Filter media performance and its influence on filtration results

Experience, expectations and possibilities in vacuum and pressure filtration
Content

- Introduction
- Filter media design
- Laboratory results
- Scale up results
- Final conclusion
- Filter media selection

6 step guideline
Introduction

Questions a filter media user should raise:

- How can the performance during vacuum or pressure filtration be positively influenced by the filter media?
- What is the influence of the filter media on filtration performance in cake filtration?
- Is it possible to influence the filtration time by using the “right” filter media?
- Which filter media parameters have to be taken in account?

- Point out influences and parameters related to the filter media during cake filtration process in pressure and vacuum filtration
- Integrate findings in filter media design and in your process!
Filter media design

Filter media parameters that could influence the filtration process:

- Fabric construction (Weaving pattern)
- Pore size, shape and pore distribution
- Number of pores per cm²
- Filter media air and liquid permeability
- Resulting flow resistance
- Suitability for the use on the filter equipment

→ Observe design influences in lab
→ Verification under working conditions
Content

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- 6 step guideline
Laboratory results

Pressure nutsch filter test set-up:

- Calcium carbonate CaCO₃ (Omya 10H) with D₅₀ = 15 µm
- Suspension with 20% solid content
- Pore size of filter media = 1.2 – 2.0 x D₅₀ of CaCO₃
- Filter media with different weaving pattern, pore designs, air permeabilities and pore count are observed

→ Laboratory tests are carried out under identical conditions- variable parameter = filter media
Laboratory results – focus air permeability

Air permeability vs. filtration time - comparison of 2 DLW generations

- DLW constructions of 2 generations
- Different air permeability

→ Significant influence of fabric design
→ Reduction of filtration time by 10 % from Gen 2 to Gen 3
→ Air permeability is one indication, but not the only selection criteria!

Figure: Air permeability vs. filtration time of two generations of DLW
Laboratory results – focus on pore count

Air permeability vs. filtration time - focus only on 20µm pore size

- DLW construction
- Same average pore sizes
- Similar air permeability
- Different number of pores

→ Number of pores has a significant influence on filtration time at a comparable level of filtrate clarity
→ The higher the number of pores, the shorter the filtration time

Figure: Number of pores vs. filtration time of DLW of the same pore size
Laboratory results – media resistance

Air permeability vs. filtration time - focus filter media resistance

- DLW construction
- Same average pore sizes
- Similar air permeability
- Different number of pores

→ Number of pores has a significant influence on filtration time and resulting filter cake and media resistance
→ Lower filter media resistance, shorter filtration time

Figure: Filter media and filter cake resistance vs. filtration time
Conclusion

How to decrease filter media resistance, have the same particle retention and improve throughput at the same time?

- Ideally shaped pores for good particle retention and highest flow rate
- Good media drainage to avoid micro liquid patches thanks the support and drainage layer (Double layer weave fabrics)
- High permeability (air and liquid due to the high pore number)
- Increased number of pores per cm²

→ Appropriate filter media selection leads to shorter filtration time and increases filtration efficiency
Conclusion

These findings were integrated in latest filter media developments

→ Verification of laboratory results under working conditions
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Scale up- Zinc ore beneficition

Starting position (Laboratory)

- Improve filtration rate to cope with increased slurry feed
- Filtrate clarity shall be kept stable (≤ 1 g/l)
- Moisture content target: less than 45%

Actions taken (Laboratory)

- Carry out vacuum nutsch test
- Analysis of current used filter media
- Select alternative fabric to achieve the listed targets

Result: Targets should be met with SEFAR TETEX® DLW HD

<table>
<thead>
<tr>
<th>Parameter filter test lab</th>
<th>Unit</th>
<th>Details &amp; Values</th>
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<td>Test reference</td>
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<td>Vacuum Nutsch Test RDno. 21/14</td>
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<td>Vacuum pressure</td>
<td>mHg</td>
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Filter media | SEFAR TETEX® DLW | Single layer fabric

| Filtration rate | (m³/sec) | 18.00 | 17.42 | 17.11 | 16.78 |
| Filtration capacity | (m³/m²) | 17.71 | 16.95 |
| Solid content filter | g/l | 0.77 | 0.73 | 1.01 | 0.90 |
| Residual cake moisture | % | 54.40 | 55.72 | 56.70 | 57.10 |
| Thickness of cake | mm | 1.10 | 1.20 | 1.00 | 0.90 |

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<th>Test 2</th>
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<td>m³/sec</td>
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SEFAR TETEX® DLW HD
Scale up- Zinc ore beneficación

Results (Scale-up)

- Filtration rate increased by 7%
- Reduced cake moisture (4%) and reduced solid content in the filtrate
- Confirmation of the lab data during 40 production days
- A more stable filter belt in terms of lifetime (4000 hrs +) and elongation was provided

Conclusions (Scale-up)

- Improved mechanical performance due the double layer weave construction
- One layer is mainly for the filtration and one layer for the mechanical performance responsible
Scale up - Coolant filtration

