

## **The application of single stream digestion at Votorantim Metais/CBA refinery**

**Thiago Franco<sup>1</sup>, Roberto Seno Jr.<sup>2</sup>, Anderson Duck<sup>3</sup>, Alexandre Freitas<sup>4</sup>**

1. Process Engineer,

2. Bauxite and Alumina Technology Development Manager,

3. Process Engineer,

Votorantim Metais/CBA, Alumínio SP, Brazil

4. Process Engineer,

AJP Engenharia, Rio Verde GO, Brazil

Corresponding author: thiago.franco@vmetais.com.br

### **Abstract**

Environmental sustainability has had a relevant position in guiding new developments and influences in the industry to make better use of energy. New energy efficiency targets in Bayer process plants have been the driving force to improve heat transfer processes and its supporting maintenance activities. The Bayer digestion process is an important area in the refinery in terms of energy consumption, where different technologies may be applied. These technologies might be atmospheric digestion, sweetening process, double (dual) stream and single stream digestion. Currently, The Votorantim Metais-CBA refinery utilizes the dual stream digestion process, however, studies are being conducted to convert the digestion area to a single stream process. This paper presents the challenges and energy saving benefits of the application of this technology.

**Keywords:** Bauxite digestion; single stream; energy efficiency.

### **1. Introduction**

Companhia Brasileira de Alumínio (CBA), of Votorantim Group, is located in Alumínio, 74 km from São Paulo city, and it is the biggest integrated aluminium plant in the world, as it owns the alumina refinery, smelter, casthouse and downstream process at the same site besides the mines in Minas Gerais and Goiás states. CBA started its operation in 1955 and is part of the Votorantim Group, one of the largest Brazilian conglomerates operating in the industrial market segment. CBA is the leading Brazilian producer of primary aluminium. The alumina production capacity of the plant is 0.9 Mt per year, using a traditional low temperature Bayer Process.

### **2. Energy**

Energy consumption is one of the largest costs in alumina refineries, reaching 20 to 40 % of total alumina production cost. Strict energy efficiency targets are driving alumina refineries to improve heat transfer processes and related maintenance activities due to the economic and environmental impact. Votorantim Metais-CBA has been conducting projects to reduce their energy consumption. These projects include paste heaters recirculation, boiler and calciner economizers, fuzzy logic controllers in digestion units, new live steam heaters in evaporation unit, along with other opportunities.

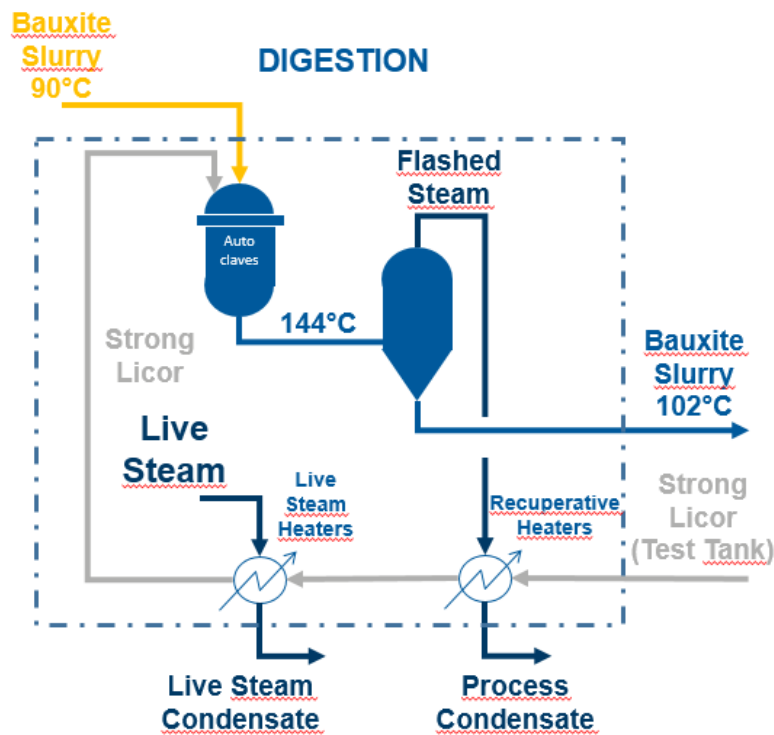
The Digestion process is an important area in the refinery in terms of energy consumption. Regarding this, the conversion of dual stream digestion to single stream is being studied. Many alumina refineries in the world had converted their digestion units to single stream or had already been designed this way. The table below shows some examples of refineries that use single stream digestion and its heat exchange technology.

