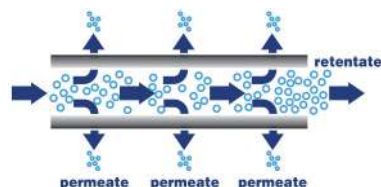




Principle

The principle of crossflow filtration is shown in the diagram below.

The product to be filtered is passed over a porous surface. As a result of a differential pressure, some of the liquid passes through the membrane and is collected as permeate (or filtrate). The remainder of the liquid flows through the channels of the element, back into the retentate tank and is recycled through the system.



Mantec Technical Ceramics Limited offers a range of Crossflow Microfiltration Elements and Housings.

We have been involved in the manufacture of Ceramic Crossflow Microfiltration Elements for many years and have enjoyed significant success with our Star-Sep™ Ceramic Elements in a number of varied applications.

To facilitate the cost effective use of ceramic technology for the treatment of larger volumes, Mantec Technical Ceramics has redeveloped the Star-Sep™ Ceramic Crossflow Membrane, which has a 5 x increase in filtration area compared with the original membrane.

Available Elements

The elements are available in two types, depending on the specific application.

- 1) Star-Sep™ Ceramic Crossflow Element 1200mm long x 32mm Dia, having 19 x star channels.
- 2) Star-Sep™ Ceramic Crossflow Element 600mm long x 20mm Dia, having 7 x star channels.

19 Channel x 1200mm Star-Sep™ Ceramic Crossflow Elements

The new generation of our 19 channel star tubular energy efficient crossflow microfiltration membranes incorporate all the proven advanced features of the original seven channel star membrane but with the following advantages:

- A 5 x increase in filtration surface area
- Cost effective ceramic membrane element
- Reduced module dimensions for a given membrane area
- Less complex module installation
- Reduction in footprint size
- Reduced axial pressure drop per unit length

The Star-Sep™ membrane filter has been specifically developed for efficient Crossflow Microfiltration. The filter channel's unique 'star' form increases the filtration area and induces



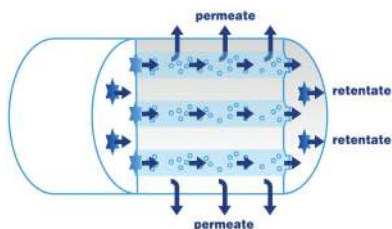
turbulence at lower crossflow velocities. Not only does this lower the volume compared with a circular channel of the same diameter, but also results in a reduction of the pumping energy requirement.

The cost effectiveness of the process is therefore substantially improved.



7 Channel x 600mm Star-Sep™ Ceramic Crossflow Elements

As with the 19 channel Star-Sep™ element, our 7 Channel component is designed for high value feedstocks, smaller systems and pilot plant flux and separation verification trials. It deploys the same unique *Star Form* geometry, providing the user with all the benefits of the Star-Sep™ technology.



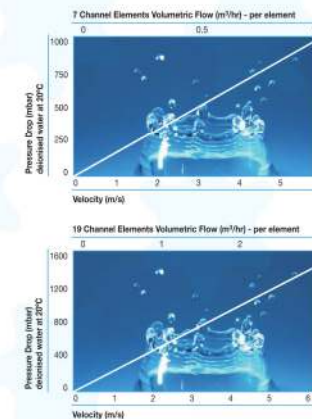
Advantages of the Ceramic Membrane

- Long and Reliable Lifetime
- High Stability in organic media
- Rigid with no creep or deformation
- Stable over a wide pH range
- Corrosion and abrasion resistant
- Insensitive to bacterial action
- Can be repeatedly sterilised by steam or chemicals
- Greater void area per unit area of filtration surface
- Ability to be backwashed
- Consistent pore size
- Can process highly viscous fluids
- Capable of regeneration after fouling
- Membrane surface-bonded to substrate by strong ceramic bonds

Hydraulic Characteristics of the Elements

The graphs below indicate the pressure drop through the membrane cross-flow star channels for given cross-flow velocities and volumetric flows.

Operating cross-flow velocities typically fall within the 4-6M/sec depending on the process fluid being filtered.



