Efficiency on the test bench

KIT: Maximum cleaning performance with minimum use of filtrate

Cake-forming solid-liquid separation is an established standard in numerous industrial processes. However, thin filter cakes are often formed during filtration of suspensions with low concentrations of fine-grained particles which then prove problematic during backwashing. Since they adhere so strongly to the filter medium, full regeneration is difficult. Patrick Morsch, postgraduate student at the Institute for Mechanical Process Engineering and Mechanics (MVM) from the Karlsruhe Institute of Technology (KIT), is investigating which parameters can sustainably improve the efficiency of these processes. Optimized dutch weaves (ODW) made of stainless steel from GKD – Gebr. Kufferath AG play a key part in his results. He spoke to us about the overall procedure and his findings to date.

What is the significance of residue-free filter cake discharge in industrial production processes with fine-grained particles?

Patrick Morsch: Small particles form very small pore diameters in the filter cake, leading to high flow resistance even at minimal cake thicknesses. The fast drop in the flow rate of the filtrate stream caused by this leads to a significant loss of efficiency. The key is then to reverse the flow and thereby remove the cake. However, if the cake refuses to come away completely, fragments can stick in place and cause increased flow resistance, rendering the backwashing process ineffective. The required backwashing rate then needs to be increased and the process performance drops.

In which applications is this a typical challenge?

Patrick Morsch: Examples include algae filtration during production of biodiesel, anode slime during electrolysis, partition of a catalyst in pharmaceutical processes or cleaning of process streams in the petrochemical industry. With these examples, the particles dispersed in a suspension are smaller than 20 µm. Classic applications are titanium oxide, fine chemicals, precious metal catalysts, cooking oils and fats, as well as paints and pigments. As a general rule, however, the flow rate and backwashability are key factors for process efficiency in any solid-liquid separation process.

What was the main objective of the investigations?

Patrick Morsch: The investigations focused on defining the process parameters for optimum cake discharge with use of as little filtrate as possible. The idea here was to give users the opportunity to determine the required backwashing rate for a complete cake discharge without the need for time-consuming measurement processes. In light of the large number of weave types, particle systems, and different backwashing filtration designs, the key was initially to define criteria for good or poor cake discharge. One qualification feature was the quantity of filtrate required per square meter of filter surface for good backwashing results. This parameter was coupled to the qualification feature of the covered area based on image evaluation. The images captured removal from the surface of the media covered by the filter cake and thereby the regeneration progress over time – based on the mesh type, the particle system, and the cake thickness.

How was this implemented by experiment?

Patrick Morsch: The experiments were performed in a fluid environment with leaf and cartridge filters under laboratory conditions and then on a large, industrially used pilot filter with analogous process parameters. Five different mesh types used in industrial applications – Atlas, Dutch weave and twill meshes – were investigated. In terms of synthetic meshes, one 11 µm and one 14 µm twill mesh, as well as one plain Dutch weave were used in the leaf filter. With the laboratory cartridge filter, this range was expanded even further. For the metal meshes, we tested optimized weaves (ODW 10 and ODW 20) from GKD, as well as one 25 µm Porometric mesh. The selection was made on the basis of the mesh size and flow rate, since Dutch weaves and twill meshes display marked differences in terms of porosity at the same mesh size due to the type of weaving employed in their production. When selecting the particles, we not only chose various materials, but also quite intentionally varied the particle shape and size distribution. That's why we also used aluminum oxide and other materials in addition to silicon and calcium carbonate particles. Ranging from 0.1 to 2 bar, the backwashing pressure corresponded to the typical parameters of backwashing in liquid phases. The filter cakes were between 0.3 and 3.3 millimeters thick.

What did the investigations show?

Patrick Morsch: On the leaf filter system, we were already able to observe that the concentration of the suspension for a volume concentration < 1 percent by volume does not have any impact on the backwashing results. At the same time, it became clear that the weave type and stability of the materials used play a key part in terms of mesh performance. High porosity of the media is essential for efficient backwashing. However, atlas meshes and twill meshes have a low porosity due to their structure. Plain dutch weaves made of plastic and metal offer the porosity conducive to a high flow rate and thereby also very few contact points for the filter cake to adhere. This lower adhesion means that a lower backwashing rate is required.

Where do plastic and metal meshes differ in terms of backwashing results?

