NEW CLOSURE FOR LEAF FILTERS

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ABSTRACT

The alumina purification is still produce mainly by the Bayer process as it was many years ago. However it is when looking at each step of the process that the evolution can be observed. Many of the steps have been optimised during last years and now the global productivity of plant has been increased. It is surprising today that the security filtration on leaf filters is one of the steps that remain as it was many years ago. In order to improve the process, a new closing system for leaf filter was developed. This new system was design to reduce leakage in the outlet pipe area, remove the use of a knife during installation and reduce the scale growth. The new closure has been tested in 4 different plants and countries so far. The test results of the new closure in one plant and its impact will be presented.

1. INTRODUCTION

In 2012 the world aluminum oxide production reached more than 70 Million metric ton. Most of this alumina is still being produced using the old Bayer process. The Bayer process starts with bauxite ore as the main feeding source. After grinding the ore, the ground powder is mixed with a solution containing about 250-350 grams per liter of sodium hydroxide. The resulting slurry is heated above 140 C to extract alumina and then cooled around 102-110 C. Once in the decanter, the mud settles down and the relatively clean solution at the overflow is sent to filtration area. This step called security filtration is the last ore before aluminium hydroxide precipitation.

Even though the Bayer process has existed for more than 100 years, each step of it has been improved over the years. The object of this work is to improve the security filtration step. Nowadays the security filtration in new plants is done by using multichannel filter bags. However a large part of the alumina production is still done using the old and quite simple technology of leaf filters. A first patent related to the leaf filter was filed by Henry Hunter in 1839, but it has been only in 1892 that a first leaf filter was used on a larger scale when the first alumina refinery has started. At the very beginning leaf filters were fitted with natural fibers fabric such as cotton. It can be imagined how limited was the service life in Bayer process conditions. When the first bags made of synthetic fabrics appeared on the market, they were quickly tested and adopted by the industry. Today staple fibers, multifilament and monofilament fabrics made of polypropylene yarns are still in use by the industry.

2. RESULTS AND DISCUSSION

Typical horizontal leaf filters are composed of a round vessel having about 15-25 rectangular steel frames. Each frame is a leaf made of steel mesh covered by a filtration fabric. A complete leaf filter needs about 250-500 square meter of fabric to cover all of the 15-25 leafs. During operation, the vessel is closed and the solution is pumped into it. When the vessel is full, under the pumps action, the pressure rises and the solution flows through the fabric. An outlet pipe allows the filtered solution to be evacuated outside the vessel. The purified solution full of solubilised alumina is ready for production of solid alumina.

Today the bags for leafs are made of pieces of polypropylene fabric sewed together. The bags are replaced on a regular basis to ensure high productivity. As example, in a typical plant, bags are replaced each 4-6 weeks on each filters. Depending on the size of the plants, it is about 225-625 bags that have to be replaced each 4-6 weeks. The bags replacement requires an important manpower operating in difficult conditions. With today new safety level and working conditions, some attempts have been made

to make easier bags replacement; so far none of them was successful.

One of the most important issues regarding bags replacement is to make sure that they are leak free. This goal is still not been achieved in many plants since the installation process is inefficient and dependant of man's skill. The result is an annual loss of many hundreds of bags. To the bags loss value that cannot be re-used, a production loss is added. Indeed, when a leak is observed after bags replacement, the spigot is closed instead of being replaced. This is to prevent contamination of filtrate by solids.

The bags are factory closed by sewing or welding on three sides, the last side being kept open to introduce the frame. This open side is the most problematic one and the main source of leaks. The challenge is to get a perfect seal on a 2-3 meters long opening in spite of the presence of outflow pipes with a scaled uneven surface.

A typical horizontal leaf filter closing is shown on figures 1 and 2. The figure 1 shows the top part of the closure. One of the challenging parts to seal is around the pipe. Because of the scaling process that occurs in all alumina plants, the pipes are frequently hammered. This results in a very rough pipe surface hard to seal. What is done actually to make a seal around the pipe is to partially cut a 15 cm band of fabric from bag's end using a sharp knife. The cut is limited to make sure that the band is still attached to the bag; it is then used as a tie and wrapped around the pipe. Once tightly wrapped around the pipe, the seal is kept in place using a twisted wire or bandit clamps. Unfortunately all the sealing process is linked to the workers skill. If the band cutting is not stopped at the right location, means that it is too far or too close to the pipe, it may result in leaking bags. It also has been reported that some workers were knife injured when cutting the fabric band.

The figure 2 shows the bottom part of a typical leaf filter closure. The fabric is crumpled and stapled. Again the seal quality is linked to the workers skill. If the wrapping of the fabric around the pipe is not properly done or if the distance between the staples is too long, again it may result in leaking bags. Moreover the wrapped fabric is a nice nest for scale growing. The figure 3 shows a scaled closure after about 90 days of operation. The scale is formed by mixed phases of aluminum hydroxide with carbonates and/or oxides of iron, silicon and sodium. It is a very hard layer that can be sometimes 15 cm thick. It can be attached to the steel frame and then must be removed by breaking it using a hammer or a pneumatic tool. The use of these tools is also reported as an injury source for workers.

Figure 1: Typical top part of leaf filter closure

Figure 2: Typical bottom part of leaf filter closure

Figure 3: Scaling of actual closure after 90 days of production

The figure 4 shows the new closure. It is formed from two parts. The first part on the top is made of polypropylene felt. The felt was chosen because it is a better gasket material on a rough surface like the pipe's one. The felt is also more prone to scaling which is considered as a quality at this location. It is expected that if small leaks are present once placed in production, they will be quickly sealed by scale in the next hours. The second part of the closure is made of two extruded parts of ethylene propylene diene monomer (EPDM). This material has a good resistance to hot sodium hydroxide solution and is not affected by scaling. The shapes of the two EPDM parts are shown on the figure 5. The two parts are designed to be locked in order to ensure a good sealing. Finally the two parts are fixed permanently by stapling.

The new closure has been tried in four different plants so far. The results obtained in one of the plants are presented on Table 1. The test compared two complete filters, one having 15 leafs with the new closure and the other having 15 leafs with the regular closure. The feeding solution contained about 360 grams of sodium hydroxide per liter and the alumina to caustic ratio was about 0,12.The value of 3,9 mg per liter of solid in filtrate indicates a good filtration with no leak during the 393 cycles of about 6 hours of filtration. The formation of scale during the process was also limited as can be observed on figure 6.

Figure 4: Complete view of new closure

Table 1. Comparison of plant results for regular and new closure

	Regular Closure	New Closure
Days	94	116
Average flow (l/min)	2800	2600
Cycle number	293	394
Average solid (mg/l) in filtrate	4,0	3,9
Caustic g/l	358	370
A/C ratio	0,12	0,14
Temperature (C)	96	101

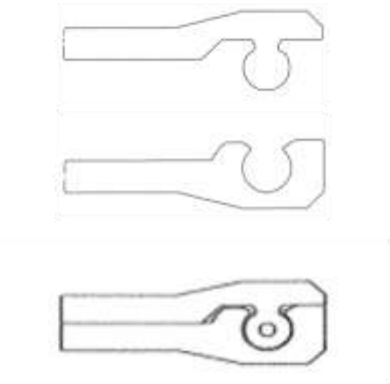

Figure 5: shapes of extruded EPDM parts

Figure 6 : New closure after 116 days of production

3. CONCLUSION

The new closure is easier to install and does not rely on man's skill. It is a reliable seal as proved by the results on large scale test. It is safer to install since it doesn't require knife and safer to remove since it doesn't require a hammer to break the scale on it.