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A NEW TECHNOLOGY FOR DRY DISPOSAL OF ALUNORTE'S BAUXITE RESIDUE

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Abstract

Alunorte uses dry stacking based on the technology of Giulini for bauxite residue storage. The residue is washed and filtered in drum filters. This paper presents a study of a new technology to move from dry stacking to dry disposal for the next implementation phase of Alunorte's residue disposal area (DRS). A key element is the use of press filters for residue filtration. With this technology will be possible to increase the residue solids content to about 80 wt.-%. This will result in various advantages, such as maximizing the residue storage capacity as a consequence of steeper disposal angles, increasing lifetime of the DRS, lower amount of water within the dump and lower environmental impact.

1.0 Introduction

Alunorte is located in the state Pará, north of Brazil, near to the city Belém. The plant started operation in 1995 and has expanded three times since then. The actual alumina production capacity is close to 6.3 Mtpa. The latest Expansion 3 included the installation process of lines 6 and 7 and was commissioned in 2008 (Khoshneviss et al. 2011).

Alunorte uses dry stacking for bauxite residue disposal. This technology is considered as state of the art. It was implemented on the start-up of the plant and Alunorte can look back more than 15 years of operational experience with this technology. Although Alunorte considers this concept to be good (Alves Filho et al. 2011), there are ambitions to further decrease for environmental impact of Alunorte's bauxite residue storage. This can be achieved by increasing the solids content of the disposed residue and means a transition from dry stacking to dry disposal. There is a trend in the alumina industry to move towards a densification of the residue. At higher solids content the amount of liquid disposed with the residue is reduced. More bauxite residue can be stored per unit area. This reduces the space requirement of the residue deposit area (DRS). Furthermore, the generation of liquid effluent is smaller since less rainwater is collected and there is the potential to decrease controllable soda loss. Capital cost can be reduced due to the larger mass of residue disposed per DRS area and the correspondingly extended lifetime of the deposit. In comparison to older wet disposal concepts no large perimeter dykes are required.

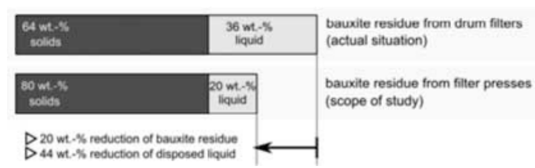

Figure 1.1 Comparison of bauxite residue from drum filters and filter presses.

Actually with Alunorte's dry stacking technology a solids content of about 64 wt.-% of the disposed residue is achieved. With a new dry disposal concept the aim is to achieve up to 80 wt.-%. The benefits in terms of environmental impact are shown in Figure 1.1. The total amount of bauxite residue is reduced by ca. 20 wt.-% compared to the actual situation and the amount of liquid disposed is reduced by 44 wt.-%.

Dry Disposal has been recently used as the most advanced method for residue disposal. The residue from the mud washing circuit is filtered to dry cake (>65% solids). It is assumed that the material is also washed on the filter with water or steam to recover soda and minimize the alkalinity of the residue. The residue cake is carried by truck or conveyor to the disposal sites, where it is dumped without treatment. There is no significant further deliquoring once the residue has been delivered to the storage area.

These factors distinguish it from the dry stacking (above), in which the mud is thickened to a 50-55% solids paste and pumped to the storage area, where it is further deliquored to produce a dry stack whose ultimate solids content is around 78%.

Figure 1.2 - Evolution of storage practices at 17 refineries currently in operation (CSIRO)

The figure 1.2 shows he distribution of the broad categories of residue methods for 17 refineries, which the information could be found in the public domain for each of the years nominated.

2.0 Alunorte's DRS Concept

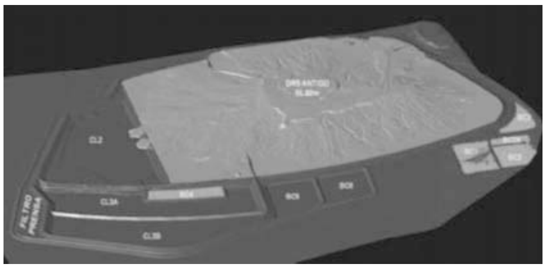

Figure 2.1 – DRS1 occupation by October 2011

Alunorte uses the dry stacking technology which is considered as state of the art for bauxite residue disposal. The concept used at Alunorte was developed by the German company Giulini Chemie Gmbh and reviewed by Alcan.

Alunorte was one of the pioneer refineries to utilize Drum filters to dry red mud disposal. The red mud disposal area consists of the DRS-1, including old cells, CL-1, CL-2, and CL-3 (under construction).

