	12
6/15/04 15:00	4	7	890	11
6/16/04 6:00	6	7	451	13
6/16/04 9:00	5	7	628	12
6/16/04 12:00	3	7	12361	10
6/16/04 13:00	4	7	970	11
6/16/04 14:00	4	6	28549	10
6/17/04 6:00	4	7	799	11
6/17/04 9:00	9	0	890	9
6/17/04 10:00	8	0	754	8
6/17/04 0:00	7.5	0	782	7.5
6/17/04 13:00	**7**	**0**	**884**	**7**
6/18/04 10:00	5.25	1.75	12852	7
6/18/04 12:00	8	2	617	10
6/18/04 13:00	3.5	3.5	41349	7
6/18/04 14:00	8	2	668	10
6/18/04 15:00	1.75	5.25	63212	7

From the data above, along with several other test runs on different decanters, it was determined that the optimal location to inject the flocculant was in the feedwell injection point alone.

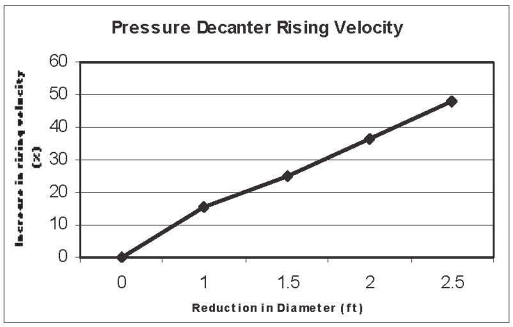
Today, flocculant is only injected into the feedwell of each vessel. It was found that this is the optimal configuration for maintaining the accepted overflow solids while using the lowest flocculant consumption. Flocculant consumption was reduced by approximately 15% by operating in this manner.

2. Floc concentration testing has also been done concerning the pressure decanters. The original concentration used at the start-up of the decanters was 1.15 %. That concentration has since been incrementally reduced to 0.85% based on the theory that the lower concentration of flocculant will enhance contact between the mud particles and the polymer. It is planned to eventually operate with a 0.80% flocculant concentration.

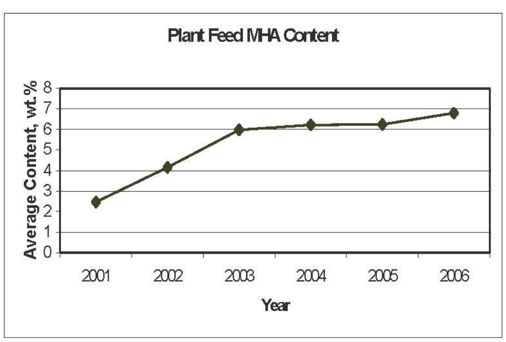
3. One of the greatest problems facing the decanters with respect to flocculant is the increase in flocculant requirement over the life of a vessel. Young vessels can use as little as 10 gpm of flocculant. This amount can increase to 30 gpm by the end of a life cycle. The flocculant consumption over a typical decanter life cycle is depicted below.



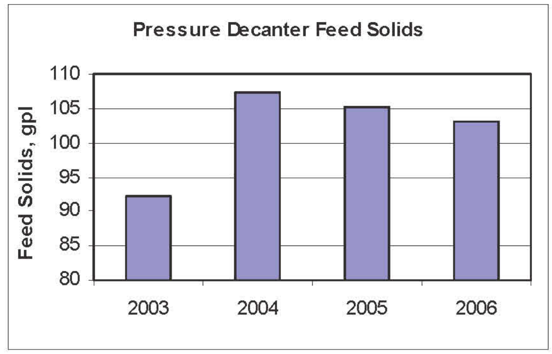
Compared to the original design, the pressure decanters are now operating at A/C ratios 0.020 higher than design to meet production demands. Due to variability in bauxite, maximum A/C ratios can be 0.030 above original design. These high A/C ratios lead to excessive mud loads and scaling rates that more and more flocculant is needed to settle the mud due to decreased settling area. This leads too higher rising velocities. The rising velocity of a pressure decanter just off of turnaround is 96 ft/hr. With just a reduction of 1.5 ft in diameter, the rising velocity rises to 120 ft/hr.



When a decanter is opened and inspected before a turnaround, it is typically found that the scale formation tends to be the highest in the feedwell area. The width of the scale on the outside of the feedwell is approximately one foot. The scale growth on the walls of the decanter tends to be about 1 foot thick. It is believed by the end of a decanter life cycle that the settling area inside the decanter is reduced to not much more than the area of the feedwell plus the very small area below it. The increased mud loads being processed by the



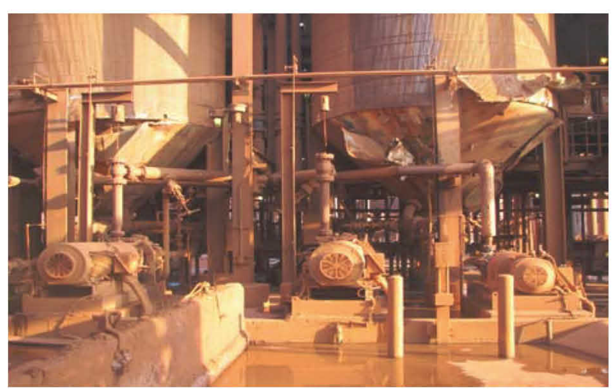
decanters can explain this high scaling



rate. The trend below shows the increase in the mono-hydrate content from 2002 to 2005 of the bauxite used at Gramercy. This increase in mono-hydrate content causes an increase in the feed solids to the decanters. The decanters were designed for a feed solids of 70 g/L. Today, the feed solids range from 70 g/L to 125 g/L.

