Gardanne Refinery – Lessons Learned on Temporary Shutdown of Bayer-type Process

Laurent Guillaumont[1], Valérie Esquerre-Cacha[2] and Serge Campanaro[3]
1. Technology Director
2. Technical Department Manager
3. UODP and Calcination Production Manager
Alteo Alumina, Gardanne, France
Corresponding author: laurent.guillaumont@alteo-alumina.com
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Abstract

The Gardanne plant, cradle of the Bayer process, transformed itself in 2022 by suspending digestion of bauxite after nearly 130 years of operation, in response to local environmental constraints. As the focus continues to shift towards specialty alumina, controlling precursor quality remains a major challenge, leading the plant to maintain a variation of the Bayer process as hydrate dissolution/re-precipitation process to control quality, known as the UODP (Unit Operation of Dissolution and Precipitation) process. On the other hand, the variety and specificity of our markets, which can lead to significant upsets in volume throughout the year, demand great flexibility in terms of production rates and quality control.

In the second half of 2023, a sharp drop in demand forced a drastic reduction in production, and whereas the high price of energy, Alteo Gardanne decided to stop production of the UODP process for several weeks on two occasions to limit stocks while minimizing energy consumption. This paper reviews the preparation and anticipation of risks, the operating conditions of these shutdowns and their consequences on the quality and the operations, which were generally very well controlled. These two shutdowns demonstrate that, under certain conditions, a Bayer-type process can be shut down without any major risk to hydrate quality.

Keywords: Hydrate digestion, Hydrate quality, Shutdown, Energy saving.

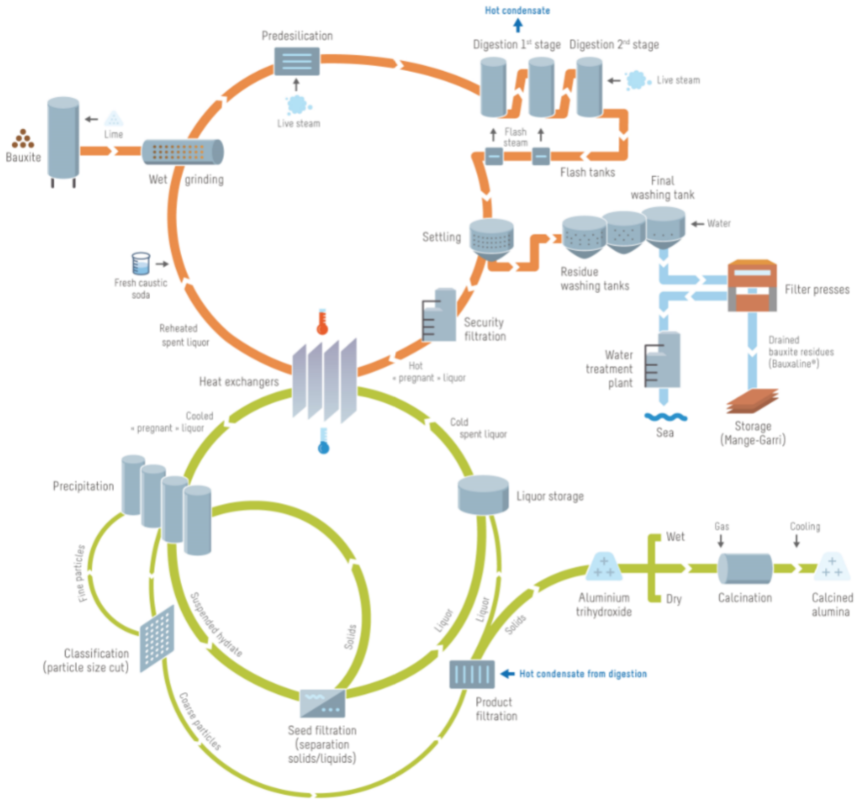
1. Alteo Transformation

1.1 Nature of the Change

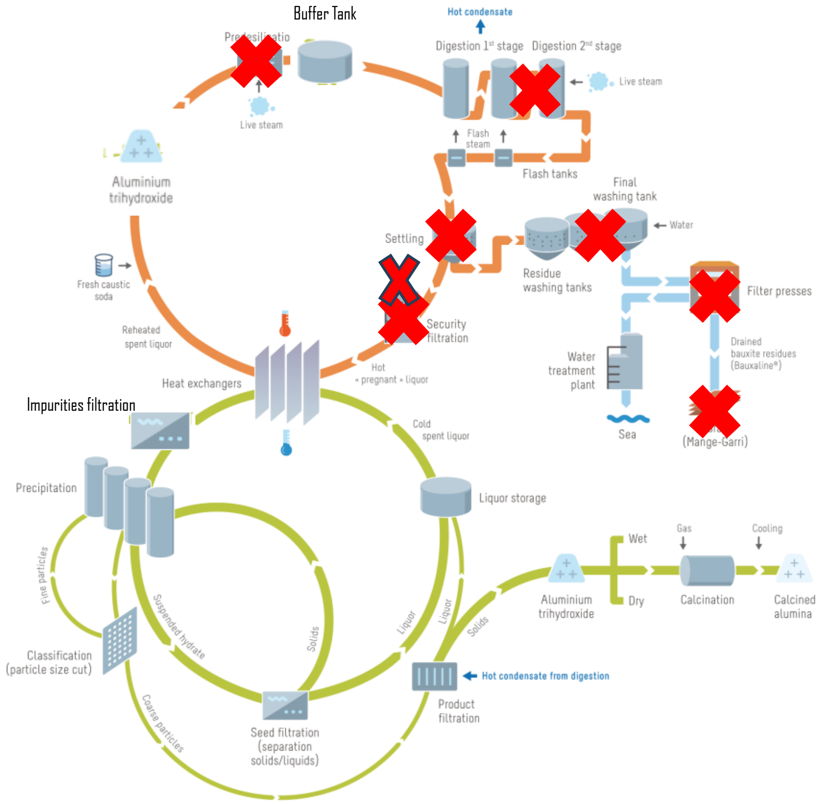
As a reminder, the core steps of a Bayer process are:

- To dissolve alumina hydrate from bauxite, using concentrated caustic soda at high temperature in sodium aluminate liquor;
- Discard the insoluble material, known as bauxite residue or red mud via a counter-current washing circuit;
- To precipitate alumina trihydrate in a controlled manner from sodium aluminate liquor, decreasing both temperature and caustic concentration, and to separate this solid from the liquor.

The new process flow sheet, using commercial hydrate as a raw material instead of bauxite, has been simplified as this feed stock does not generate any solid residue to be washed and discarded: settling and washing residue areas have thus been definitely shut. Other parts of the process (digestion and precipitation) have been conserved, ensuring the production of the same product for the calcination step. The name "Unit Operation for Dissolution and Precipitation" (UODP) has therefore been put forward for the simplified process and will be used throughout the text. A schematic overview of the simplification is shown in Figure 1.



Bayer process with bauxite



New UODP process without bauxite

Figure 1. Schematics of Bayer process vs UODP process.

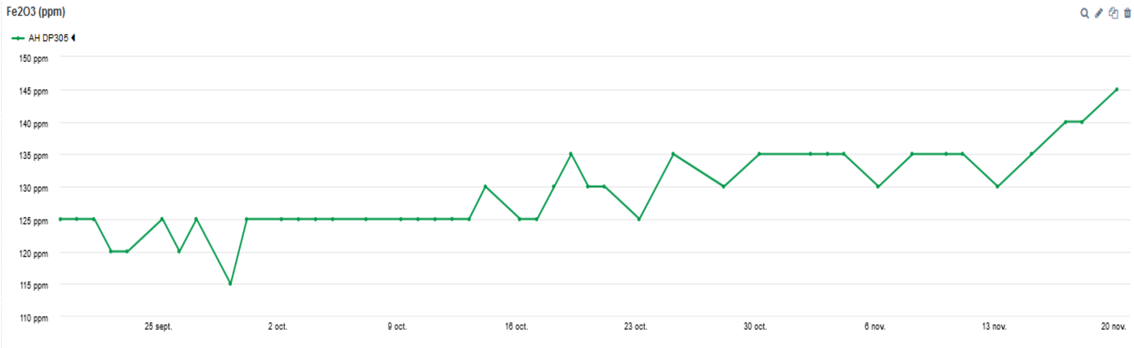


Figure 17. Second shutdown results: iron in hydrate (scale of Y-axis [110-150 ppm]).

The liquor has also shown a marked increase in chromium, as shown by the trend in Figure 18. This suggests that this contamination is linked to wear in the piping, particularly in the valves of the circuit used to heat the slurry.

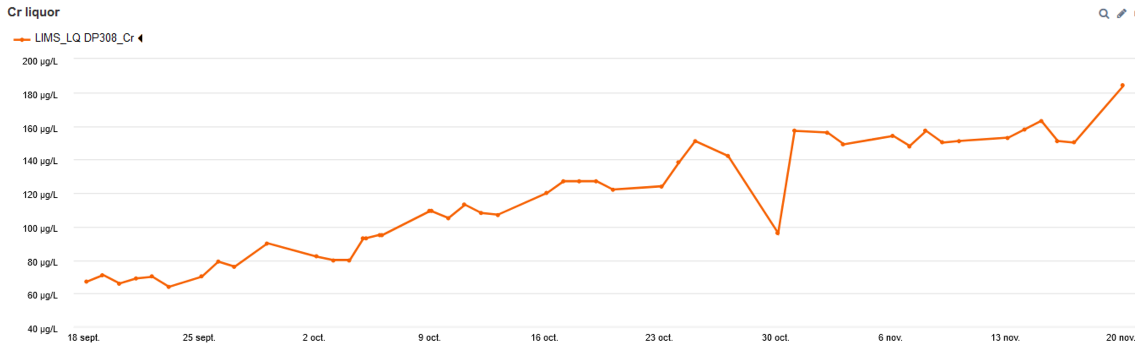


Figure 18. Second shutdown results: chromium in liquor (scale of Y-axis [40-200 µg/L]).

7. Conclusion

Before deciding to launch these prolonged shutdowns of the UODP process, a number of questions had to be addressed. Quality control was of prime concern, particularly particle size control and silica precipitation. Laboratory tests enabled us to eliminate concerns due to silica and to establish the necessary conditions for oxalate control.

By operating at temperatures above 50 °C, with an intermittent heating of the hydrate slurry, ensuring that any cooled hydrate suspension is not mixed, and adapting operational routines to keep the precipitators running smoothly, we have not encountered any problems linked to the risks we had identified. On the other hand, we had not anticipated the rise in iron content due to wear on the equipment when the slurry is reheated.

The initial conditions, particularly in terms of impurities in the pregnant liquor, are a decisive factor in the success of this type of shutdown.