Patrick Morsch: Striking differences were observed in the context of material stability and backwashing results. The apertures of plastic dutch weaves are limited by the production process. Apertures < 10 µm can only be achieved through calendering. This makes the mesh thinner and less stable – causing it to bulge during backwashing. This increases the risk of a thin cake rupturing and only being partially removed. In addition to this, the bulging increases the required backwashing rate for synthetic meshes as compared to rigid meshes by slightly more than double. Thanks to their material-specific stability, metal meshes with similar separation rates do not suffer bulging. The optimized dutch weaves from GKD performed accordingly well in the test. The backwashing rate with ODW 10 was just 2.5 liters per square meter, and ODW 20 was even better at 0.8 liters per square meter. Thanks to their high porosity, a thin cake is also sufficient for complete discharge. The faster cake buildup increases the number of cleaning cycles, for example in intermittent cake filtration – so the overall level of filtrate is extremely high – and thereby further improves process efficiency. Out of the five meshes being tested, the ODWs therefore impressed the most in terms of backwashing rate and quality of cleaning.

How did the other metal mesh perform in the test?

Patrick Morsch: The Porometric mesh from GKD did not really have any competition during these tests, as it is still a very new mesh type and one which we had not originally planned to include in the testing. We were therefore also skeptical as to whether the plateaus of the meander-like surface structure would present contact surfaces with too strong adhesion. During filtration, however, the extreme porosity of this three-dimensional mesh type was the real challenge. The initial volumetric flow was so high that our measurement system was at first unable to capture it due to the nozzle in the flow meter. Only after making adjustments were we able to establish the required cake thickness and then perform backwashing. As a result of the very high porosity, we were able to observe both good filtration properties and a very good regeneration performance. It should be noted that the discharge direction of the filter cake ran parallel to the meander form of the mesh, which I would recommend to the user for this mesh.

How would you summarize your investigations?

Patrick Morsch: Particularly in the case of fine-grained, thin filter cakes, the stability of the filter medium plays a key part in terms of the quality of cake discharge with use of as little filtrate as possible. The fineness of synthetic mesh is limited by the weaving technique used. Finer apertures can only be achieved through calendering. In preliminary trials, a tested 5-6 µm synthetic satin mesh exhibited extremely high flow resistance, however we still plan to test several others. The stretching properties of plastic can increase the backwashing rate by up to 100 percent. Thanks to its material-specific stability, metal mesh enables higher stability of the wires and thereby a finer mesh with greater porosity. This also means that only a thinner filter cake is generally required for complete cake discharge, which leads to shorter cleaning cycles and improved process efficiency. In terms of the meshes investigated, optimized dutch weaves and Porometric mesh made of stainless steel therefore displayed the best results with regard to porosity, reduction in backwashing rate, and quality of cleaning. However, I am currently only able to confirm that this statement applies for Porometric in terms of quality. Porometric is still being installed in the laboratory filter for further tests to enable us to gain quantitative results as well, as we have for the other meshes.

9.272 Zeichen inkl. Leerzeichen

GKD – WORLD WIDE WEAVE

As a privately owned technical weaver, GKD - Gebr. Kufferath AG is the world market leader in metal, synthetic and spiral mesh solutions. Four independent business divisions bundle their expertise under one roof: Industrial Mesh (woven metal mesh and filter solutions), Process Belts (belts made of mesh and spirals), Architectural meshes (façades, safety and interior design made of metal fabrics) and Mediamesh® (Transparent media façades). With its headquarter in Germany and five other facilities in the US, South Africa, China, India and Chile – as well as its branches in France, Spain, Dubai and worldwide representatives, GKD is close to markets anywhere in the world.