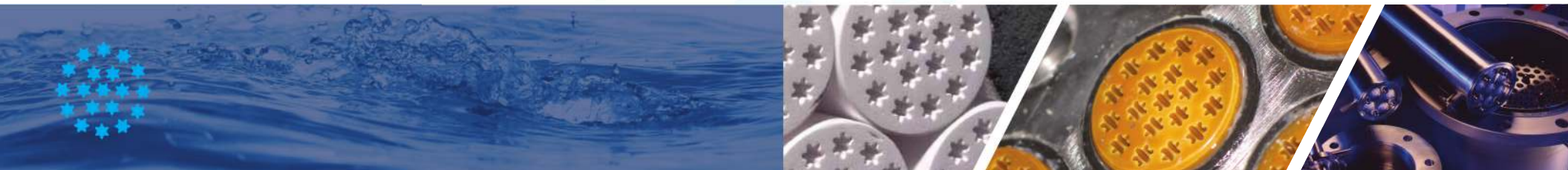
Housings

To complement our range of ceramic membrane elements we have developed a series of stainless steel module housings, each one being designed and constructed to exacting engineering standards.



Special housings are available on request. The housings are of modular design and can be combined to provide greater filtration area resulting in increased flow rates.

Single and Multi Element Housings are available to accommodate either the 7 channel or the 19 channel membranes. Our standard housings are designed to PD 5500 but the design can accommodate the requirements of ASME VIII if required. Materials include Stainless Steel, Duplex and Super Duplex. Housings are available to accommodate up to 300 elements, however, being modular, the housings can be stacked where greater permeate flow is required.



Systems

Mantec Technical Ceramics Ltd is associated with many of the leading system houses, process plant designers and contractors who regularly specify our Star-Step™ membranes. The OEM equipment can be made suitable for operation in all environments including zoned areas and can be constructed from materials that are compatible with all operational environments.

The performance of the Star-Step™ membranes enables the OEM systems to be skid mounted and modular in construction with particular emphasis



placed on ease of operation, maintenance, transport and installation.

Additionally, our subsidiary, Xtract Filtration Systems Ltd has developed a recovery technology through close collaboration with Mantec's Star-Sep™ technical team. This has resulted in an enabling filtration technology unique to Xtract and its customers. The unique filter technology is combined with sophisticated control over the filtration process that is fully automated and totally reliable, resulting in a raw material recovery system that becomes indispensable to the production and operational process management.

Xtract filtration technology is:

- A consistent separation technology delivering a controlled density filtrate.
- Based on a chemically inert filtration media.
- A sophisticated, automated and reliable recovery process.

For more information, please visit www.xtractfiltrationsystems.com

Applications

- Oil / Water Separation
- Fuel Oil Cleaning
- Grey Water Treatment
- Bilge Water Separation
- Laundry Water Recycling
- Biomass Separation
- Blood Plasma
- Effluent Concentration
- Sterile Filtration
- Purification of Proteins
- Wine Clarification
- Fermentation
- Solvent Purification
- Fruit Juice Clarification

Pharmaceutical Antibiotic Production

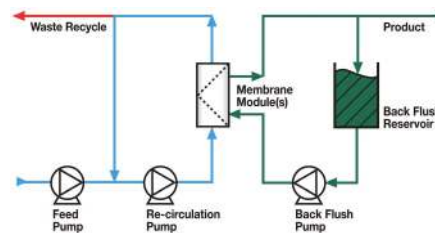
A major pharmaceuticals giant cut operating costs at its drugs plant in the UK, by replacing polymer with ceramic membranes. The filtration system supplied by Mantec Technical Ceramics comprised 4 banks of 8 housings, each housing containing 108 ceramic membranes. The total installation being 208 m².

The high profile antibiotic plant benefitted from the installation of the ceramic membrane system, with a payback time in a less than 15 months. The principal of crossflow microfiltration is common in many processing environments and is used in anti-biotic drug production to separate residual matter from a process liquor.

