

Application of Data Analytics Tools for Increasing Liquor Productivity in Alumina Refinery

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Abstract



Data analytics has emerged as a major technology enabler for the manufacturing industry to achieve operational excellence. Digitalization is an important pillar in the strategy deployment of refineries with the emergence of the concepts on Internet of Things, Robotics, Digital Twins and Block chain helping organizations accelerate their performance with higher customer engagement and lower operating costs.

Although, cost competitiveness was a major driver for the alumina refineries earlier also, this has gained a major focus with the stringent regulations on the decarbonization and net carbon input. Improvement in liquor productivity has a major impact on operations leading to substantial savings in power consumption, and reduction in net carbon.

Improvement in liquor productivity involves optimizing the hydrate precipitation process, as well as strengthening the precipitation growth & cooling circuit, which are very capital intensive. However, application of data analytics concepts can help in identifying the optimized conditions for increasing liquor productivity, without going into major technological upgradations.

In this present development work, process data from the precipitation section was analysed using data analytics tools to arrive at an optimum condition for increasing liquor productivity. Systematic process was put into place involving the following major steps viz.

1. Data Review & Classification
2. Data Cleaning
3. Capability & Normalization and
4. Predictive Analysis

The predictive model developed for liquor productivity was deployed for arriving at operating conditions & implementing by process tweaking to achieve the desired process conditions. This led to an increase in liquor productivity from ~ 73 g/L to ~ 78 g/L consistently. Increase in liquor productivity led to substantial savings in steam consumption for the refinery.

This paper presents a detailed process of model development, its application, and the benefits in terms of operational excellence for the alumina refinery.

Keywords: Alumina refinery, Bayer process, Data analytics

1. Introduction

Alumina Industry, at present, is at the cusp of embracing digitalization as an enabler for achieving operational excellence for the refinery. Refineries are undergoing digital transformation on operation and maintenance, changing from manual and paper-based tasks to new ways of working based on digital automation and software. Alumina refineries are deploying digital operational infrastructure, with wireless sensors, purpose-built data analytics, industrially hardened tablet computers for digital document and software forms, location awareness for personnel and assets, and connected devices using cloud computing technology and Industrial Internet of Things (IIoT) in order to enable these new ways of working, [1].

Application of data analytics for process improvement in alumina refineries has gained a major importance in the recent years with the emergence of digital twins, with predictive and prescriptive models especially for digestion and calcination areas of the refinery, leading to substantial savings in specific energy consumption as well as the total net carbon input. Successful application of data analytics in digital twin for predicting the air flow & mass flowrate in a calciner has been successfully demonstrated, leading to ~ 25 % reduction in fuel consumption and consistent product quality. In addition to the digital twin development, which requires mapping of the measurement points and deployment of soft sensors for its implementation, data analytics tools can also be used to arrive at a set of optimized process conditions through predictive models. One such important application of predictive analytics is for estimating the conditions for increasing the liquor productivity in alumina refinery. Using these analytics as a tool, historical process data on precipitation area can be analysed and a predictive model can be built in understanding the optimized conditions for increasing the liquor productivity in the refinery without going into major technological upgradations which are highly capital intensive.

Here, an attempt has been made in developing a robust model for predicting the liquor productivity using a set of optimized conditions as an input. Hence, based on the outcome of this model, a set of process conditions are implemented in the refinery with minor tweaking of the process, leading to an increase in the liquor productivity from 73 g/L to 78 g/L on a consistent basis. Increase in liquor productivity led to substantial savings especially in the steam consumption.

This paper presents a detailed process of model development, its application, and the benefits in terms of operational excellence for the alumina refinery.

2. Conceptual Approach

Liquor productivity in alumina refinery is dependent on the following parameters viz.

1. Caustic concentration of the LTP [2]
 - a. Higher the caustic concentration of the liquor, higher will be the alumina holding capacity of the liquor under given conditions of temperature.
 - b. Higher caustic, however, has a negative impact on the soda content in hydrate.
2. Alumina / Caustic ratio (A/C) of the LTP
 - a. Operating at a higher A/C of LTP (albeit depending on the solubility conditions of liquor), increases the driving force for precipitation thereby increasing the liquor productivity
 - b. Operating at a higher A/C also increases the supersaturation at start of precipitation and increases the rate of precipitation.

agglomeration & growth conditions and total residence time in the precipitation area, thereby resulting in an increase in the liquor productivity to 78 g/L consistently. This increase in liquor productivity resulted in substantial savings in steam and power consumption for the refinery.

6. References

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