Process Description

DuPont Water Solutions

MEMCOR® XS, CS & CSII

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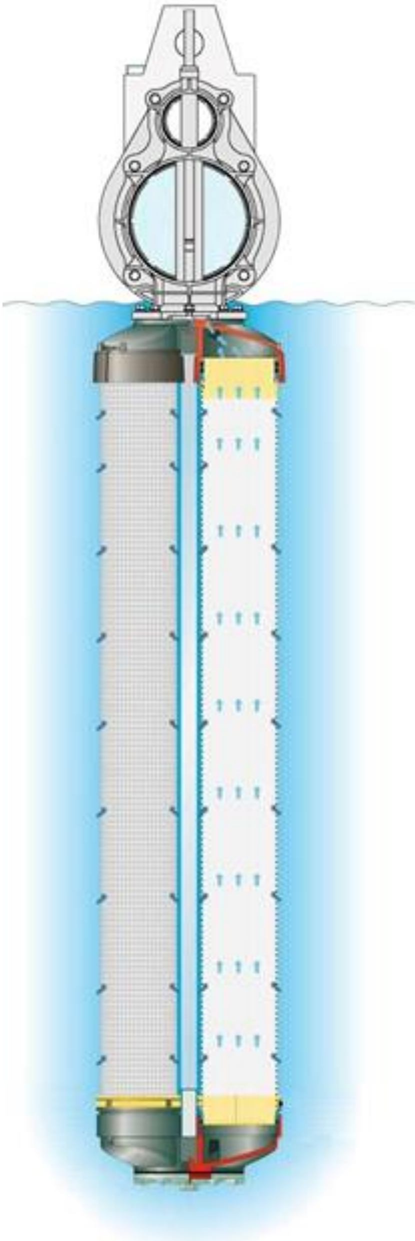
MEMCOR® XS, CS & CSII SUBMERGED MEMBRANE FILTRATION SYSTEMS



Note: Design, data and dimensions are subject to modification without notice.

INTRODUCTION

DuPont Water Solutions has unrivalled experience in the research and development of membrane filtration products and membrane manufacturing processes. It continues to produce leading edge technology membrane filtration systems that are used around the world for a wide range of industrial and municipal filtration applications.

For large capacity plants, the latest submerged technology from DuPont is the MEMCOR® CSII Membrane Filtration system. For these systems, DuPont will typically supply a number of CSII MemRACK® module rack header assemblies of the required length for the Cells in a plant. The module racks are then fitted with MEMCOR® L20 Membrane Filtration Modules in groups of four prior to installation of the rack into a Cell. A typical CSII MemRACK is shown in the figure below.