The red mud generated during the alumina extraction process during digestion is separated and washed via thickeners and mud washers in counter-current mode. The mud slurry from the last washer in Area 28 is directed to mud filtration in Area 34, where it is filtered by Drum filters.

The mud filtration Area (A-34) consists of 20 Drum filters distributed in 7 lines which receive the mud slurry from the last washers from lines A,B,C, and D. Mud resulting from MRN and MPB bauxite are processed separately with dedicated filters and common spare. Process condensate is used for final washing of the mud cake.

The mud cake generated from the filters is discharged into trucks that transport the mud from Area 34 located at the Refinery to the Red Mud Deposit (DRS-1) in the Area 54. The trucks dump the mud into the DRS-1 cell at the top of a platform.

A minimum 40m distance is maintained between the farthest distance reached by the mud and the limits of the cell wall, only decanted water from the mud solids and rainfall is allowed in that area. A free board of at least 1 m is also kept to prevent overflow. Approximately thirty-three (33) trucks transfer the mud from the Refinery to the DRS area 24 hours a day.

The location of mud dumping from the cell platform depends on the available free board of the walls in the direction of mud dumping, on the degree of homogeneity of the mud surface, and finally, on the need to advance the platform as mud fills up near the platform.

The moisture content of the mud cake discharged by the Drum filter does not allow trucks to be used to compact the mud. There is no sufficient time for the mud to dry until another batch of mud is poured again; compaction of the mud using trucks is not possible.

The existing residue disposal area consists of the old DRS-1 and new cells, the surrounding channel that collects the runoff water, the runoff collection ponds and the pumping and piping system that direct the water to the water treatment station (Area 82). As old cells are filled up, new cells are added to the DRS deposit. CL-1 cell lifetime is running out, and CL-2 started operations in 2011. CL-3 is under construction and is expected to start operations in 2013. The Figure 2.1 shows the occupation of the DRS-1 by April 2012, the CL-2 and the CL-3 are predicted for the future.

For the production target of 6.3 mtpy of Alumina, Alunorte generates around 4.4 million tons of bauxite residue per year (dry bases), as can been seen in the Table 3.1.

In Figure 2.1 the layout of the existing bauxite residue disposal area. The DRS is located on the south of the alumina plant, approximately 1,600 m, straight, and 2,500 m from the effluent treatment plant, with an operational area of 215 ha.

As old cells are filled up, new cells are added to the DRS-1 deposit. CL-1 cell lifetime is running out, and CL-2 is ready to start operations. The cells 2 and 3 have dimensions of around 1,000 x 400 m each.

3.0 New Technology for Red Mud Filtration

There is an opportunity to increase the solids content of the mud cake discharged by the Mud Filtration Area by 25-30% with the replacement of the existing Drum filters (60-65% solids) by press filters (75-80%). A lower moisture content result in a mud cake with higher solids content, which reduces the mass and volume of wet mud to be transported and distributed into the DRS cells for the same mud generation rate based on current production rate.

Test work has been done by Alunorte with various press filter manufacturers using slurry of last washer underflow which processes MPB bauxite residue. MBP bauxite was used because it is finer than MRN bauxite, and therefore represents the worst case scenario. The resulting mud cake solids content ranged between 75 to 80%.

The introduction of press filters for mud filtration brings several benefits which are described below:

3.1 Increases Capacity of Red Mud Storage due to Solids Content Increase in the Cake.

The mud storage capacity per unit volume of the DRS area can be increased as it reduces the volume of wet mud to be stored in the DRS as shown in the Table 3.1.

Table 3.1: Equivalent wet mud cake volumes produced by Drum and Press filters (x1000)

Parameter	Unit	Value	Notes
Dry Mud	dry t/year	4,382	For 6,2 mtpy Al_2O_3 production rate.
Wet Mud @ 60% for Drum filter	t/year	7,304	
	m^3/year	4,395	Wet mud density in the deposit is 1.662 t/m^3
	wet m^3 / dry t	1	Wet mud volume per ton of dry mud.
Wet Mud @ 78% for Press Filter	t/year	5,618	
	m^3/year	2,710	Wet mud density in the deposit 2.073 t/m^3
	wet m^3 / dry t	2	Wet mud volume per ton of dry mud.

From Table 3.1 it can be inferred that there is approximately 62% reduction in the volume of wet mud produced by the Press Filter per unit mass of dry residue generated. In other words, for the same volume of storage residue area, the life time of the respective DRS area can also increased in 30% compared to current mud disposal system.

The life cycle of the DRS can also be increased with the higher height of the pile as demonstrated in the following item.

