THE FOCUS ON FILTRATION

Alumina filters undergo some of the harshest conditions in the filtration industry due to the caustic nature of the chemicals used for alumina extraction. However, removal of these chemicals is crucial to the superiority of the final product. Additionally, aluminium smelters have ever increasing demands for higher quality alumina which can improve smelting processes by reducing production costs, emissions and wastage. For these and other productivity reasons, security filtration has found itself in the industry spotlight.

Vertical Pressure Filter (VPF) technology was initially developed by Australian Process Technology Pty Ltd, a reputed filter designer and supplier to the alumina refining industry. Since its first installation, dating back to 1979, VPF technology has become established as a proven method of security filtration, with over 80 units in operation to date.

The VPF polishing filter is designed specifically to optimise removal of suspended solids impurities prior to alumina hydrate precipitation. The results of which, no pun intended, are clear with filtrate solids averaging a clarity of less than 6mg/L over a single cycle. In addition to high quality filtrate, VPF technology offers significant benefits in simplicity of maintenance and operation, as well as providing a more cost effective polishing solution. Operator safety is also a key feature of the overall design.

ALUMINA DIGESTION

Typically, separating alumina from crushed bauxite involves digestion under high pressure and temperature. This digestion slurry is then fed through a number of flash tanks to lower temperature and pressure levels before being clarified, separating the slurry into pregnant liquor-overflow.
and bauxite residue-underflow, (see Fig. 1). While the bauxite residue is pumped to the washing circuit, the pregnant liquor, now containing alumina hydrate and 100-200mg/L of suspended solids impurities, (mainly iron oxide), moves to security filtration to remove the impurities. It is essential to achieve as low an impurity level as possible to prevent occlusion with the alumina hydrate crystals during crystallization. Occluded impurities can lead to poor quality alumina and subsequently impose a negative impact on the physical properties of the aluminium metal after smelting.

The VPF’s target is to obtain a liquor with less than 10mg/L suspended solids impurities.

Vertically Pressure Filter

By modifying the 21 filter leaves, suspended from the top of the cylindrical tank (see Fig. 2), the VPF’s filtration area of 400m² can be expanded to 440m². The filter leaves, made up of three different widths, each have their own outlet(s) and are equipped with on/off and sample valves. The valves are used for monitoring pregnant liquor clarity and for isolating individual filter leaves not performing to specification. Filter units can be delivered with single or double outlet configurations depending on final sizing and/or customer layout.

Fig. 1: VPF location within the Bayer flowsheet

Fig. 2: VPF with single pregnant liquor outlet
To enable simpler, safer operation and maintenance, the VPF design has some innovative features, such as the ‘sealed’ shell design which offers excellent operator safety. Also, a fully automatic Programmable Logic Controller (PLC) allows complete automation of the filtration and sluice wash cycle. Another feature is the clever swing bolt system for lid closing. The lid has a unique lip seal design which activates when internal pressure builds inside the vessel [see Fig. 3]. This negates the need for a special torque wrench to open and tighten the swing bolts. Also, pipe connections are not housed within the filter lid, therefore, changing the cloth, for example, becomes a less time and labour intensive operation.

The length of the pregnant liquor filtration phase depends on various parameters, such as the amount of impurities in the liquor and the level of TCA dosing. Also the type of filter cloths used influence cycle time as well as the minimum acceptable filtration rate.

Phase 1 - filtration
The filtration phase is divided into two parts, with the first being the constant flow and the second, constant pressure [see Fig. 5]. During this phase, a constant flow is maintained as filter cake forms. When the feed control valve is fully open from the pressure of cake formation, it moves into the constant pressure mode. As cake thickness increases, the flow of pregnant liquor into the filter, decreases.

Phase 2 - cake discharge
Upon reaching the minimum set-point, the VPF automatically switches to the cake discharge phase. With the filtration phase now complete, the entire 70m³ volume is full of pregnant liquor and cake deposited on the filter leaves. Filtration continues until the minimum flow set-point of 400 m³/h is reached, equivalent to a filtration rate of 1.0 m⁻³/m².h. The set point however, is flexible and can be higher or lower depending on the process requirements.

With VPF technology, a complete security filtration plant based on customer specifications can be supplied. Figure 4 illustrates an example of a plant with processing capacity of 1.5m tpa alumina.