Typical industrial sectors

- Cosmetic
- Oil & Gas
- Marine
- Pharmaceutical
- Dairy
- Brewery
- Chemical
- Petrochemical
- Food
- Water Treatment

Typical System Configuration



Application Examples

Pharmaceutical Inoculants Production

In 2006, Mantec Technical Ceramics's Star-Sep™ Crossflow Microfiltration Membranes were installed by a major bioagronomics company as a key part of their inoculant production process. Inoculants, containing naturally occurring beneficial bacteria, are an essential crop input to produce legume crops.

The Crossflow Microfiltration System, incorporating the Mantec Technical Ceramics Star-Sep™ Ceramic Membranes, were installed at a UK facility to provide a means of concentrating the fermentation broth, following harvesting of the live bacteria, thereby increasing the production yield.



Oilfield 'Produced Water'

Produced Water is a growing problem for the Oil and Gas industry both on and off shore, as increasingly severe global legislation is focusing the industry's attention on finding a cost effective and environmentally acceptable answer.

A major oil company based in India successfully utilised a Star-Sep™ plant on produced water at three different oilfields. The resulting filtrate had <10ppm TSS and <5ppm oil. This plant was subsequently sent to Mumbai to be used by other oilfield operators and non-oilfield contaminated water.



Military/Naval Bilge Water

Mantec Technical Ceramics supply ceramic membranes for an innovative 'Bilge Water' separation system technology (below).

This system, produced by a major fluid systems OEM, is installed on the MoD type T45 & T23 frigates.

This system deals with complex combinations of hydrocarbons, from light hydraulic oils to heavy greases, in salt water that is heavily contaminated with bacteria. Oil in water content in discharges overboard of <5 ppm are achieved and the water is bacterially inert.



Military/Naval Fuel Filtration

The same OEM has based its innovative 'Fuel Filtration' system technology (below) on the Mantec Technical Ceramics Star-Sep™ membranes to remove water and solids from gas turbine fuel.

These systems are installed on the MoD T45 frigates and are being considered for retro-fit to other warships as well as the new design CVF.



Application Examples

Commercial Laundry Water Recycling

One of Europe's leading commercial washing machine manufacturers is using Mantec Technical Ceramics's Star-Sep™ membranes for economic water recovery/recycle systems. The LWR systems utilise the Star-Sep™ membranes to recover 70 to 88%* of the effluent discharged to the quality requirements of the TSA specification.

Their current range of LWR systems are designed to cover effluent volumes in the range of 15 to 66 m3/hr. The main benefits of laundry water recycling include substantial reductions in water and effluent costs, significant reduction in energy costs (associated with heat recovery) and also reduction in salt usage. Typical payback of 1 to 3 years can be expected in most cases.

*Exact recovery is dependent on system design and TDS loading within effluent discharge.

Recovery expectations would be discussed on completion of site survey.



Essence Extraction Food and Drink / Fruit Juice Clarification

A company specialising in the processing of natural botanical extracts for the food and beverage industry have deployed a ceramic crossflow system, based on the Star-Sep™ membrane, to extract the essence for production.



Minerals Extraction / NORMs Separation

Imerys, formerly the world renowned 'English China Clay' company, have adopted the Mantec Technical Ceramics ceramic membrane to remove 'Naturally Occurring Radioactive Materials' (NORMs) which are concentrated by the membranes for safe disposal.



Star-Sep Technical Specifications

	19 Channel x 1200mm Star-Sep™ Ceramic Crossflow Element	7 Channel x 600mm Star-Sep™ Ceramic Crossflow Element
Material	α Alumina	α Alumina
Maximum Pore Size	5µm (substrate)	5µm (substrate)
Median Pore Size	2.7µm (substrate)	3µm (substrate)
Available Membranes	0.2, 0.35, 0.5, 0.8 and 1.2µm	0.2, 0.35, 0.5, 0.8 and 1.2µm
Porosity	31-35 Vol %	31-35 Vol %
Flexural Strength	40 Mpa	40 Mpa
Nominal Diameter	32mm	20.5mm
Length	1200mm	600mm
Channel: Star ID Nominal	2.8mm	2.8mm
• Star OD Nominal	4.6mm	4.6mm
Number of Channels	19	7
Filtration Area	0.33m2	0.06m2
pH Range	0.5 to 13.5	0.5 to 13.5
Maximum Temperature	140°C	140°C
Maximum Pressure	8 bar	8 bar



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