AA14 - The Role of the Alumina Refinery Laboratory: Monitoring, Optimisation and Control of the Bayer Process

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Abstract

This paper reviews the role of the laboratory in an Alumina Refinery. The key function of the laboratory is in the monitoring of process streams to ensure production is maintained and is essential for quality control purposes. Analytical data on the process streams are constantly fed into a process control system which then automatically makes decisions on the optimal flow conditions in the refinery. During the circulation of liquor throughout the refinery it is imperative to have a constant quantitative understanding of each individual process unit. The equipment used, and the wide variety of routine and non-routine tasks that are conducted are examined. The laboratory also acts in a service capacity to solve a wide range of operational problems, helping reduce operating costs, and improving the overall efficiency of the refinery. Small incremental improvements in a large alumina operation can deliver significant financial benefits when measured over a year. Selected examples of the laboratory's contributions are briefly described. The importance of routine examination of flow streams is critical and helps guide planned and preventive maintenance. Monitoring short and long-term chemical trends in liquor streams can help identify existing and long-term process related issues.

Keywords: Ma'aden, laboratory, quality, Metrohm, alumina.

1. Introduction

It is the quality and production cost of the final product that will determines the success of any alumina refinery. The target is a high-quality alumina product made at a cost lower than its competitors. For this reason, the alumina laboratory provides an important service and support role in process control and monitoring and helps deliver a pure product to the customer.
Simplistically the Bayer process solubilizes alumina from a bauxite, then an alumina-rich liquor is separated from the inert solids. Alumina is then concentrated from the liquor by a seeding procedure. The whole process can be summarized in a simple equilibrium reaction. The forward reaction represents alumina dissolution, and the backward reaction represents seeded precipitation and the regeneration of NaOH.

$$Al_2O_3 + 2\,NaOH \underset{\text{Precipitation}}{\overset{\text{Digestion}}{\rightleftharpoons}} 2\,NaAlO_2 + H_2O$$

In a modern Refinery this chemical reaction is scaled-up and engineered to a size that usually delivers at least 3000 to 6000 tonnes of alumina per day. To deliver a profit the refinery is operated continuously with minimal downtime and operated to deliver the design tonnage. On-line measurements alone are not sufficient for operational purposes and the laboratory must provide other essential analyses to complement the on-line process data. The laboratory also acts as a support and back-up for calibrating and checking the on-line instruments which can malfunction and give misleading results through scaling, corrosion or abrasion. Chemical data on process streams allows calculations to be made on digestion recoveries, flow rates, mass balances, precipitation yields, etc, and enables the whole operation to be continually adjusted and corrected. Without routine chemical analyses the refinery using the automated process system would fail. The analytical data on process streams is built-up into a historical record of operational performance which can then be used for comparison of trends and for trouble shooting and optimization purposes.

Figure 1 identifies the wide variety of roles that the laboratory provides in collaborating with engineers and customers in cost reduction and quality control. Table 1 reviews some of the technical investigations that the laboratory is routinely involved with.

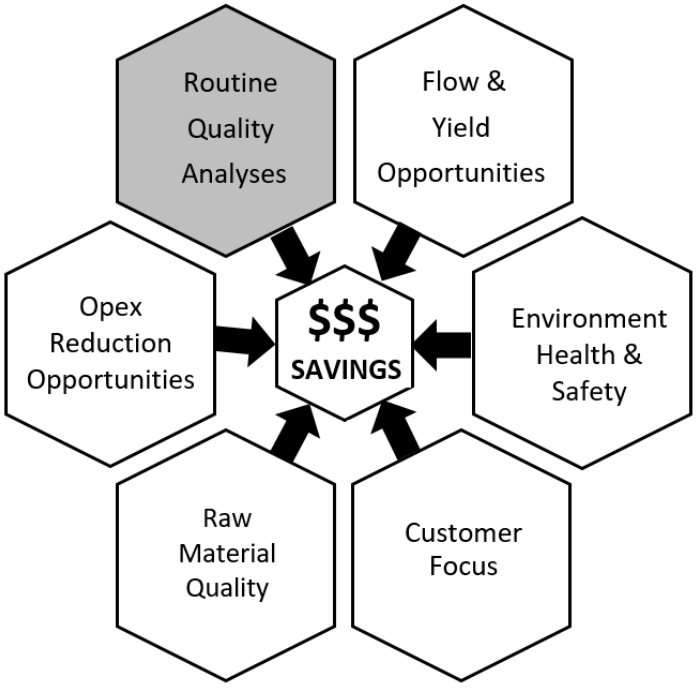

Figure 1. Role of the laboratory for control of operations and in delivering incremental improvements.