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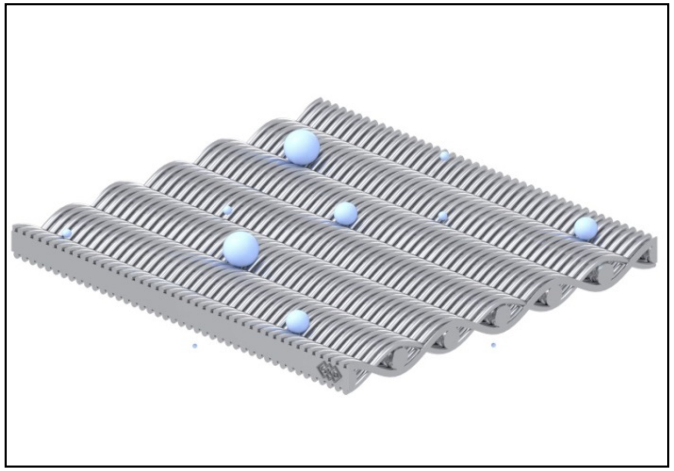
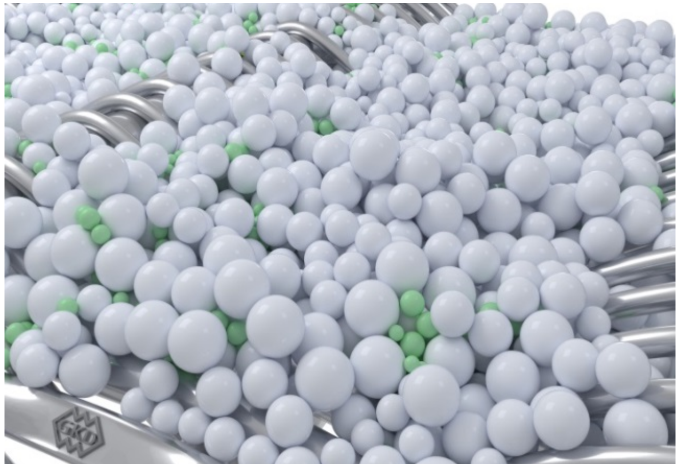
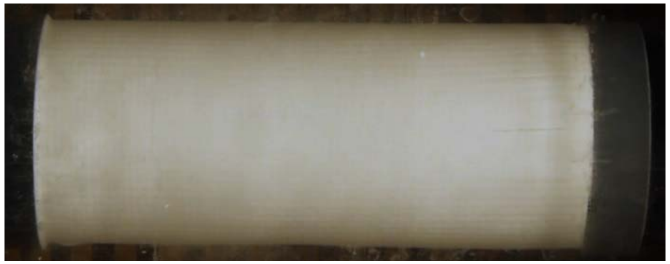
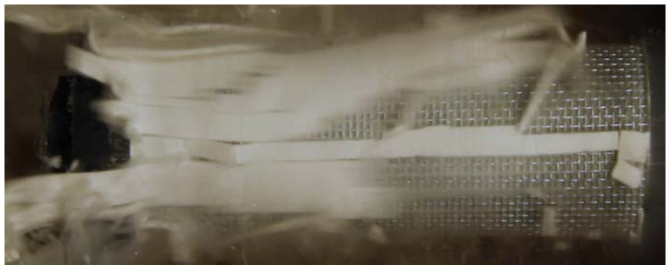


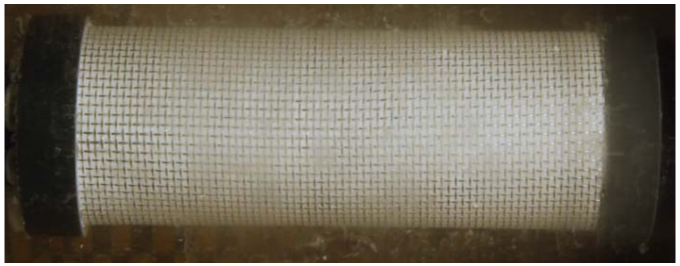
Picture 1: Optimized dutch weaves made of stainless steel from GKD do not bulge at mesh sizes < 10 µm and exceed the tested meshes in terms of backwashing rate and cleaning quality.



Picture 2: As a result of the high porosity both good filtration properties and a very good regeneration performance were observed.







Picture 3-5: Cleaning behaviour of optimized dutch weaves from GKD in test.

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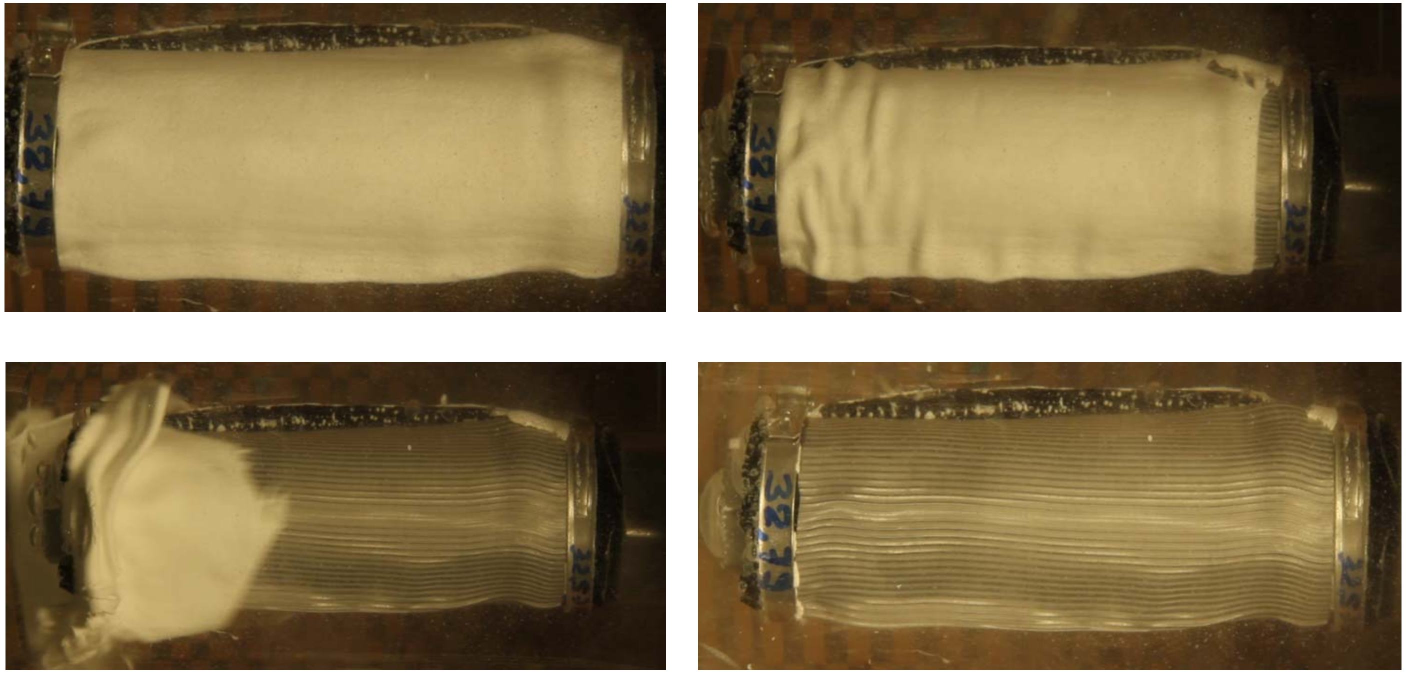