THE VPF PROCESS
The total filtration cycle of the VPF has two phases, pregnant liquor filtration (phase 1) and cake discharge (phase 2). Both are controlled by the PLC with phase 1 taking between 4 to 18 hours and phase 2 typically complete in under an hour.

Even though the feed pump is stopped, pregnant liquor filtration proceeds until ca.70% of remaining pregnant liquor is pushed forward and polished. Remaining unpolished pregnant liquor can be recycled back to the filter.
SIMPLE, SAFE OPERATION AND MAINTENANCE

Alumina filter technology once required intensive labour to discharge the filter cake in a chemically hazardous and potentially unsafe environment. VPF technology offers a safe working environment with automatic (PLC) control for cloth cleaning and cake discharge steps at the end of each filtration cycle. During filtration the filter vessel and piping arrangement is completely sealed from process liquid splashes and the shell flange, being only a metre above the level of operating platform, offers easy and safe operation, inspection and maintenance access.

After the cake discharge phase, the VPF automatically goes into the filtration phase unless a caustic cleaning or maintenance stop has been selected. Caustic cleaning is ideally performed every 3-4 filtration phases and takes only one hour to complete.

Following caustic cleaning, the VPF automatically performs a maintenance check. Generally, maintenance stops will be for filter cloth changing which must be done if pregnant liquor clarity is over 10mg/L suspended solid impurities. Poor clarity can be the result of damaged filter cloths or if cycle time has become too short due to filter cloths ‘blinding’. These situations are easily remedied as a full set of filter leaves can be immediately replaced using an overhead crane to transport them from a nearby dedicated dressing station, with the additional option to recover media by means of acid dissolution. Additionally, individual leaves can be sampled, checked and isolated for filtrate clarity.

LOWER COSTS – BETTER RESULTS

With no moving parts, the operating cost per cubic metre of produced filtrate is low, while the quality of filtrate is high. Production capacity increases, as does the quality of alumina product. Low electrical energy consumption is another cost-saving benefit as the low-flow-rate filtration technique also uses low pumping pressure. With the filtration cycle lasting up to 18 hours, the filter technical time, including cake sluice and cloth cleaning, is minimised, as is the consumption of filter aid (Tri-Calcium Aluminate [TCA] dosing). Due to short and effective sluice washing and cake removal, a single cycle time can be a short as 4 hours, depending on factors such as minimum filtration rate, cake thickness and age of filter cloth.

Filtration plant throughput is maximised due to the automatic (PLC) control of cloth cleaning and cake discharge phases at the end of each filtration cycle. Additionally, when one filter is taken offline for the washing cycle, it is immediately replaced with a stand-by filter. This ensures maximum filtration time and reduces the need for supervision.

IN SUMMARY

Accurate selection of filter cloths and TCA dosing ensure that from the start of the filtration cycle, pregnant liquor filtration solids is less than 10mg/L. At the end of the filter cycle, pregnant liquor contains approximately 2mg/L of suspended solids, giving an average clarity less than 6mg/L over a filtration cycle.

VPF sizing is flexible, being based on the customer’s process parameters, their operation principles and other requirements. The filter geometry maximizes the filtration area in relation to the floor area, ensuring a high filtration rate per filtration building floor area. One standard VPF 400 has a reference capacity of 500m³/h of polished pregnant liquor.
About the authors...

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PRODUCT NEWS: RELINE MACHINES

Outotec can now offer the design, manufacture and commissioning of a range of reline machines (liner handlers), to complement mill reline services to the grinding industry.

With a strong focus on the reduction of reline incurred downtime, the reline machines and material handling systems have been developed to be truly ‘fit for purpose’. Unlike other lifting and placement tools, the Outotec reline machines are engineered with a unique knuckle boom facility, similar to excavators, which allow the machines to push and pull components on or off the mill face, reducing risk and reline incurred downtime.

The design and build team have extensive experience using these specialised reline machines and know first-hand the conditions and operational requirements of this technology. As such, the machines have been designed to be robust, simple to operate and extremely reliable.

The machines range from small cost effective options for the smallest of ball mills to large multi-tonne machines for SAG mills. A separate jib option on the back of the machine is also available for material handling issues on the mill deck.