Table 1. Main activities within each focus area.

Theme	Activities
Customer Focus	Ensure product (SGA) has the correct specification (particle size, composition, impurities). Supply hydrate particle size and quality, Collaboration, trouble shooting and problem solving, Liaison with smelter laboratories Liaison with reagent suppliers and monitoring lime & caustic quality Liaison with mine and refinery on blending and on operational details. Identifying other uses of products and grow specialty bauxite and alumina uses. Supply MSDS documents, Coordinate sample shipments.

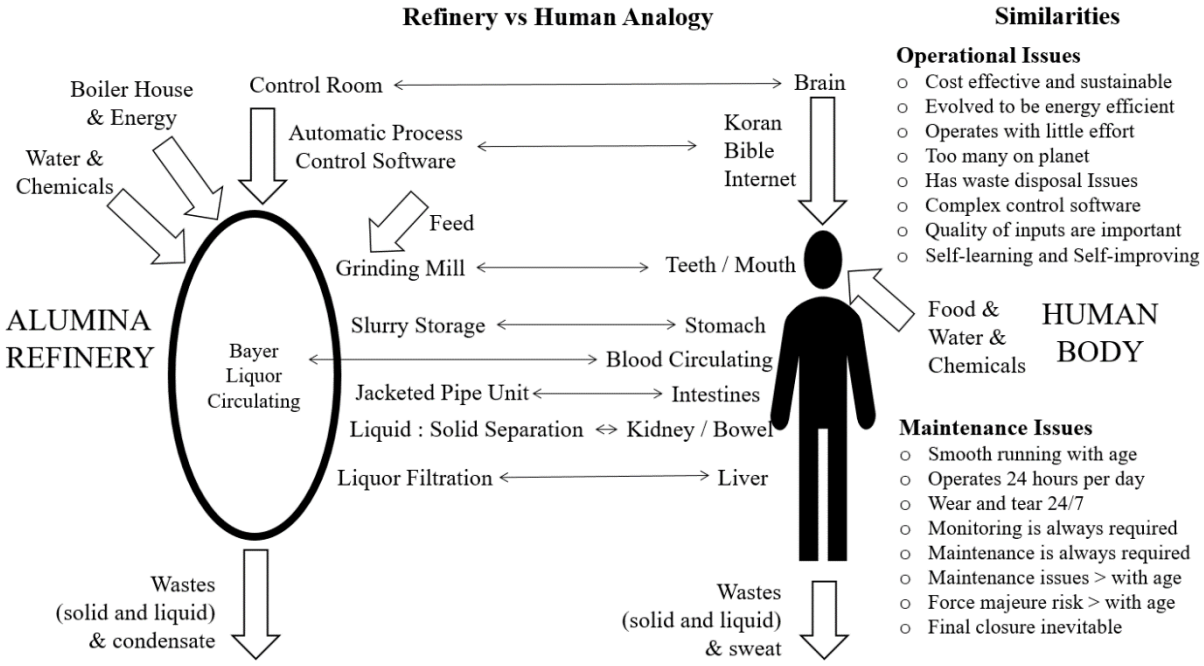

Figure 3. Constant monitoring of health helps guides preventative maintenance.

12. Conclusions

A modern alumina refinery requires a laboratory to supply it with analytical data on a wide range of process streams. The data allows monitoring, optimization, control and adjustment of the process plant. The laboratory has the capability to ensure and certify the quality parameters for the mine and alumina refinery. Compositional trends must be fully understood, and operational changes selected. The idea of process streams being perfectly constant in composition is not realistic in an operating alumina refinery as small changes in bauxite quality can readily take place and the refinery must adapt to these changes which in turn creates further variations throughout the whole plant. Variability may be due to small changes in bauxite: size, hardness, grade, mineralogy or impurity content. These in turn cause changes in liquor composition, fluid flow-rates, settling-rates or in liquor impurity composition over time. For these reasons the laboratory has an influential role to play in analyzing samples and monitoring the chemical trends in the refinery operation.

Focused research projects with engineers and laboratory personnel can contribute towards incremental improvements on the plant. Such improvements deliver important cost savings and help justify laboratory costs and the continual need for the replacement of equipment. Flexibility and the ability to provide data 24 hours a day is the key for a successful laboratory service. The faster the problem can be solved the better for plant availability, liquor flow, precipitation yield, production, and cost savings.

13. References

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