Influence of Weaving Parameters on the Mechanical and Filtration Properties of a Fabric

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Abstract

In Alumina industry, the process consists of many different steps of filtration using different types of fabrics. The fabrics must answer to different functionalities such as particle retention, productivity, cake moisture, chemical and temperature resistance. Moreover, all the fabrics have also to be adapted to the type of machines, where they are used, and have to be sometimes elastic or dimensionally stable, resistant to scaling but also against abrasion, be flexible to secure the sealing, and more. All these parameters will influence the filtration performance and the lifetime. But a fabric is built with totally different parameters such as type of yarns, count yarns, weave pattern, and those parameters will define, weight, pore size, air permeability, tensile strength at breaking, T3, T10. So, a legitimate question is how to build the most efficient fabric for the customer with weaving parameters, and how those parameters are relevant.

For that, Sefar has launched a complete study based on fabrics used in the alumina process and create a lot of variants built by changing different weaving parameters, only 1 element at each time, to be able to evaluate the impact of each of them and be able to better adapt the fabric to the functionalities requested. In that study, a standard fabric used in alumina, has been declined in different versions of weave pattern, diameters of yarns in warp direction, count yarn in warp, type of yarns in weft direction such as mono in different diameters up to multi in different dtex. Moreover, to be able to extract correct conclusions, all this changes have been done on the same machine with the same conditions of finishing and even, when it was possible during the same weaving production.

The first results found in lab, shown that some parameters of the fabric have a huge influence on important functionalities such as particle retention or cake moisture but are in contradiction with other important parameters such as tensile strength. This study has shown also that some parameters are not always part of the technical datasheet. But this first conclusions found in lab test is not enough, so in parallel, Sefar and a customer partner have also launched tests to check the relevancies of common parameters in the definition of the fabric as representative of needs.
In the presentation, Sefar will share the results of this study, with answers to some questions but also an opening to new questions.

Keywords: Filter media, Filtration properties, Filtration behavior, Lifetime, Cake moisture, Filtration performances.

1. Introduction

Before to study the impact of the filter media specifications on service life or filtration properties such as cake moisture, or particle retention, it is important to understand the filtration principles and how a filter media is designed. Indeed, those three items of complementary information will illuminate the possibilities given by the filter media in terms of process optimization.

1.1 Filtration Principles

The first important notion is the filtration theory described by Darcy laws and its impact on the filter media development.

$$\frac{Q}{\Omega} = \frac{\Delta P}{\mu \times R} \qquad (1)$$

Where:

Q Outflow (also equal to dV/dt)
Ω Surface
μ Viscosity of the slurry to be treated
R Resistance to the flow (incl. Resistance of the cake & resistance of the fabric)
V Volume

Considering $\mathrm{R} = R_{\mathrm{cake}} + R_{\mathrm{cloth}}$
And as $R_{\mathrm{cake}} = a \bullet \frac{dM_{cake}}{\Omega}$
And $dM_{cake} = R_{\mathrm{cake}} \bullet dV$

where:

α specific weight of the cake (/ unit if surface)
W density of the cake
M Mass

We find after some integrations into the previous formula, the following formula:

$$\frac{t}{\mathrm{V}} = \left(\frac{\mu \times \alpha \times W_{cake}}{2 \times \Omega^2 \times \Delta P}\right) \times V + \left(\frac{\mu \times R_{cloth}}{\Omega^2 \times \Delta P}\right) + Constant \qquad (2)$$

With this formula, by working at constant pressure, the formula becomes a linear curve type

$$\frac{t}{\mathrm{V}} = a \times V + b \qquad (3)$$

In laboratory as t, V, Q, Ω, μ and ΔP are measurable, it is possible to evaluate different filter media and compare their relative own resistance R_{cloth}, independently of the slurry or the equipment type.

Just as an example, the development of our fabric "High Capacity".

