

# Innovative Membrane Technologies BV is a producer of polyethersulfone (PES) membranes.



*Its founders are well experienced in the design and production of polymeric membranes, particularly as required for use in ultrafiltration (UF) and microfiltration (MF) – filtration of the types now in great and growing demand.*

The Company's membranes offer significant benefits in many areas of liquid filtration, including applications in the water treatment industry, the beer industry, the wine industry and the pharmaceutical industry. Of these, IMT's primary focus is in the water treatment market.

IMT's flagship product is a revolutionary UF membrane called SevenBore<sup>®</sup>, a multibore design incorporating seven capillaries into a single fibre. This breakthrough has effectively eliminated the primary cause of failure for hollow fibre membranes – fibre breakage. SevenBore<sup>®</sup> UF membranes offer superior quality and performance in water treatment applications, and can be installed in facilities that were originally designed for other membrane types.





### The Technology

Innovative Membrane Technology produces hollow fibre PolyEtherSulfone ultrafiltration and microfiltration membranes in a variety of configurations, materials and sizes, each designed to meet the needs of specific applications.



Membranes serve as a microporous physical barrier that permits the passage of materials only to a certain size, shape or character. While membranes can be designed for separating a variety of substances, IMT membranes focus on removing contaminants from fluids (liquid and gas) such as water, beer, wine and pharmaceuticals.

IMT membrane modules are designed for inside-out filtration, meaning that the liquid passes from the inside of the hollow fibre, through the fibre's wall structure to the outside of the fibre. The fibre wall restricts the passage of contaminants. The filtrate is then exhausted from the membrane, ready for its intended use (e.g. drinking water, industrial process water, reclaimed wastewater, etc).

MF and UF are fundamentally similar filtration processes. They differ in terms of the size of molecules the membranes retain. Typical MF membrane pore sizes range from 10 to 0.1  $\mu\text{m}$  (micrometers, or millionths of a meter), while typical UF membrane pore sizes range from 0.1  $\mu\text{m}$  to 0.001  $\mu\text{m}$ . Other types of filtration include nanofiltration (NF) and reverse osmosis (RO), which retain even smaller molecules.

The hollow fibre geometry allows for a high membrane surface area to be contained in compact modules, or elements, providing high capacity while requiring minimal space. Unfiltered mixture flows through each hollow fibre (also known as a lumen). As the filtrate (the desired substance, comprised of small molecules) passes through the pores, or holes, in the microporous wall structure of the hollow fibre, the undesired substances (comprised of large molecules) are prevented from passing through the membrane wall.

The size of the pores in the fibre wall determines the size of the contaminant molecules removed. The removed portion, or retentate, is flushed from the membrane on a regular basis as part of standard operations for any facility in which it is installed.