Underflow Pumping Capabilities

Each pressure decanter underflow system is comprised of a recirculation pump and an underflow pump. The underflow pump pumps into a crab pot then to the mono-slurry pumps. The mono-slurry pumps are centrifugal booster pumps that pump together in series with a variable speed drive on the second pump. These pumps take the mud from the decanters and pump it to the high-pressure desilicator.



The average underflow rate from a decanter is typically 35% of the feed flow rate. The recirculation rate is maintained at approximately half of the underflow rate. As can be seen from the picture above, the underflow and recirculation flows exit the decanter through the same 8-inch outlet. This has been a problem because the underflow pump and the recirculation pump tend to compete for flow from the decanter. A great majority of time the underflow pump was at maximum output.

In order to remedy this pumping issue, the feed control valves of the decanters were relocated to the overflow line. This enabled the decanter to be operated at a higher pressure. The operating pressure increased 40 psig allowing the underflow pump to operate at approximately 85% output. This modification was completed to all four pressure decanters in late 2004 and has worked well to maintain controllability of underflow pumping.

Scaling issues are not only isolated to the decanters themselves. Scaling tends to also be a problem with the underflow system as well. The underflow and recirculation pumps do have to be taken off-line periodically to clear the impellers of scale.

Another reason for underflow pumping problems is that Gramercy does not have a grinding facility. A trommel screen with one-half inch openings is used to screen the bauxite before it enters the Digestion area. At times, breaks in the screen can allow large material to get by and enter the process. The pressure decanter underflow system tends to be the area where this material will settle out causing total pluggages of the decanter underflow systems. When this occurs, the underflow pumps must be taken off-line and cleared of the pluggage one at a time. This usually results in reduced production rates.

Instrumentation

The pressure decanter instrumentation is subjected to a very harsh environment due to the amount of mud processed through the decanters. It is very common for a feed or underflow flow meter to not be working properly. It is typically not advisable to take a decanter off-line temporarily to repair instrumentation due to the difficulty in re-establishing a steady underflow rate.

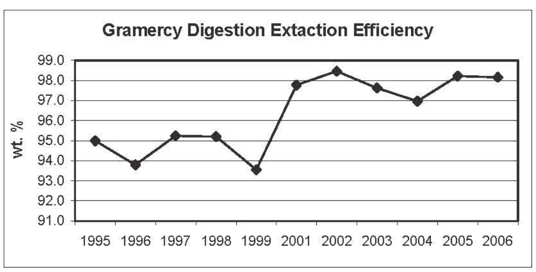
One area where a lot of work has taken place is in the measurement of mud level in the pressure decanter. Originally, the pressure decanters contained four differential pressure cells that measured the differential pressures along the height of the decanter. This differential pressure was converted to a specific gravity and then to a level used by the control board operator to use to control underflow pumping. It was found that this method of measuring level was not reliable due to pluggage of the pressure taps.

The pressure taps were changed to measure specific gravity. Instead of four taps there are now only two to insure all taps receive maximum purge water flow. The first is located on the lower half of the vessel and measures the mud specific gravity in that area. The other is located in the upper half of the vessel and measures the specific gravity of the liquor in the top half of the vessel. These specific gravities are used to calculate a total mud inventory for the vessel. The control board operator pumps the vessel to maintain a target mud inventory. It was found that maintaining higher mud inventories caused higher solids in the overflow. There are constraints to maintaining the mud inventories. Gramercy has a limitation in the amount of steam available to the high-pressure desilicator and the amount of spent liquor available for the first high-pressure digester. Both of these issues make it very difficult to "catch up " if a pressure decanter mud inventory is allowed to rise above aim.

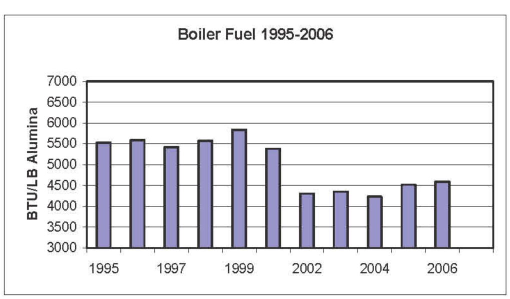
Benefits

Although the operation of the pressure decanters has been a steep learning curve for plant personnel. The pressure decanters have been a very beneficial addition to the Gramercy facility.

The Digestion extraction efficiency has increased from 94% before their installation to 98% after. Below shows the increase in extraction efficiency from 1995 to 2006.



Energy usage has also been greatly improved since the installation of the Double Digestion process. The trend below summarizes the boiler fuel usage from 1995 to 2006.



Path Forward

Much work and focus has been put on the operation of the pressure decanters at Gramercy Alumina. In the past four years much has been learned regarding the operation of the pressure decanters, but there are some areas of work that are continuing.

1. Flocculant testing of different types of flocculant to reduce flocculant consumption even farther.

2. Re-size recirculation pumps so they act as spares for underflow pumps.

3. Increasing tri-digester extraction efficiency to reduce mud loads in the decanters and maintain the same production levels.

4. Install turbidity meter on main overflow line for on-line monitoring of overflow solids.

5. Install bayonet valves on entry into feed and overflow headers.