Developments in the membrane technology sector

Report about the "2019 Aachen membrane course for water technologies"

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AVT's "Membrane course for water technologies" held at RWTH Aachen university and directed by Prof. Dr Matthias Wesseling, was presented as an international event once again this year: the event has been held alternately in German under the "Hochschulkurs Membrantechnik" title or, as in 2019, in English under the "Aachen membrane course for water technologies" title. Its international orientation was also reflected in the participants: 34 participants from 7 countries and different industrial sectors made their way to Aachen.

A wide range of topics covering membrane separating technology were presented to the group of predominantly young participants. The selected topics provided an overview of the multitude of different membrane processes, separation models, module designs and membrane materials used in a wide variety of applications such as treating drinking water, treating municipal waste water as well as the treatment of industrial waste water flows.

A carefully organised basic lecture helped to orient and structure the complex and extensive topics. The basic difference between pore flow membranes and solution-diffusion membranes is still expedient and it was clearly explained here. Transferring the different substance transporting models into the designing and structuring of membrane processes for use in applications went very well.

The participants were given fascinating insights into the architecture and structuring that has to be used with different membrane materials and types through the presentation of high-resolution SEM (Scanning Electron Microscope) images in the "Materials & Structures" section.

Fig. 1 shows a polymer membrane with circular pores and a pore size of approx. 5 µm, to which another membrane layer with a pore size of approx. 0.2 µm was added. Inorganic as well as ceramic membranes, their manufacture, configuration and application options were also discussed and explained in detail during a guest lecture given by P. Bolduan, from atech innovations GmbH. Fig. 2 shows a cross-section of the different geometries used in ceramic tubular membranes. Going from so-called "single-bore" membranes, which are just "simple" tubes, up to "multi-bore" modules with different diameters and sizes and round, oval or even angular flow channels means that (virtually) everything is now possible. A new thinking direction here is to use helically-profiled flow channels to improve the fouling properties of ceramic membranes.

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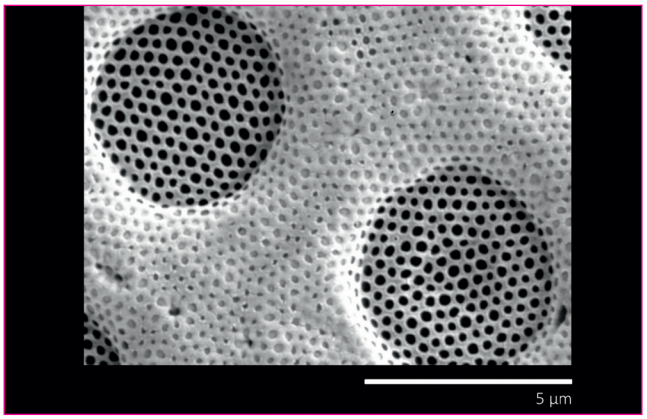

Fig. 1: Membrane architecture / Image: AVT

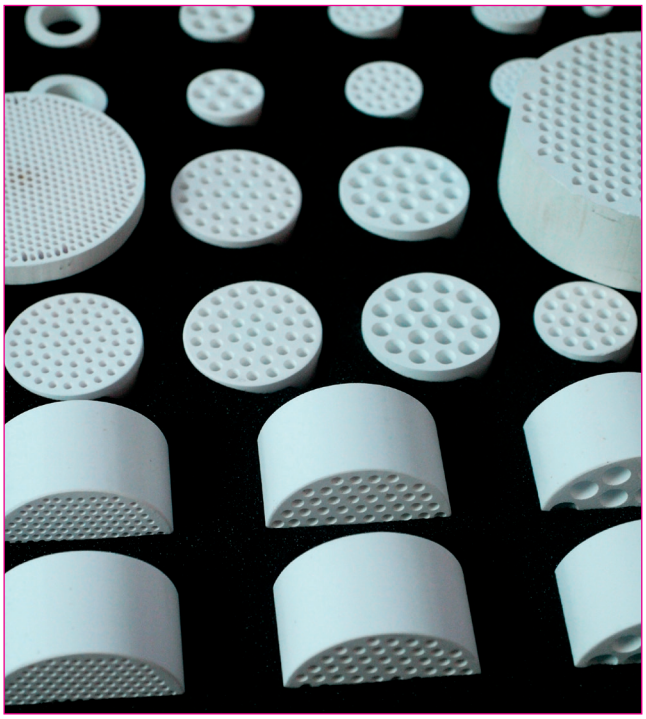

Fig. 2: An example of ceramic membrane technology

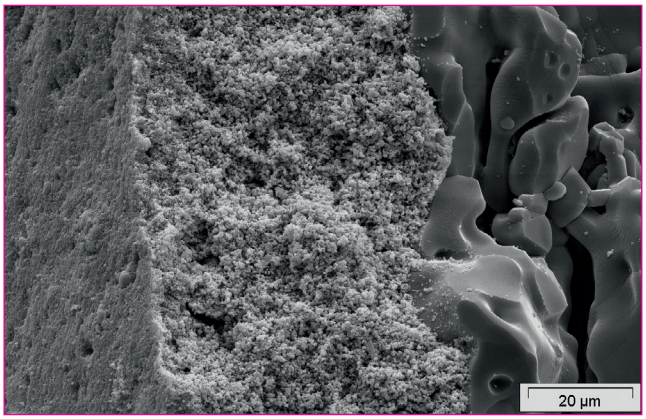

Fig. 3: Ceramic 6-8 µm carrier structure with an MF coating (Image: atech innovations GmbH)