3.2 Mud Storage Capacity Increase due to Angle of Repose

The angle of repose of the mud area can be increased from the present 2°30' to 23° based on stability studies of the deposit. This new angle of repose will also be the final angle of the residue area at closing, which represents additional benefit. The new angle of repose directly impacts the mud storage capacity per unit area of the DRS. A comparison between current and future storage volume per unit area for the DRS-2 is shown in Table 3.2.

Table 3.2: DRS-2 Volume Storage Capacity Increase (x1000)

DRS	Area (ha)	Angle of Repose	Volume (m^3)	Storage Volume per unit area (m^3/ha)
DRS-2	141.57	2° 30'	24,432	172
	141.57	23°	62,279	434

The storage volume capacity increase per unit area is approximately 2,5 times, which directly impacts the deposit lifetime when angle changes from 2° 30' to 23°.

The capacity increase of the new DRS is even larger when compared to the storage capacity of dry mud per unit area as it directly impacts the lifetime of the respective DRS as shown in the Table 3.3. The storage capacity of dry mud per unit area is increased by 2,9 which also means that the life time of the deposit is increased by 2.9.

Table 3.3: DRS2 Dry Mud Storage Capacity Increase (x1000)

DRS	Area (ha)	Angle of Repose (°)	Dry Mud (t dry mud)	Storage Volume per unit area (t dry mud/ha)	N° of years of Refinery residue production (years)
DRS-2	141.57	2° 30'	28,431	201	6.4 5
	141.57	23°	81,534	576	18.6 5

3.3 Existing DRS-1 Cells Mud Storage Capacity Increase with Press Filter

The implementation of the press filtration method will also impact in the extension of the life cycle of the DRS-1 where the final angle of repose can be increased from the current 2.5° to 5.8°. The figure 3.1, 3.2 and 3.3 shows the differences between the final DRS-1 configurations for the drum filter, drum + press filter options and DRS-2 final configuration only press filter.

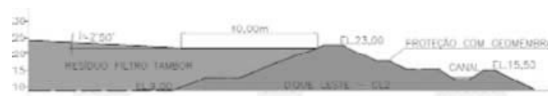

Figure 3.1 – DRS-1 / CL-3 final configuration with Drum filter only method

Figure 3.2 – DRS-1 / CL-3 final configuration with Drum + Press Filter methods

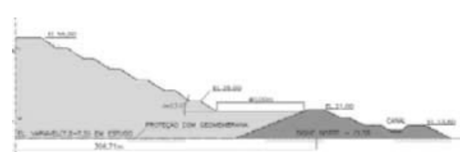

Figure 3.3 – DRS-2 final configuration only press filter

3.4 Runoff water from DRS Mud Disposal

The mud cake solids increase about 15 to 18% will also reduce the water runoff resulting from mud deposit after mud disposal. Current DRS's show a gradient profile of solids content with depth between 68 to 85%.

Disposing the red mud at higher solids content of 78% will eventually reflect in less runoff water as the solids concentration profile would be smaller. Less runoff water would mean less water from the runoff collection ponds to the Water Treatment Station in Area 82.

4 Residue Disposal Capabilities

Considering the volume available in the residue deposits for each scenario (scenario 1 – Drum Filter; scenario 2 – Press Filter) studied and a residue generation rate (dry basis) of 4,702,970 t/year, table 4.1 shows the disposal capability of each deposit, i.e., the ratio between total mass deposited in each deposit and the respective footprint.

Scenario	Residue Deposit	Footprint (ha)	Total mass deposited (dry basis) (tx1000)	Disposal capability (t/ha)
SCENARIO 1	DRS1	243,33	19.519	80.215
	DRS2	141,5	27.928	197.373
	DRS3	185,45	43.452	234.307
	TOTAL	570,28	90.899	511.895
SCENARIO 2	DRS1	243,33	55.045	226.219
	DRS2	141,5	83.457	589.807
	DRS3	185,45	129.226	696.827
	TOTAL	570,28	267.730	1.512.853

Table 4.1 – Residue disposal capability

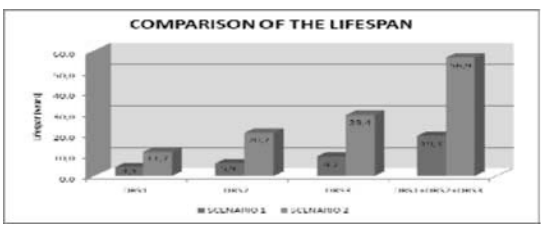

Figure 4.1 – Comparison of the lifespan of the DRS-1 DRS-2 and DRS-3 systems

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