Picture 6-9: Cleaning behaviour of the Porometric mesh from GKD in test.

We will be happy to send you the desired images in printable resolution by e-mail.

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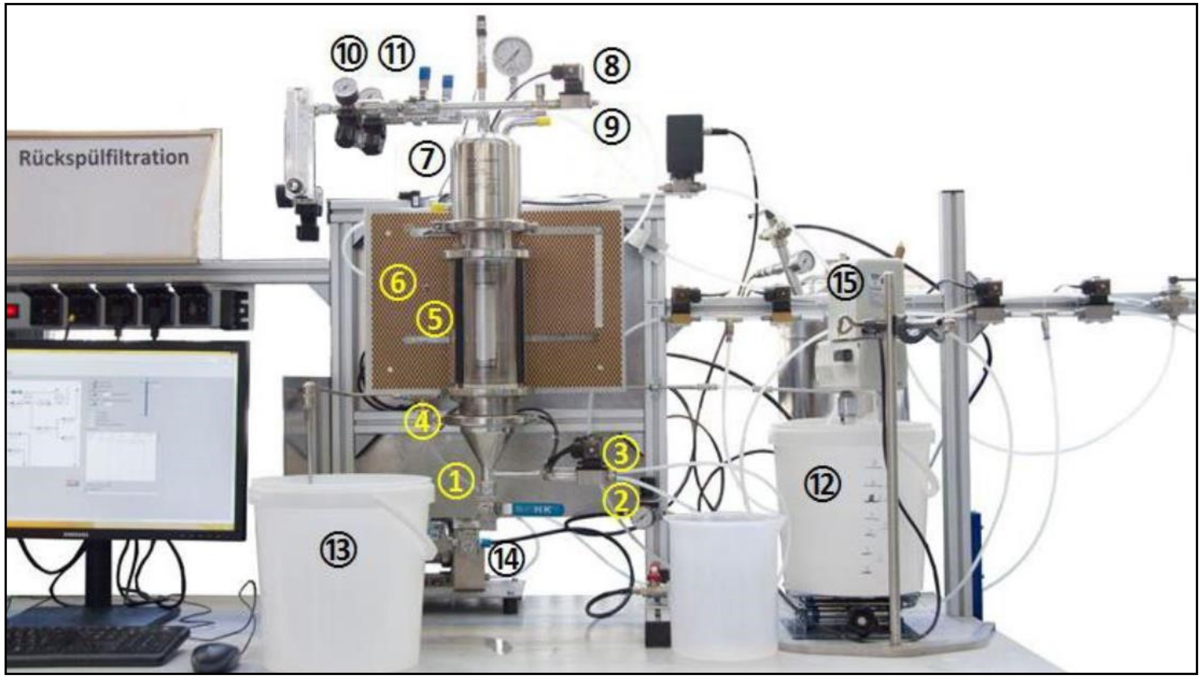

Picture 10:

1 = Drain sleeve
2 = Infeed into the glass cylinder
3 = Tube for performing the backwash
4 = Bottom end of the filter
5 = Glass cylinder
6 = Contrast plate with LED lamps and scale
7 = Head connection of the laboratory filter
8 = Filtrate outlet
9 = Overflow
10 = Tube in which the gas for providing the impulse for the regeneration flows
11 = Tube for performing drying
12 = Container for the suspension consisting of tap water and particle system
13 = Clear water container
14 = Double membrane pump
15 = Agitator

GKD
WORLD WIDE WEAVE

Picture 1-2 © GKD

Picture 3-10 © Patrick Morsch

We will be happy to send you the desired images in printable resolution by e-mail.

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