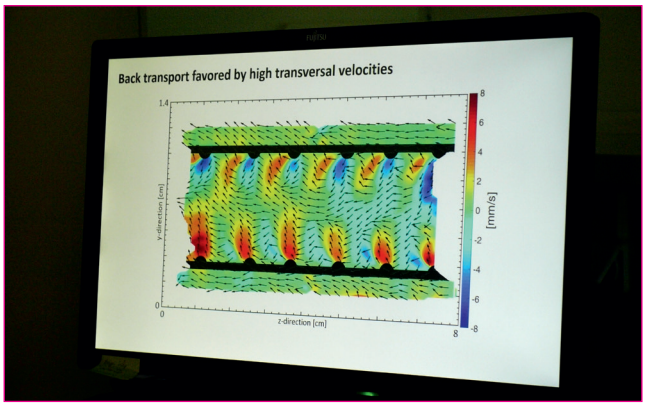

Fig. 4: Flow performance in a tubular membrane, longitudinal section

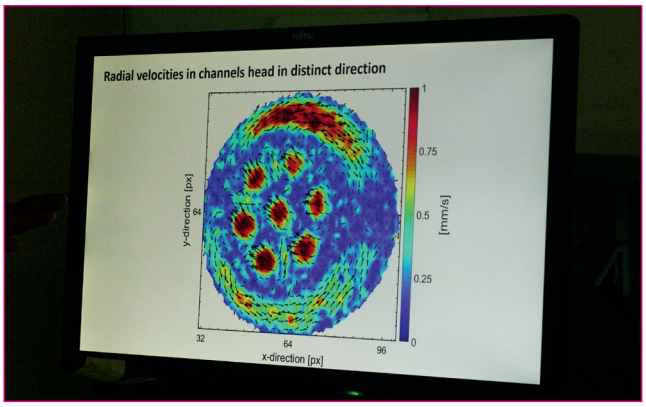

Fig. 5: Flow performance in a multi-bore tubular membrane, cross-section

The structuring and morphology of ceramic membranes are shown in Fig. 3. A carrier material (right side of the image) with a pore width of 6 to 8 µm was coated with a finer suspension here so that a micro-filtration membrane (left side of the image) could be created.

Beside the pressure-driven reverse osmosis, nano-filtration, micro- and ultra-filtration membrane processes, two examples for electro-membrane processes were also discussed: well-established electro-dialysis and the relatively new capacitive membrane desalination or "Capacitive De-Ionisation" (CDI) process. Many interesting developments can be expected here, especially with the relatively new CDI process. A processing version was presented in which, to simplify matters, a "liquid electrode" was used in an activated carbon suspension to ensure that the ions were continuously removed. This provides continuous desalination without any process interruptions.

One of the seminar highlights was the AVT-lab-tour. Excitingly innovative and surprising discoveries are being made here almost every day! An imaging method able to display the flow patterns in technical devices was presented this year. As opposed to CFD simulations, the actual flow patters are displayed in real time. The technology used for this, i.e. CT (Computer Tomography), has been used in medical technology for a long time. With its help, a membrane can actually be seen "working" in real time.

Fig. 4 shows the flow distribution with direction and velocity of a flow going through a tubular membrane piece with small increases on the wall inside the tube. Also clearly visible here are the effects of the increases on the return transport into the core flow and the flow performance on the membrane's permeate side.

Currrently there are spatial limitions due to the dimensions of the CT's measuring chamber. The to be examined structure needs to functionable inside a small void. Nonetheless, the described measuring process provides deeper insights into the mass-transport-processes and this allows to verify the fluid-dynamic models and improve simulations. Fig. 5 shows the fluid-dynamic performance of a multi-bore ultra-filtration module. An unexpectedly inhomogeneous and non-symmetrical velocity distribution can be seen on the permeate side.

A spirally-curled hollow-fibre membrane caused much amusement amongst the presentation's participants – more so because it is not yet known whether and if an advantage would result from using this special geometry.

Given the huge amount of content that was imparted during the relatively short time available, it is all the more pleasing to find that all of the course documents and presentations are still available to the participants online after the event. The so-called "Moodle" (Modular Object-Oriented Dynamic Learning Environment) platform was used for this. It provides both the relevant presentations as well as extensive reference and literature lists for further study. The contents can be specifically post-edited and used optimally. The user will also receive feedback about the specific "processing statuses".

To summarise, we are talking here of the successful continuation of an already legendary event. Organisation, course contents, didactic preparation and supporting programmes all help to create a positive learning atmosphere and make it easy for us to digest the "heavy stuff" involved in membrane technology.

Wether the younger engineers are taking their first steps into the world of membranes or if the "older hands" are refreshing their knowledge: either way, the ATV's MCW is worth the while.

Quality matters.

Filtration plants must guarantee a reliable separation performance and a long service life - the quality of the membranes is critical to achieve these goals.

With its **ceramic membranes atech innovations gmbh** provides quality in every respect: State-of-the-art ceramic know-how, many decades of experience with materials and process technology, use of high-purity materials for internationally unrivalled products in top quality at affordable prices.

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