Starting position (Laboratory)
- Metal impurities in coolant increased (process changed)
- Utilized filter media needed to be adjusted
- Improve particle retention (reduce load on secondary filter)
- Improve throughput (reduce number of filter cycles)

Actions taken (Laboratory)
- Analysis of current used filter media and amount of particles in the coolant
- Select fabric to reduce amount of particles in the filtrate at similar flow rate as today

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<th>Test Condition</th>
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<td>Zeit in Sekunden</td>
<td>Filtrationszeit, Kuchenbildungszeit</td>
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</table>

6. Particle retention behavior of analyzed fabrics

Fig. 3: Cake formation on reference fabric
Fig. 4: Cake formation on alternative 1
Fig. 5: Cake formation on alternative 2
Scale up- Coolant filtration

Results (Scale-up)
- Fines in filtrate reduced by 29%
- Liquid throughput increased up to 66%
- Lifetime of the filter belt increased

Conclusions (Scale-up)
- Fabric with higher air permeability and different pore structure created a higher resistance during trials
- Cake build-up time and overall resistance were improved by different fabric design
- Permeability is not sufficient to describe the filter media properties
Summary scale-up results

- New filter media constructions offer additional benefits
- Separation of function (filtration and drainage/transport layer) creates significant advantages
- Pore size and permeability are not sufficient to describe the filter media properties
- Additional information as pore count are needed
Content

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- 6 step guideline
Final Conclusion

- Media resistance and resulting cake resistance depending on fabric construction, pore size, pore shape, pore count and media permeability
- Filter media design is one key element for a successful filtration
- It is possible to enhance the filtration performance significantly with
  - Higher permeability
  - Increased number of pores
  - Improved pore shape
Filter media selection 6 step guideline

A high air permeability and a high number of pores results in a lower filter media resistance while still keeping back the same amount of fines. The lower filter media resistance leads to shorter filtration time and/or better cake washing and drying behavior.

→ Paying attention to a key element means often reducing overall costs!
The versatile filter media manufacturer

- Leading filter media manufacturers have to provide more than physical filter media data
- Application and process know-how is needed in order to define the most suitable filter media solution for a specific filtration task
- Sefar offers these services and helps its customers to enhance their results
Thank you for your kind attention

For more information visit our booth or check www.sefar.com
Laboratory Tests - utilized materials

**Filter media** - different generations of DLW (Double layer weave) constructions with similar MFP and reference single layer fabrics

<table>
<thead>
<tr>
<th>No.</th>
<th>Material</th>
<th>Filament type</th>
<th>Weave pattern</th>
<th>Pore size MFP (µm)</th>
<th>Pore count (1/cm²)</th>
<th>Air permeability @ 200 Pa (l/(m²·s))</th>
<th>Water permeability (l/(m²·s))</th>
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Laboratory Tests - utilized suspension

- **Suspension** - CaCO$_3$ (Omya 10H), 20 % saturated

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**Figure**: Particle distribution and particle characterization of CaCO$_3$ suspension

<table>
<thead>
<tr>
<th>Particle size distribution</th>
<th>μm</th>
<th>0.4 – 80</th>
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<td>D$_{50}$</td>
<td>μm</td>
<td>15</td>
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<tr>
<td>D$_{80}$</td>
<td>μm</td>
<td>25</td>
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<tr>
<td>D$_{90}$</td>
<td>μm</td>
<td>55</td>
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<td>pH</td>
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<tr>
<td>Density Solution</td>
<td>g/ml</td>
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</table>
Laboratory Tests- utilized equipment

- **Test equipment**
- Pressure nutsch @ rt
- Filter area of 12.6 cm²
- Max. cake height 25 mm
- Pressure of 0.7 bar
- Suspension volume 40 ml

Filter media resistance $R_T$ and filter cake resistance $r_c$ were calculated as characterizing factor. It unifies all influences such as particle size and distribution, pore shape, porosity and structure of filter cake and filter media. Both factors are calculated, analyzing the measured filtrate quantity over time (1), (3).

$$R_T = \text{filter media resistance (1/m)}$$
$$a = \text{axis intercept} \, a$$
$$A = \text{filter area (m}^2\text{)}$$
$$\Delta p = \text{pressure difference (Pa)}$$
$$\eta = \text{viscosity liquid (Pa's)}$$

Figure: Right: test set up – schematic (1), left: pressure nutsch test equipment
Laboratory results – focus air permeability

Air permeability vs. filtration time - focus on 20µm avg. pore size

- DLW construction
- Same average pore sizes
- Different air permeability
- Different number of pores

Air permeability is no significant influence when comparing same pore sizes

Number of pores is the only difference and has to be taken in account

Figure: Air permeability and filtration time at same pore size
Laboratory results for fabric selection

Filter media resistance vs. filtration time

- Same average pore sizes
- Improvement of filtration time by choosing a media with lower resistance
- Lower resistance is achieved by selection of a filter media with a higher number of pores
  ➔ Filtration can be enhanced significantly by dedicated media engineering (permeability, pore count and shape)

Figure: Filter media resistance vs. filtration time