Modern Concept for the Desanding of Red Mud

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Abstract

Red Mud is a waste product from the aluminum production process. Due to its high sodium and high iron oxide content, it is difficult to use unprocessed bauxite residue in the steel industry as a substitute for iron ore. Therefore, a common way until now is to deposit the untreated red mud in various places, although this represents a significant risk to the environment because of potential pollution of surrounding soil and groundwater (e.g. the sodium content). Due to a poor exploitation of this resource, the industry faces here more and more important market challenges, since the volume of red mud is constantly increasing and the places for landfilling or deposition are reaching their limits. Among other things, the players also suffer from the high landfill costs. To relieve the landfills (reduce volume) and enable dry stacking, the use of filters prior to deposition is more and more adopted. Therefore, to protect the process pumps and filter cloths against wear, the coarse sand particles might be separated by special hydrocyclones before filtration step. To receive valuable fractions from the red mud, the desanding and recovery technology from AKW Equipment + Process Design is used. For the challenging conditions of red mud desanding and classification, special designed hydrocyclones AKA-VORTEX, in wear and temperature resistant Polyurethane or cast steel lining, followed by a washing/dewatering screen unit or also combined with a teeter bed separator AKA-SIZER, would be the effective solution. An introduction of the installation and operation of such highly specialized desanding unit will be presented in this paper.

Keywords: Alumina, Red mud, Desanding, Hydrocyclones, Washing.

1. Originating of Bauxite Residue

Bauxite residue is a by-product generated from the Bayer process for refining bauxite to alumina. The amount of bauxite residue produced by an alumina plant or refinery is mainly dependent on the bauxite composition (country of origin) and on the extraction conditions. The “residue factor” (or mud factor) is often represented as the tonnes of dry residue per tonne of alumina produced and ranges from 1.0 to 2.5, with an average of 1.23 [1].

Since 1893 the Bayer process has been mostly used and there are approximately more than a hundred plants running with this process around the world, with more than 60 plants in China only. Especially there, the number of alumina refineries continues increasing rapidly, to fulfill the rising demand of aluminum that enjoys an average growth rate of 6 % per year. Therefore, the annual bauxite residue generation is currently around 150 million tonnes, to be added to the already accumulated quantity of old bauxite residue, estimated at nearly four billion tonnes [2].

2. Composition of Bauxite Residue

The bauxite residues composition is highly influenced by different factors such as the bauxite source and composition (gibbsitic, boehmitic or diasporic bauxite), but also the temperature and the pressure level used in the transformation of the bauxite into alumina. Bauxite residues composition consists of iron oxide, titanium oxide, silica and undissolved alumina. These materials are found mixed with some other oxides depending on the country of origin of the raw bauxite. The high concentration of iron compounds in the bauxite residue is responsible for the reddish color and therefore called "red mud." The typical chemical and mineral compositions are given in Table 1 and in Table 2. It is highly alkaline with pH around 13 [3].

Table 1. Chemical composition for bauxite residues [3].

Component	Typical Range (%)
Fe_2O_3	20–45
Al_2O_3	10–22
TiO_2	4–20
CaO	0–14
SiO_2	5–30
Na_2O	2–8

Table 2. Mineralogical composition for bauxite residues [5].

Component	Typical Range (%)
Hematite (Fe_2O_3)	10–30
Magnetite (Fe_3O_4)	0–8
Goethite (FeOOH)	10–30
Silica (SiO_2)	3–20
Calcium aluminate ($3CaO.Al_2O_3.6H_2O$)	2–20
Titanium Dioxide (TiO_2)	2–15
Muscovite ($K_2O.3Al_2O_3.6SiO_2.2H_2O$)	0–15
Calcite ($CaCO_3$)	2–20
Kaolinite ($Al_2O_3.2SiO_2.2H_2O$)	0–5
Sodalite ($3Na_2O.3Al_2O_3.6SiO_2.Na_2SO_4$)	4–40
Gibbsite ($Al(OH)_3$)	0–5
Perovskite ($CaTiO_3$)	0–12
Cancrinite ($Na_6[Al_6Si_6O_{24}].2CaCO_3$)	0–50
Diaspore (α-AlO(OH))	0–5
Boehmite (γ-AlO(OH))	0–20

Specifically for the red mud de-sanding application, a caustic and temperature resistant material for the screen frame as well as for the screen mesh need to be selected. Therefore, stainless steel is the appropriate material to resist against these conditions [7].

For the handling of the separated sand on the screen, a further washing step with process water has to be considered. This is aimed at further reducing the caustic content in the sand in order to help the potential use of the sand in several valorization applications. Such a washing concept will be realized by so-called spray bars. The number of spray bars equipped with special spray nozzles should be related to the wanted wash effect and the needed water amount. This additional wash water amount needs to be considered by sizing the required screen mesh area to reach the requested dewatering effect.

Figure 5. Dewatering screen, discharge of separated and dewatered sand [6].

7. Conclusions

In order to minimize the environmental impacts of bauxite residue deposits, use of filtration prior to stacking is more and more adopted by the industry. However, coarse fractions in bauxite residue can have negative impacts on this step. AKW Equipment + Process Design has gained strong knowledge in this field over several years of tight cooperation with major aluminium refineries and was able to develop solutions that offer appropriate treatments for the bauxite residue chain by focusing on the handling of the waste generated and targeting a reduction of the environmental impact and reusability of part of the waste flow. As such, these solutions contribute to the concept of a circular economy in this demanding and growing aluminum industry.

The AKA-VORTEX hydrocyclones, made of high wear and temperature resistant polyurethane (PU), are an important addition to the alumina industry. Their unique designs ensure a specific cut size for the separation, while offering the needed flexibility to adjust the separation specificities in order to maximize the overall production yield and minimize the energy demand.

8. References

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