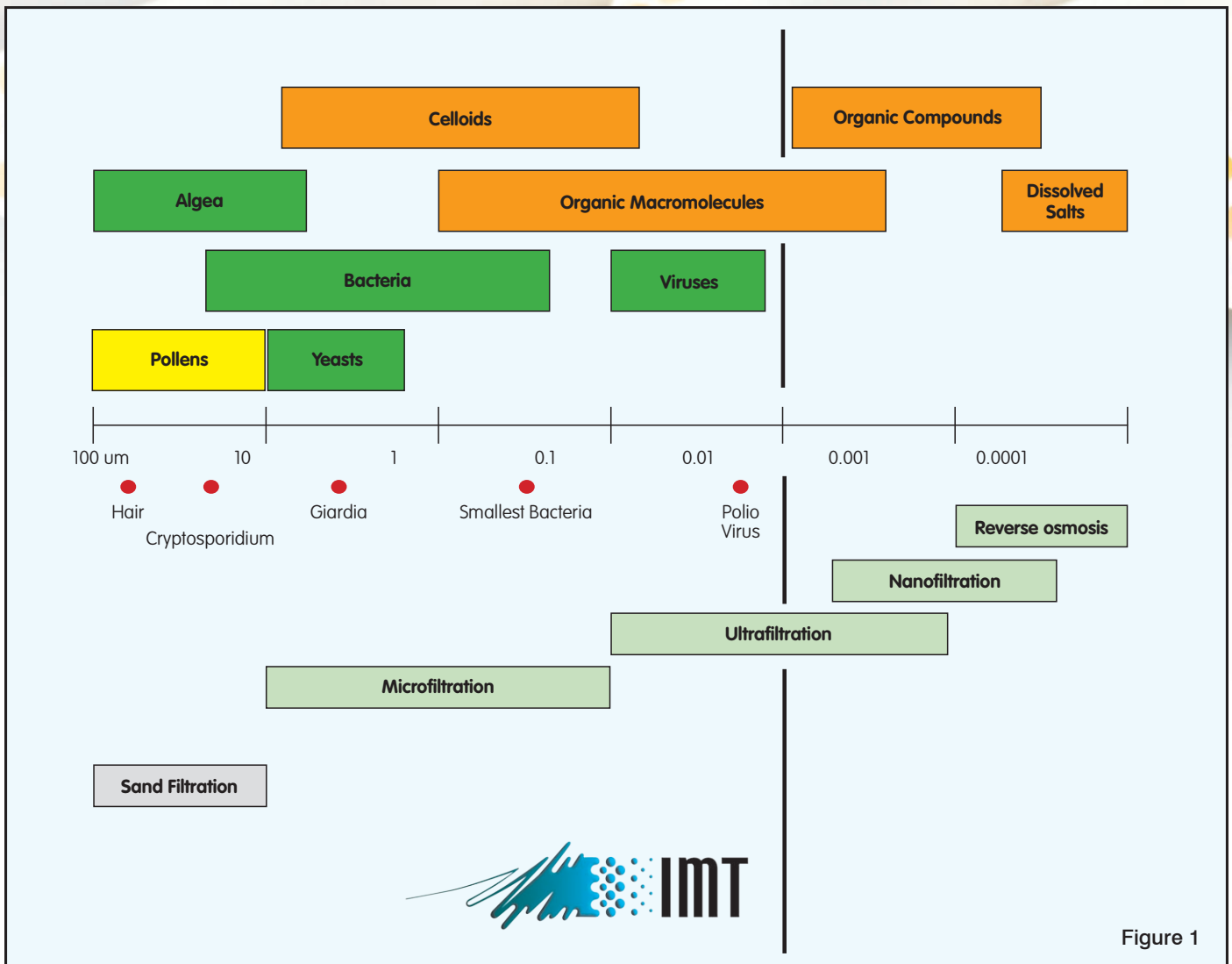


Figure 1

**Figure 1: Contaminant size vs. membrane pore size, measured in micro-meters, or millionths of a meter.**

As mentioned above, IMT produces membranes in the middle two categories, MF and UF.

**Microfiltration**

IMT offers MF membranes that provide an absolute barrier to the passage of solids from the carrier fluid (such as water) and therefore are capable of removing metals, bacteria, and other contaminants to their solubility limits. This also results in the removal of most colloids and therefore provides a filtrate that exhibits a very low Silt Density Index (SDI)

IMT can produce these hollow fibre membranes with inner diameters up to 2,2 mm.

**Typical applications for IMT’s MF membranes include:**

- Pretreatment RO
- Reclaim of water out of waste water
- Industry (proces) water out of surface-, or groundwater
- Non Water applications like Wine and Beer quarification

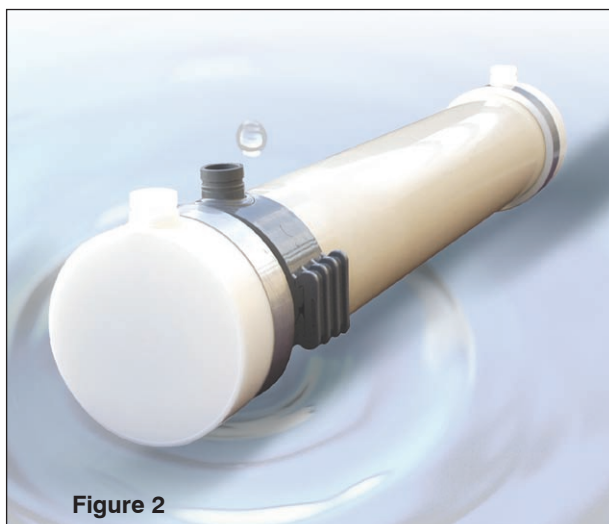


**SevenBore® Ultrafiltration**

IMT's flagship product is the breakthrough SevenBore® UF membrane, available in a variety of sizes and temperature ranges. This revolutionary membrane design offers superior strength, durability and hydrophilicity (friendliness to water), delivering high performance and excellent anti-fouling behaviour. The smallest elements offer 0.5 m<sup>2</sup> of membrane surface area, while the largest and most popular contain 50 m<sup>2</sup>.

hydrophilicity of its membrane material, thus significantly decreasing the “fouling”, that is commonly seen amongst the competition. The result: a longer-lasting membrane that offers superior cost benefits over time.

The SevenBore® elements are designed for a vertical configuration (see Figure 3), which allows the membrane to operate without pressure vessels, thus allowing for a smaller footprint for the rack installation. The inside-out filtration makes cleaning the membranes easy and efficient using backwash processes and Forward Flush.



