Enhancing Energy Efficiency in Alumina Refineries through Motor Underload Current Monitoring

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Abstract

Electric motors are indispensable in alumina Refineries, consuming a significant portion, typically 70 % or more, of the total electricity. Despite various energy-saving initiatives like the use of Variable Frequency Drives (VFDs), energy efficient motors, power factor improvements, etc., there is still room for improvement. The operational hours of small and unmonitored motors remain largely unaddressed which ultimately increases the specific energy. Surprisingly the number and utilization of small motors (15 to 37 kW) is high in alumina refinery, especially those used for sump pit cleaning purposes. This type of area is typically controlled manually and not monitored on a regular basis which ultimately increases the overall specific energy consumption of the plant. Traditional pit level controllers, such as float and capacitance sensors, installed to optimize sump pump operation, often fail due to sedimented solids because of the nature of the process slurry. Consequently, the associated energy consumption increases. Monitoring motor load and underload currents can play crucial role in controlling operational hours. In our research, we have successfully utilized motor underload current monitoring to reduce more than 50% pump runtime, resulting in substantial energy savings by 70 kW to 80 kW per day per pump within the alumina refinery, thereby contributing to a carbon footprint reduction.

Keywords: Alumina Refinery, Energy Optimization, Motors, Underload Current.

1. Introduction

Alumina refining turns bauxite into alumina using the Bayer process, a reversible chemical reaction. First, bauxite is cleaned, crushed into powder, and then dissolved in caustic soda (sodium hydroxide) at high temperature and pressure. It takes about four tons of bauxite to make one ton of alumina, and roughly two tons of alumina to produce one ton of aluminum.

The mixture of bauxite and caustic undergoes digestion in digester vessels under high temperature and pressure to dissolve the aluminum hydroxide from the bauxite. The resulting solution is then cooled in flash tanks. Next, in the precipitation step, aluminum hydroxide crystals are recovered from the caustic solution through mechanical stirring in open tanks.

Finally, the precipitated material undergoes calcination, where it is washed and dried at temperatures exceeding 1 000 °C. This process transforms it into dry, white anhydrous aluminum oxide powder (alumina), which is cooled and stored for further use.

The entire process is based on caustic so any overflow or drain of vessel need to be taken back into the process. So, catching points are located at different locations across the plant. The job of

the catching point is to collect the slurry (grinded bauxite mixed with caustic) by using gravity and pump the slurry back to process. Those pumps are called sump pumps.

The number and rating of pumps varies from plant to plant. The number can surpass 150 and rating starts from 5 HP (Horse Power unit, equal to 746 W) and may go beyond 100 HP as per requirement and process volume. Important to mention they, are installed with a redundant setup. Most of the time those pumps are operated manually and neglected, as it is not considered a mainstream equipment. But its number and cumulative energy consumption cannot be neglected.

During initial stage of installation different solutions like level sensor or float type proximity switches are installed to optimize the running time but over the operating time, they are damaged because of scaling and remain bypassed or out of operation which results in high energy consumption.

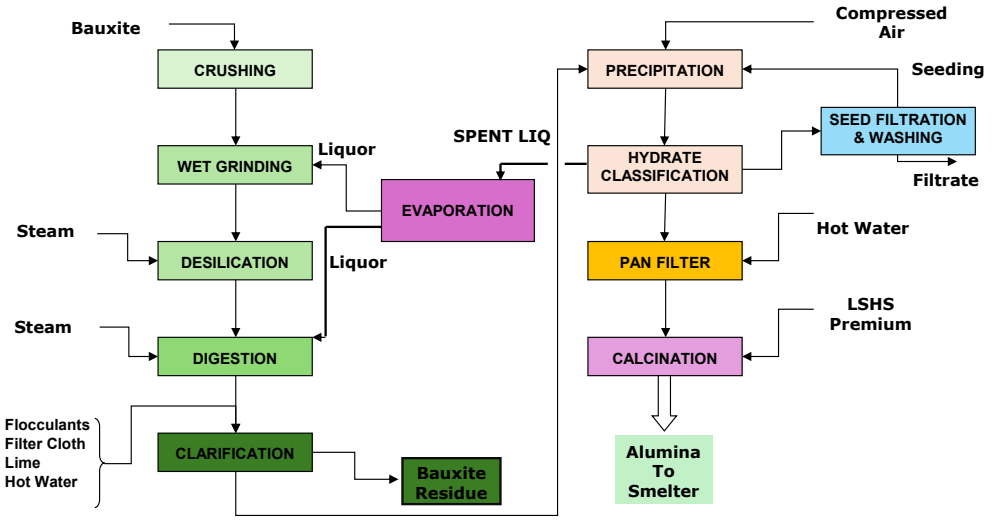

Figure 1. Basic Bayer process flow diagram.

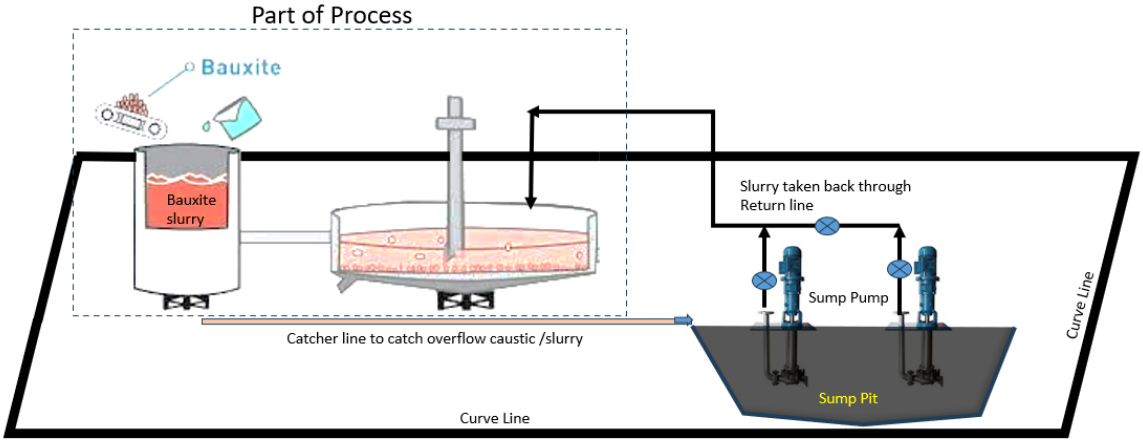

Figure 2. Sump pump installation location.

1.1 Working of Sump Pump

A sump pump is a device used to remove slurry/caustic/rainwater that has accumulated in a sump pit. Sump Pit is a basin dug into the lowest part of the curbed area. Slurry naturally flows into this

underload current can play a crucial role in reducing energy consumption in an alumina refinery. From the experiment it was observed that approximately 79.07 kWh per day can be saved from a single 50 HP sump pump. The saving will become significant with the increase in number of pumps.

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