Non-circular channel ceramic membranes: Why are they worth it?

The dilemma of circular channel ceramic membranes

Tubular ceramic membranes used in Ceramic Tangential Flow Filtration (CTFF) operate in inside-out mode and can have from one to multiple channels, through which the retentate is recirculated and concentrated.

They were first developed at industrial scale more than three decades ago, but existing state-of-the art know-how only allowed the production of membranes with circular channels. This fact soon created a dilemma in the use of ceramic membranes in CTFF:

- The filtration area of each filter element could only be increased by increasing the number of channels;
- However, the addition of more circular channels reduced their respective hydraulic diameters, making the channels unsuitable for higher concentrations and prone to blockages.

As a solution to this dilemma, TAMI Industries launched in the market the first industrial tubular ceramic membranes with non-circular channels in the mid 90's, after several years of R&D. Customers were skeptical due to the novelty of the solution and competitors assured that the concept was flawed. Trusting the science and strongly convinced by the efficiency of its products, TAMI Industries remained as the sole supplier of non-circular channel ceramic membranes for over a decade.

Ceramic membranes with different channel geometries produced by TAMI Industries.

Today, the existence of multiple competitors following the lead of TAMI Industries and copying the concept of non-circular channels is the strongest evidence that the non-circular channels solution is exhaustively tested, proved and approved.

Filtration area or hydraulic diameter?

In the past, having both was unthinkable

Why non-circular channels?

The circle is the geometric shape with the smallest perimeter for a given area. This means that membranes with circular channels present the smallest filtration area for any given hydraulic diameter. Therefore, combining the knowledge in fluid mechanics, ceramic material handling and CTFF, the scientists of TAMI Industries developed and mastered the production at industrial scale of ceramic membranes with non-circular channels.

This major breakthrough in tubular ceramic membrane production technology achieved by TAMI Industries in the '90s finally allowed the market to choose to have both: more filtration area in the same filter element without reducing hydraulic diameter. In other words, to produce more with less filter elements.

The advantages of non-circular channel membranes

Circular channel membranes are better represented in the market by 7-channel and 19-channel membranes. These are the shapes that require the lowest level of membrane manufacturing technology and are the only shapes produced by many suppliers even at the present. Some other suppliers followed the lead of TAMI Industries and developed their own versions of aftermarket non-circular channel membranes.

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The most obvious advantage presented by non-circular channel membranes is the increased filtration area compared to circular channel membranes of same hydraulic diameters. This advantage is illustrated in Table 1, comparing circular with non-circular channel membranes:

- 1 => 7-channel vs. 8-channel: for the same hydraulic diameter of 6mm, the 8-channel membrane delivers 25% more filtration area (0.16m^2 vs. 0.20m^2);

0.16m^2/membrane 0.20m^2/membrane

7-channel vs. 8-channel membrane

- 2 => 19-channel vs. 11-channel: for the same filtration area of 0.25m^2, the 11-channel membrane presents a larger hydraulic diameter, by 31% (3.5mm vs. 4.6mm);

0.25m^2/membrane 0.35m^2/membrane

19-channel vs. 23-channel membrane

- 3 => 19-channel vs. 23-channel: for the same hydraulic diameter of 3.5mm, the 23-channel membrane delivers 40% more filtration area (0.25m^2 vs. 0.35m^2);
- 4 => 31-channel vs. 49-channel: for a similar hydraulic diameter (2.8mm vs. 2.5mm), the 49-channel membrane delivers 51% more filtration area (0.33m^2 vs. 0.50m^2);

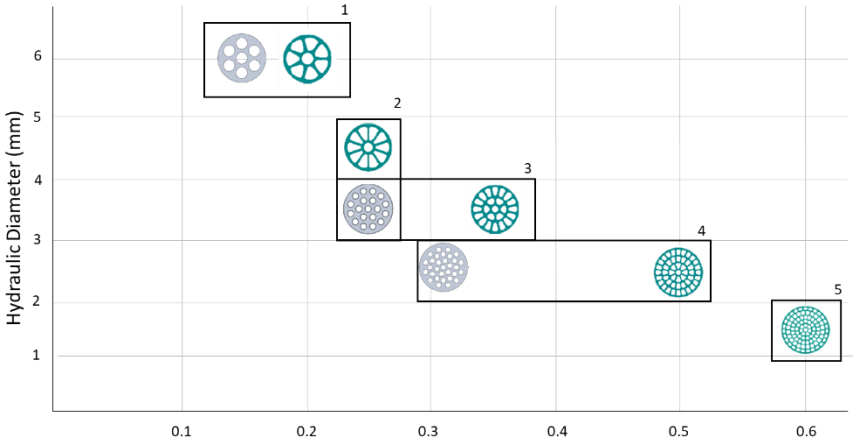

Figure 1: Comparison of membranes by Hydraulic Diameter x Filtration Area

- 5 => the 93-channel non-circular channel membrane is an unparalleled product. Offering 0.6m^2 per filter element, this is the true "hollow-fiber ceramic membrane" with 1.6mm hydraulic diameter.

In new CTFF units, non-circular channel membranes reduce the total cost of the project by reducing the total number of membranes and housings. This translates into compact units that require less pumps, less piping, less instruments and less accessories. This also reduces the number of parts and components that will require maintenance in the long-term.

In existing CTFF units, the replacement of circular channel membranes by non-circular channel membranes can increase the overall production capacity of the unit by 25% - 40% at a fraction of the cost of purchasing an additional CTFF unit.

Are all non-circular channel membranes the same?

"All that glitters is not gold."

No, non-circular channel membranes are not all the same. The creation of new channel shapes is not a simple exercise of imagination. The rationale of increasing the filtration area to produce more with less filter elements is only valid if the productivity of the membrane (i.e. the production of permeate) increases proportionally to the increase of the filtration area.

The current range of non-circular channel membranes offered by TAMI Industries is a result of decades of R&D and strong focus on innovation, protected by more than 30 international patents. This is the reason why, despite of the presence of aftermarket non-circular channel membranes, TAMI Industries can confidently answer to new and existing CTFF projects by saying: "*Yes, our range of non-circular channel membranes are the best solution*."

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- How a biorefinery increased capacity by 40%. Faster, cheaper and conveniently.
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- 23-channel vs. 31-channel ceramic membranes for degreasing bath.

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