**Figure 2**

**Figure 2: IMT's main product - the 50m<sup>2</sup> SevenBore™ UF element**

Introducing seven capillaries into a single fibre resolves the breakage problem common to other UF membranes. To date, not a single SevenBore® membrane element used for drinking water purification has failed due to fibre breakage. And the seven-capillary design is not the only breakthrough present in the SevenBore® membrane.

IMT's latest membranes also address another problem common to hollow fibre membranes – fouling. In a recent breakthrough, IMT developed a propriety method of increasing the



**Figure 3**

**Figure 3: Vertical installation of 50m<sup>2</sup> elements**

And with parallel operation of the elements, backwash does not pass to other modules. With pore sizes of 10 nm (0.001 μm), these UF membranes have a high removal capability for bacteria, viruses, colloids and silt (SDI – Silt Density Index).

**Non-water Liquid Separation**

While water treatment is the primary market for IMT's membranes, the Company's products can be used in all forms of liquid separation, including beer, wine, pharmaceuticals, etc. IMT has specialised customers using our



membranes for Wine Beer, Pharmaceuticals and Chemical separation. Specialised companies are active in these markets and IMT is sometimes closely involved in the realisation of such new applications.

#### **Recent Developments**

The Company recently achieved two major developments in its core membrane business. IMT has improved the hydrophilicity of its membranes, and also developed a method for manufacturing hollow fibre with an open outer surface. Both breakthroughs result in increased performance and cost benefits.

#### **Improved Hydrophilicity**

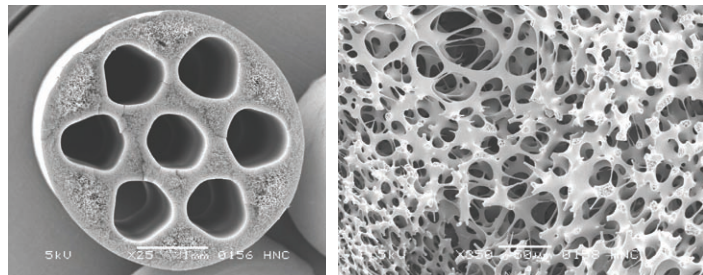
IMT recently developed a proprietary process for creating PES membranes with greatly improved hydrophilicity characteristics, effectively addressing the problem of “fouling,” a problem common to all other hollow fibre membranes. Fouling occurs when the pores begin to resist the passage of water, decreasing a membrane’s effectiveness over time. Most PES membranes use PVP (polyvinylpyrrolidone) as a coating to increase the hydrophilicity of the PES. Unfortunately, the PVP degrades over time, washing away during operation, decreasing the hydrophilicity and permitting more rapid fouling.

To solve this problem, IMT developed a proprietary additive and bound it into the structure of the PES fibre. This new additive cannot be washed away and, therefore, fouling is significantly reduced. This, in turn, increases the membranes efficiency and the ease with which it can be cleaned, further decreasing maintenance and operating costs.

#### **Open Foam and Outer Surface**

A short time ago, IMT discovered a way to produce hollow fibres in such a way that the outer surface of the membrane fibre remains open. Hollow fibre is manufactured using an extrusion process. Generally, the production of membrane fibre closes the surface of the fibre during extrusion. For a single bore fibre this is useful because it adds a little extra strength.

There is a price to be paid for this added strength. The closed outer surface impedes the exit of fluid from the membrane, which decreases efficiency. However, for single bore membranes, trading efficiency for marginal increases in strength is worthwhile. SevenBore™ fibres, on the other hand, are 20x stronger than typical single bore fibres. The added strength of a closed outer surface offers little benefit and decreases efficiency unnecessarily. So IMT developed a method for producing membrane fibre with an open outer



surface. The result is increased flow through the membrane and, thus, increased efficiency.

#### **IMT’s Strategy**

IMT focuses its business on producing membranes for the water treatment market. We think globally and seek collaborations with influential Engineering Procurement Companies (EPCs) and Original Equipment Manufacturers (OEMs) in each region of the globe. In nearly all cases, EPCs in the water treatment market are “total solution providers”. IMT enters these partnerships as the independent provider of membranes for the EPCs as they build new water treatment facilities or retrofit existing ones. As a membrane manufacturer, IMT focuses on cost leadership in the spinning of fibre and in the assembly of elements and on product and manufacturing innovation.

IMT currently does not enter into the role of providing systems or process engineering. To do so in the large-scale water treatment market would mean entering into competition with our own clients, a situation IMT seeks to avoid.