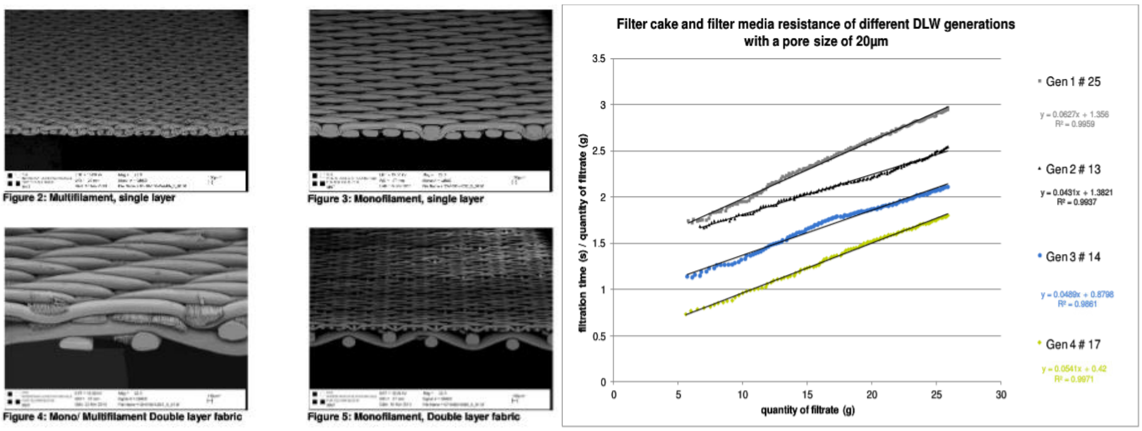

Figure 1. Evaluation of the R_{cloth} of different filter media design (on right) and picture of the corresponding filter media (on left).

Another study done by Sefar on the clogging, blinding of filter press cloths can be shared during the ICSOBA exhibition.

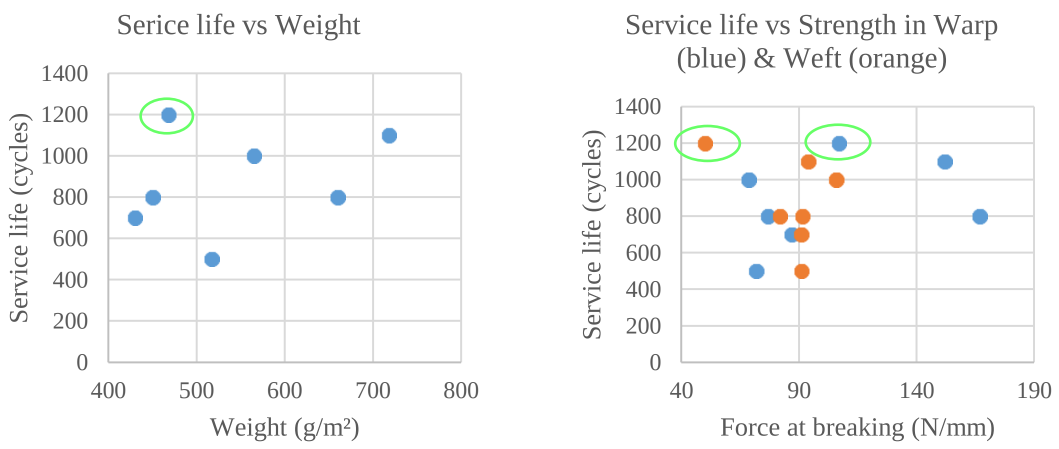

Figure 13. Relation between service life and weight (on left) and tensile strength at breaking (on right).

3. Conclusion

This study has shown three main information which contradict some common belief.

Firstly, there is no interest in using air permeability to choose the proper filter media in terms of particle retention. Air permeability can be considered as a help for possible improvement of filtration time but without full certitude. However, air permeability stays for Sefar a crucial fabrication parameter to ensure a god and reliable product.

Secondly, the medium pore size is a relevant parameter to optimize particle retention, only when we compare similar design of filter media.

Third, to increase service life, it is crucial to first analyze correctly the failure mode. Thinking that a heavier fabric with similar specifications will help would be a mistake.

Sefar is still working on better understanding the relation or no relation between filtration behavior and filter media to be able to develop the best filter media for our customers.