Use of double hose-diaphragm pumps in Bayer process for alumina production

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Abstract

In alumina production processes, highly caustic bauxite slurries are pumped at high pressure into tubes or autoclaves for digestion at high temperature. Even today, production of alumina is based on the conventional Bayer process. Within this process, MULTISAFE double hose-diaphragm pumps are involved at several stages and reliably pump bauxite slurry (i.e. in plants of Russian aluminium giant Rusal), red mud and lime milk (i.e. as just ordered for the Emirates Global Aluminium (EGA) alumina refinery Al Taweelah). FELUWA pumps provide for environmentally friendly transportation of critical media at solids concentrations of up to 70 % with associated high efficiency as well as low wear and tear. The special design of MULTISAFE pumps offers decisive advantages compared to traditional diaphragm pumps. At the heart of MULTISAFE pumps are two hose-diaphragms which are arranged one inside the other. They fully enclose the product and provide double hermetic sealing from the hydraulic drive end. Thus, the slurry is in contact with the inside of the hose-diaphragm and check valves only, so that the heavy pump casings can be made from standard materials, which means considerable cost savings.

Keywords: Hose-diaphragms; energy efficiency; bauxite slurry; red mud disposal; alumina production

1. Introduction

Whereas bauxite mining is generally characterised by relatively low energy consumption, the further processes for transforming bauxite into alumina and further to aluminium are associated with a considerably higher energy demand. Nevertheless, the alumina industry has succeeded in an almost 10 % improvement in global refining energy efficiency in the course of the past years. The saving of energy is consequence of the implementation of advanced technologies and equipment with improved energy efficiency.

The actual energy requirement of the Bayer process is to a great extent dependent on the quality of the feedstock. It uses a recirculating volume of concentrated caustic solution to dissolve the alumina minerals, separate them from still solid impurities, and then re-precipitate alumina tri-hydrate. Calcining completes the transformation of the tri-hydrate to alumina. In this Bayer refining process of high temperature bauxites (typically those bauxites requiring a digestion temperature of 250 °C or greater), there is a process variant known as sweetening. It involves injecting an extra ~ 25 % of low temperature (gibbsitic) bauxite slurry into the flash down where the heated slurry is cooled to 105 °C (and the pressure reduced back to atmospheric) by allowing steam evaporation or flashing in a cascade of vessels. The alumina in the gibbsitic bauxite slurry dissolves rapidly in the high temperature stream, allowing the concentration of dissolved alumina in the liquor to be significantly higher than could otherwise be achieved by processing high temperature bauxite alone. In this way “sweetening” allows extra alumina to be produced from an existing high temperature plant for only a very small capital and operating cost increase (pro rata, far less than the alumina produced). [1].

Whereas sweetening digestion contributes to a noticeable saving of energy in terms of process technology, additional improvement is achieved by the implementation of energy-efficient equipment. Given that up to 30 % of the electricity consumption of alumina processing facilities is used by the high-pressure digestion pumping system and by motors of the ball mills, energy-efficient equipment is indispensable for such key applications. Positive displacement pumps are typically employed to pump the bauxite slurry into the digesters under high pressure.

2. Digester feed pumps

Hydraulically actuated piston diaphragm pumps are typically applied for digester feeding. However, the suitability of traditional piston diaphragm pumps is limited when it comes to the handling of aggressive or abrasive products, because not only the diaphragms but also entire pump chambers are in contact with the product. Aggressive fluid pumping, for example, requires wet ends made of high grade stainless or even duplex steels. Solids, which are carried by fluids, tend to settle in the lower pump area between diaphragm and clamping ring and often lead to premature diaphragm failure. In the event of a diaphragm failure with such pump types, the product automatically contaminates the hydraulic system, where it comes in contact with the sliding seals and cylinder surface. This can lead to considerable destruction and consequential damage and require significant man power and cost for cleaning and subsequent repair of pump and gearbox.

2.1. Double hose-diaphragm pumps

Combined hose diaphragm piston pumps offer substantial advantages compared to traditional piston diaphragm pumps. MULTISAFE double hose-diaphragm pumps (see Figure 1) represent the highest level of diaphragm pump technology with numerous advantageous features.

Figure 1. Seven sets of double hose-diaphragm pumps.

At the heart of MULTISAFE pumps are two hose-diaphragms which are arranged one inside the other (see Figure 2) and fully enclose the linear flow path of the conveyed fluid.

3. Conclusions

Sweetening digestion contributes to a noticeable saving of energy in terms of process technology. Additional improvement is achieved by the implementation of energy-efficient equipment, such as digester feed pumps, which rank among the key equipment in alumina refineries. Double hose-diaphragm pumps are especially conducive to handle aggressive, abrasive and highly viscous fluids as used in the Bayer process. The redundant hose-diaphragm provides for a linear flow path without sedimentation and ensures double hermetic sealing from the drive end. Check valves are considered the sole real wearing parts of double hose-diaphragm pumps. Ball valves are preferable, because valve balls have a considerably higher lifespan than valve cones. Valve balls are continuously rotating and thus changing the sealing area against the valve seat. Permanent condition monitoring of check valves avoids loss of energy, because any decrease in output resulting from valve wear is usually automatically compensated by the variable speed drive through increased pump speed. Single-acting quintuplex configuration provides the lowest pulsation by means of five plungers actuated by a common crankshaft. This pump can handle up to 1 000 m^3/h. The pumps are equipped with the latest Condition Monitoring System, especially designed to monitor the smallest valve leakage, temperatures and diaphragm condition. Where several pumps operate in parallel and discharge at independent speeds into a common pipe, pump synchronisation controls phase shift and eliminates excitation of resonances significantly.

4. References

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