Integrated Water Balance Modeling of the Alunorte Refinery

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Abstract

The alumina industry is investing in sustainable water management programs to optimize water usage, considering environmental and economic aspects. As one of the world's biggest alumina refineries, Hydro Alunorte's process involves a complex integration of water flows, involving raw water, rainwater, condensate, steam, liquor, evaporation, and water from a bauxite slurry pipeline. Most of those flows permeate the seven process lines of the three operating plants, bringing one more challenging aspect to the refinery's water management. This paper describes the development of an integrated water balance model used to assess and support a circular water management program within the alumina refinery. The model was built using flowsheets to illustrate key process areas of the refinery, and calculating average flowrates based on inputs supplied by the user; its interface also offers flexibility for the development of scenarios and sensitivity analysis, to simulate different conditions and measure the impact of critical process variables. The integrated water balance provided a clearer understanding of the refinery's current operating and process conditions, and also introduced the possibility to identify improvements in the plant's water management, with a focus on reducing water, condensate and liquor waste, loss of soda and energy, and effluent treatment costs. Several opportunities to improve the plant's water management were assessed, quantified, and categorized within two main courses of action: 1) reduction of industrial water consumption and 2) use of alternative sources. The integrated model is a powerful tool that can be used to support the identification, quantification, and development of strategies to reduce water catchment and effluent generation rates towards a more circular water management program.

Keywords: Water management, Integrated model, Circular water, Hydro Alunorte.

1. Introduction

Water is an essential natural resource for life on Earth, so its increasing consumption is a global concern. In Brazil, according to the Brazilian Water Resources Conjuncture Report, carried out by the National Water Agency (ANA) in 2021, its use occurs mainly for irrigation (50 %), human supply (25 %), industrial consumption (9 %) and others (16 %). Industrial consumption can be classified into extractive and processing; Mining is the extractive activity with the highest water consumption in Brazil. Among global water consumption, industries account for about 22 % and, according to the National Confederation of Industry, this demand is expected to increase about 400 % by 2050 [1].

Inserted in the processing context and integrated with the extractive activity of bauxite, the alumina industry requires a significant amount of water resources within its production chain. Some of the activities consuming the majority of water are steam production for the digestion process; preparation of caustic soda, flocculant, and lime solutions; residue and hydrate washing. Recognizing the importance of water as a natural resource, alumina companies across the world are investing in the development of sustainable water management programmes, aimed at

intensification of recycling and reutilization of water, and therefore the reduction of non-recycled resource use [2].

As one of the world's biggest alumina refineries, Hydro Alunorte has an important role in this trend towards increased sustainability. The refinery receives bauxite from two different sources, one of them in the solid form, including moisture, and the other from a slurry pipeline. The bauxite is refined in seven process lines of the three operating plants; although mostly parallel, the seven lines have interconnection points, including some shared equipment across the plants, which adds to the complexity of the process. Involving the integration of raw water, rainwater, condensate, steam, liquor, evaporation, and water from the bauxite slurry pipeline, the water management of the refinery is achieved by the regulation of four major circuits:

- Bayer Process and condensate storage;
- Industrial water catchment and distribution;
- Bauxite pipeline receival and dewatering;
- Industrial and pluvial drainage and effluent system.

In Figure 1, a schematic of the circuits is presented, considering the main flows involved and their interconnections.

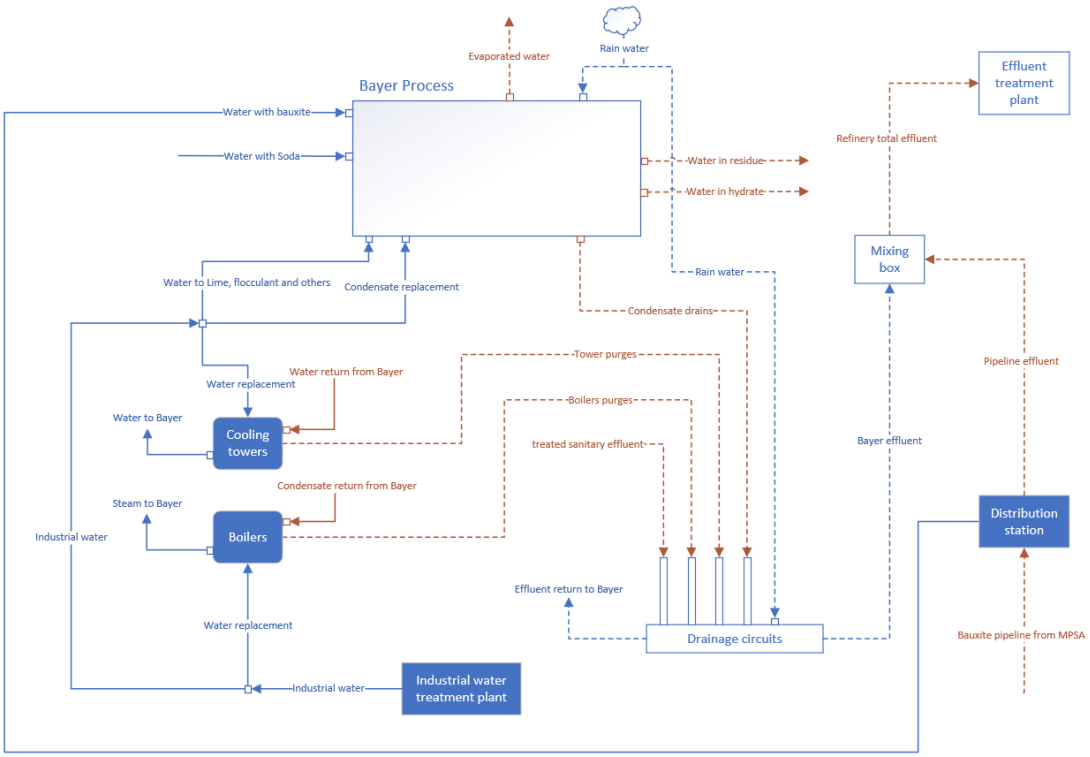

Figure 1. Hydro Alunorte integrated water balance block flow diagram.

Hydro Alunorte promotes daily monitoring meetings, in which water balance issues are discussed and actions are defined. However, as many relevant inputs and outputs are not accurately measured, and a water balance model is not available, the decision-making process is mostly based on the overall volume variation of the refinery, which results in the implementation of corrective measures that do not take into account the root cause of deviations, frequently not known.

Since these decisions impact the water catchment and effluent generation rates in all processing plants of the refinery, a better understanding and quantification of the main flowrates involved is important. In this context, the development of a water balance is an important step to optimize the

6. References

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