Alumina Production - Harsh Conditions for Filter Media

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Abstract

Refineries processing bauxite consume a large inventory of various filter media, which is a significant cost factor in a plant. The requirements of the process on a textile filter media, whether woven or felt, are most challenging: high temperatures and velocities, an extremely abrasive and highly alkaline product, truly harsh conditions. This paper gives an overview of the key solid/liquid filtration equipment in the four main process stages of alumina production and provides information on commonly used filter media. It thoroughly analyses the very different requirements and challenges of the process steps of liquor polishing, red mud filtration, seed filtration and hydrate filtration. It also indicates ways to optimize the respective processes by an alternative cloth type. Finally, as a necessary response to an increasing use of large format filter presses instead of vacuum drum filters for red mud filtration, the last section provides interesting information on what kind of filter cloth can fulfil the new demanding requirements of such large filter presses. Key issues in this context are high flow through cloths but at the same time excellent retention of even very small particles, a very good resistance against mechanical stress and the highest possible reduction of moisture content.

Keywords: leaf filter bag/cover, disc filter bag/cover, filter press cloth, pan filter bag/cover, Diastar-Filter.

1. Introduction

The selection of a suitable filter cloth for a filtration process in alumina production is a challenging task for a filter cloth producer. It requires extensive knowledge about process conditions, various machine types and of course, technical fabrics and the manufacturing of precisely fitting items. This knowledge can be only acquired by working in close cooperation with the plant operators and the Original Equipment Manufacturers (OEMs). As the process conditions and applied filter systems vary largely, comprehensive analysis of each process step and subsequent test work are the initial steps.

2. Filtration of Pregnant Liquor

The purification of liquor is usually performed on Kelly filters, vertical filters or backwashing filters. This processing step is marked by high flow rates, high slurry temperatures of 95 - 110 °C (203-230 °F), low solid contents in the liquor and very fine particles with size < 1 µm [1]. Frequently observed problems with filter media in this process step are crystallization and cloth blinding, shrinkage as well as mechanical wear and tear of the fabric. In the majority of cases shrinkage is caused by insufficient temperature resistance of the fabric used. Polypropylene, even with heat-set treatment, remains stable up to 90 °C. At higher temperatures, it starts shrinking and losing its original shape. Thereby the fabric is pressed towards the filter element and could be mechanically damaged by friction. Marsyntex® polypropylene, thermostable, has a higher temperature resistance compared to standard monofilament polypropylene fabrics which are just heat-set and thus can help to increase the lifespan of cloth considerably. Polyamide which provides better resistance to wear could also be an option for this process step. Another frequently observed problem in pregnant liquor filtration is solids passing through the filter cloth at the beginning of the cycle. These do accumulate in the bottom of the filter element and often cause serious cloth destruction. To prevent this, the selection of an appropriate cloth in regard to its filtration efficiency is an important task for a filter media specialist. The cloth should provide high throughput, but at the same time, excellent retention of even very fine particles. Number and diameter of thread but also the type of weave have to be adapted to the desired performance of cloth. Further, the precise manufacturing but also adequate auxiliary materials play an important role when it comes to the question of lifespan. Due to highly alkaline conditions and high temperature it must be ensured that all seams of cloth are made of solid thread that can withstand these conditions. This applies in particular for the channel sewing of the Diastar filter which should be preferably carried out on a sewing automat to ensure defined distance between the channels.

3. Filtration of Red Mud

The dewatering of thickened and washed red mud slurry can be performed in different ways. Traditional vacuum drum filters are widely used since they can handle large volumes of sludge and are operating continuously. In the last decade, more and more plants have replaced their drum filters by horizontal filter presses or high-bar steam filters of drum or disk filter design to increase capacity and improve the cake washing. The main claims of this process step are low moisture content in the filter cake, preferable in the range of 25 – 30 wt%, a clear filtrate and a filter cake with the lowest possible content of caustic soda. By using conventional drum filters a solid content of 50 - 65 % can be obtained.

The relatively small particle size distribution of $X_{50} < 10$ µm of the slurry often causes problems as a considerable number of fine particles pass the cloth during the beginning of the filtration cycle. As a result, the grids beneath the cloth get blocked with solids and filtrate is too high in solids. To avoid this, it is necessary to adjust the separation efficiency of the cloth preferably without losing velocity. Best results, in regards to filtration efficiency, purity of filtrate, cake release and cleaning properties are obtained from a Polyamide 12 cloth. In addition to that, PA 12 is characterized by an excellent resistance to abrasion, so can considerably prolong the life of cloth.

In the past decade, many OEMs have reacted to alumina refineries' requirement for increasing production rates by implementing filtration systems offering considerable higher capacities.

Continuous filters have improved by putting filter elements in pressure vessels which have the option to use steam to achieve filter cakes with 25 – 28 % moisture content or even below. In the case of using steam, even a Polyamide 12 would not resist these high temperatures. For this demanding application PEEK (polyether ether ketone) cloth performs best. It is applicable at high temperatures in a strongly alkaline environment and provides excellent wear properties.

Optional to the described equipment is the use of horizontal filter presses. Besides traditional filter presses, fast cycling filter presses are in use. The selection of a suitable filter cloth depends primarily on filtration speed and filter plate size. Due to the high feed rates, the filter cloth is subject to a much higher stress than on conventional filter presses. The challenge is to provide excellent retention of even very fine particles and to guarantee a high throughput at the same time. These are objectives that are actually conflicting. Secondly the enormous filter sizes require an extraordinary stability of cloths in regard to elongation and shrinkage. Practical experience has demonstrated that a heavy Polypropylene monofilament, optionally a mono/multifilament provided best results in regards to filtration results and form stability. In filters offer highest throughput performance which has a considerable mechanical impact on the filter cloth.

6. Conclusion

In summary, the following applies across all filtration process steps in an alumina refinery: the life of filter cloth and thus operating cost is closely linked to the right choice of cloth material in terms of resistance against temperature, chemical attack and abrasion. Precise manufacturing according to the needs of the equipment has a further important impact on the life of cloth. Yarn type, number and thickness of thread as well as the weave type play a significant role when it comes to the question of how to improve throughput and filtration efficiency of cloth. The Bayer process requires a great deal of filter media which is a significant cost factor in a plant. It is worthwhile to evaluate each individual process, to examine ways to improve, and thus save on costs.

7. References

1. Reinhard Bott, Advanced filtrations methods for pregnant liquor purification, *TMS*, 137th Annual Meeting & Exhibition, New Orleans, Louisiana, 9 – 13 March 2008.
2. J. Hahn, New performances in seed filtration by modern disc filters, a feasibility review *Proceedings of the 6th International Alumina Quality Workshop* 2002.
3. J. Hahn, Improved filtration and washing of AL-hydrate product: Cost savings by modern filter design.