Hydrocyclones Productivity Impact in the Alumina Industry

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Abstract

Alumina (Al_2O_3) is an important and elementary raw material for numerous industrial applications ranging from construction to filling materials, abrasives and catalysts. It is calcined from aluminium tri hydrate [$Al(OH)_3$], smelted to produce metallic aluminium which is casted in different forms and shapes as per the end user industry.

The challenge to any existing or new designed alumina refinery is to maximize the production recovery of alumina out of bauxite ore and minimize the energy costs per ton of alumina. Hydrocyclones AKA-VORTEX and distributors AKA-SPIDER, arranged as primary and seed distributors, constitute essential elements of the overall manufacturing process for the treatment of the aluminium tri hydrate [$Al(OH)_3$] under challenging conditions of hot caustic soda slurry. These wet mechanical process solutions are used in the classification step of the aluminium tri hydrate crystals, to get the coarse (sandy) particles as the pre-product for the alumina (Al_2O_3), and the finer particles as the seed to reuse for the precipitation process.

An explanation of the installation and operation of such highly specialized hydrocyclone systems designed and installed in a green field project at a major alumina refinery group, will be presented.

Keywords: Alumina refinery, Aluminium tri hydrate classification, Hydrocyclones, Distributors.

1. General Information on Alumina

The industrial production of aluminium is still based on a two-stage process that was introduced in principle more than 100 years ago:

- In the **alumina refinery**, the Bayer Process is used to produce alumina as an intermediate product from the bauxite raw material.
- In the smelter, the aluminium oxide dissolved in a cryolite melt is reduced electrochemically to metal (electrolysis according to the Hall-Héroult method).

In the operation of an **alumina refinery** there are large number of interacting processes, leading to frequent disturbances which sometimes act as a chain reaction. The challenge of any alumina refinery is to maximize the production of alumina and minimize the energy costs per ton of alumina. As a result, a steady-state operation is difficult to attain, and the refinery in general, does not run always at its optimal operating conditions [4].

All equipment used in the refinery should able to be operated satisfactorily, even with considerable fluctuation of the process parameters. But, due to the fact that all the function of the equipment is based on physics, there are some limitations which have to be considered for the design of a plant as well as for the operation. In this respect AKA-VORTEX hydrocyclones and AKA-SPIDER distributors, arranged as primary and seed distributors, constitute essential elements of the reliable overall manufacturing process for the treatment of the aluminium tri hydrate [$Al(OH)_3$] under challenging conditions of hot caustic soda slurry.

The importance of a satisfactorily running alumina plant can also be seen in the high demand and the corresponding production of alumina over the last decade, presented in the following chart, Figure 1.

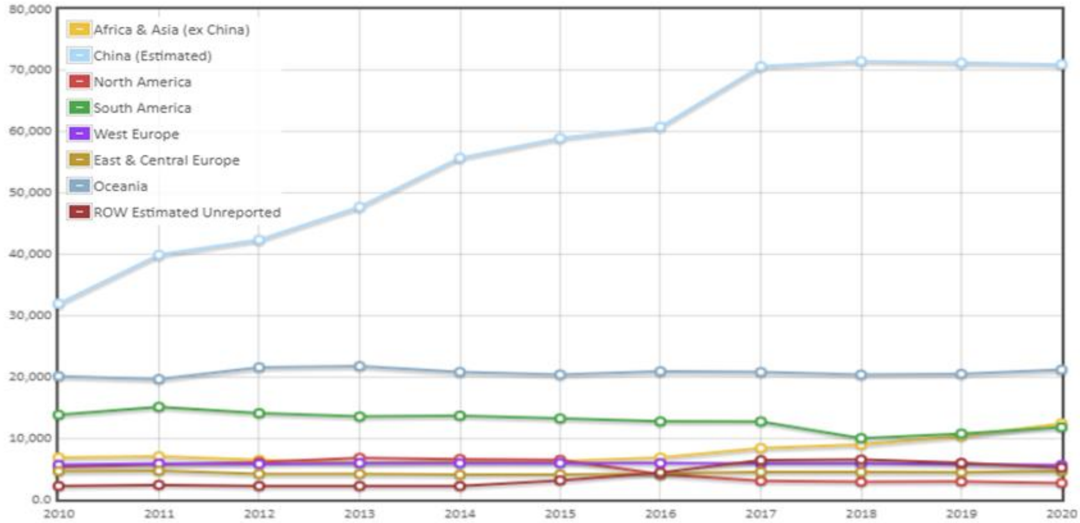

Figure 1. Alumina production 2010–2021 [1].

The total alumina production of 1,284,167 thousand metric tonnes is the quantity of aluminium oxide tri hydrate produced from 2010-2021 and expressed as 100 %, nominal aluminium oxide (Al_2O_3) equivalent, irrespective of further processing. Total alumina production figures have two components, that to be used for:

- the production of aluminium (metallurgical grade alumina)
- any other purpose (chemical grade alumina)

2. Overall Process and Integration of AKW A+V Equipment

The production process for aluminium starts with the mining of bauxite ore. Layers of bauxite are typically found near the surface, so it is generally extracted through open cast mining. Around 90 % of the world´s bauxite resources are in tropical and sub-tropical regions.

The bauxite main chemical form is $Al_2O_3.3H_2O$ or $Al_2O_3.H_2O$ and it mainly consists of impurities such as sand, ferric oxide, titanium oxide. The extracted bauxite is treated further using the well-known Bayer Process.

In the following, the overall process procedure to produce aluminium is presented.

- Crushing: Crushing down to 10 mm
- Grinding: Grinding take place with hot caustic soda
- Digestion: Conversion of impure bauxite to sodium aluminate (supersaturated solution)
- Clarification: Bauxite residue settles at the bottom and is washed and filtered prior to disposal
- Precipitation: Conversion of sodium aluminate to aluminium hydroxide (filtered liquid is cooled down and treated with seed crystals (aluminium hydroxide))
- **Hydrocycloning: For the removal of fine aluminium hydroxide crystals**
- Filtration: Aluminium hydroxide crystals are filtered to separate them from the caustic liquid

on the units while maintaining the safety measures, in addition of having a non-interrupted maintenance and troubleshooting with full access to all parts at all times.

Due to the high quality of the proprietary polyurethane material used in the manufacturing of the hydrocyclones, the wear occurrence is relevantly less which increases the lifetime of parts and accordingly reduces the operational cost.

AKW A+V R&D are working continuously to develop and enhance the design to increase the productivity and reduce the cost. Recently, AKW A+V has launched a new concept, called AKA-SMART, that includes solutions for wear detection inside the hydrocyclones without the need of dismantling parts or interrupting the operation. Particularly, the AKA-ALERT, which is a part of the AKA-SMART solution package and consists of inserted chips in the polyurethane material at specific sections of the hydrocyclone, has gained huge attraction. Through a simple detecting device, the operators can easily check the status of the chips, and hence identify the specific parts that require a replacement whilst operation. These steps towards a greater automation will give a real time knowledge about the wearing condition inside the hydrocyclone and eliminate extra inspection activities, consequently reduce the man-work intensity and limit the production break-down.

7. References

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