**Table 1. Single stream digestion refineries.**

Refinery	Heat Exchanger
Hindalco	Shell & Tube
Worsley	Shell & Tube
Jamalco	Shell & Tube
Alumar	Shell & Tube
Sherwin	Shell & Tube
Ma'aden	Tubular
Yarwun	Tubular
Stade	Tubular

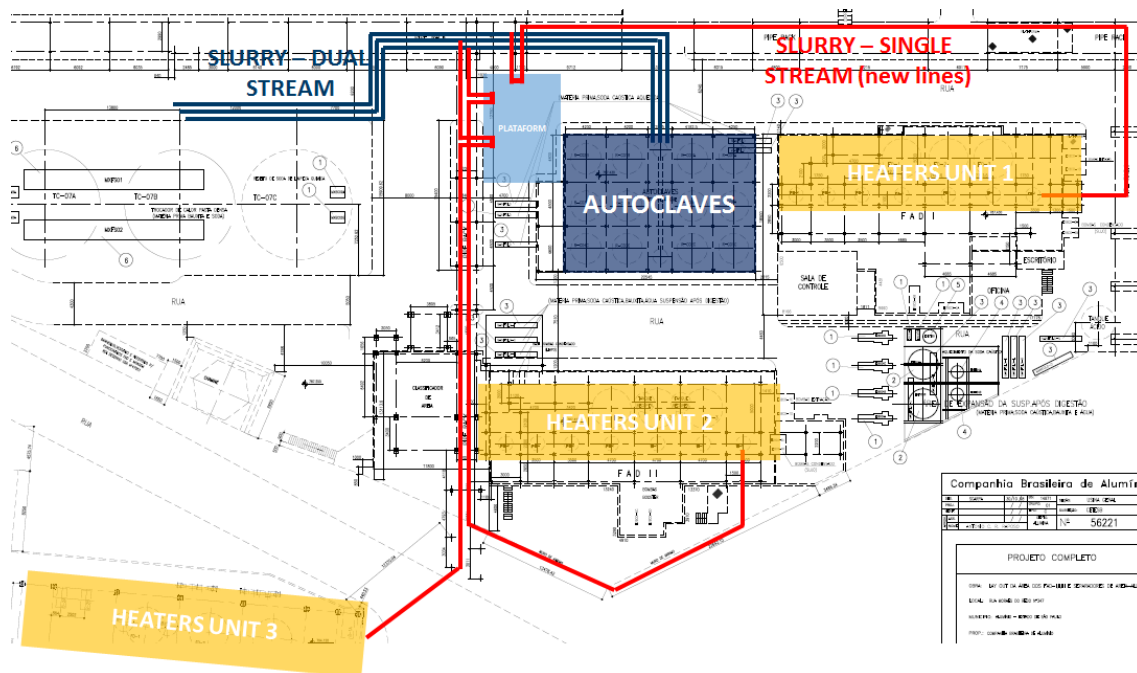
**3. CBA digestion process**

The CBA Bayer Process digestion unit has three lines, each one with three autoclaves that receive bauxite slurry and heated strong caustic liquor. In the autoclaves the ore's alumina trihydrate ( $Al_2O_3 \cdot 3H_2O$ ) is dissolved under high pressure and temperature. Then, the autoclaves discharge flows to flash tanks in which the temperature is reduced to avoid boiling in the atmospheric decanters. The flashed steam is sent to recuperative heaters, where the strong liquor from the test tanks is heated. Afterwards, the strong liquor flows to live steam heaters and soon after to the autoclaves. The live steam flow to the live steam heaters is controlled according to the autoclaves' set point temperature (close to 144 °C). Figure 1 represents the process mentioned above.



**Figure 1. Dual stream digestion.**





**Figure 3. Digestion units' layout.**

The necessary modifications for single stream conversion at the CBA refinery will be:

- Install new slurry lines, insulation, valves, drains and fittings to new tie-in points prior to first recuperative heater in each digestion unit, including some platform modifications.
- Install new spent liquor booster pumps prior to first live steam heater digestion unit 3. This will include nominally new motors, gland water supply and spent liquor pipe work.
- Add control to limit slurry and caustic liquor pumps' speed, according to pipe and equipment specs.
- Upgrade instrument materials in spent liquor lines, for when solids are added.
- Relocate injection of lime slurry to a point in the spent liquor line prior to entering the first autoclave.

### 3.2. Project phases

#### a. Phase 1

The single stream digestion conversion will be made in three steps. In the first one, slurry will be injected prior to the last live steam heater in the digestion unit 1 to provide information on heater performance, operation and maintenance requirements. So, at the end of this phase it will be possible to determine corrosion and erosion conditions in the heater tube and consequently to calculate the related operating costs more accurately.

#### b. Phase 2

The digestion unit 1 will be fully converted to single stream. In this step, it will be a learning phase for the process and operation teams in which it will be possible to evaluate the process parameters and hydraulic conditions, before converting other units.

### **c. Phase 3**

Units 2 and 3 will be converted. At the end of this phase it is expected to have all the units operating with single stream system, maximizing the steam savings in digestion.

### **4. Results and benefits**

A simulation of the digestion units shows that improved thermal efficiency has a potential to increase the heater performance profile, resulting in more than 7 % reduction in steam consumption. Also, the excess flashed steam from the digestion units used in the pre-desilication contact heaters will be reduced, eliminating the necessity to evaporate this introduced water from the process.

Other estimated benefits are the elimination of anti-scaling product and the reduction of acid cleaning in the heaters. With slurry flow inside the tubes (single stream case) scaling is reduced, and so the frequency of acid cleaning also reduces by ~ 30 %.

### **5. Conclusion**

Single stream digestion is a known technology used in many refineries and in the context of economic competitiveness and environmental awareness it is one of Votorantim Metais-CBA projects in development. Besides the steam savings in order of 7 %, it also has many benefits including reduction of acid cleaning and of anti-scaling product in the heat exchangers and reduction of introduced steam in the process (contact heater in pre-desilication that uses the excess of flashed steam from the digestion units). Simple modifications will be required to the plant that in the worst scenario studied will bring a payback of 3 years.

### **6. References**

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