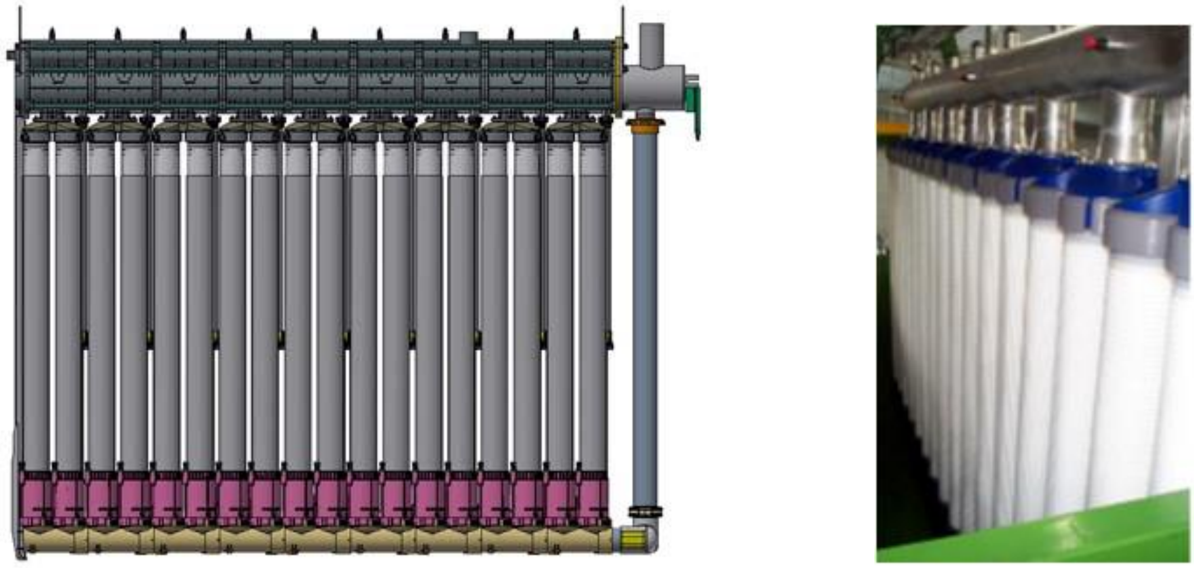


Figure 1

Left: *A side elevation of a typical CSII MemRACK® assembly, fitted with 36 L20 Modules (nine groups of four). Filtrate is collected from both the top and the bottom of each Module in the rack.*
Right: *An older stainless steel manifold rack assembly commonly used in CS and XS systems. The Filtrate Sub-Manifolds (Top Clovers, which appear blue in this image) hold the Modules in groups of four onto the filtrate manifold. Nylon Head Pieces are now commonly used instead of steel for manifold assemblies.*

Where the new CSII system is not suitable or desirable, DuPont continues to offer the Memcor CS system. CS module rack assemblies are fitted with the shorter MEMCOR® S10 Membrane Filtration Modules, also in groups of four.

CSII and CS plants are engineered and built to project specific requirements. Cells, piping manifolds, filtrate pumps, controls and instrumentation in these plants are usually provided by others to Memcor specifications.

For smaller submerged systems, DuPont offers Memcor XS Submerged Membrane Filtration Units. These Units are pre-packaged and factory tested, ready for site installation, and typically include module rack assemblies fitted with MEMCOR® S10 Membrane Filtration Modules, cell, filtrate pump, controls and instrumentation. XS Units are available with capacities of up to about 3 ML/day per Unit. Multiple XS Units can be installed to provide larger pre-packaged system capacities.

Memcor submerged systems provide high quality, highly efficient and reliable water filtration with a small plant footprint and economic operation.

A Memcor XS, CS or CSII Submerged Membrane Filtration Unit typically consists of the following equipment:

- Hollow Fibre Membrane Filtration Modules, typically with PVDF homogeneous asymmetric ultrafiltration (UF) membranes. Each Membrane Filtration Module contains thousands of fibres surrounded by a protective plastic mesh screen and sealed with polyurethane "pots" at each end;
- One or more module rack assemblies, made with either moulded plastic or stainless steel manifold components, that provide filtrate manifolding and an aeration air delivery system that feeds air to the lower end of each Module. Membrane Filtration Modules are mounted on the rack assembly in groups of four;
- The Cell, an open top tank in which the module rack assemblies are installed. XS Units are typically supplied with a pre-fabricated steel Cell. CS or CSII system Cells are usually supplied and built by others in either steel or concrete to Memcor specifications;
- A Filtrate Pump which draws water from the Cell through the Membrane Filtration Modules;
- Valves, instrumentation and controls;
- A frame, skid or supports on which the Cell, pipework and other core equipment is mounted.

Each Membrane Filtration Module forms a serviceable filter element that is easily removed from the rack for repair or replacement.

Memcor S10 Membrane Filtration Modules used in CS and XS systems are "single-ended" with filtrate drawn only from the top of the Module. The lower pot seals the bottom end of all the fibres and slots in the bottom pot direct aeration air up into the fibre bundle during backwashing.

Memcor L20 Membrane Filtration Modules used in CSII systems are "double-ended" meaning that filtrate is drawn from both the top and the bottom of each Module. This improves the efficiency of the filtration and backwash processes. Aeration air is delivered to the bottom of each L20 module, and aeration efficiency is optimised by a centre tube that surrounds each module and retains the air inside the fibre bundle until it reaches the upper part of the module.

For further submerged MF Unit details please refer to drawings including the MF Unit Process and Instrumentation Diagram and General Arrangement and to relevant equipment specification sheets.

TYPICAL SYSTEM COMPONENTS

One or more Memcor XS, CS or CSII Submerged Membrane Filtration Cells form the core equipment necessary for an operational membrane filtration plant.

When the membrane system is installed on site, external equipment, typically supplied by others, is connected to it by means of appropriate termination points. Please refer to the relevant MF Unit and System Process and Instrumentation Diagrams and to the MF Unit Termination Point Schedule for further details.

Figure 2 below shows the equipment in a typical submerged membrane filtration process. The main parts of the system are described in the following sections.

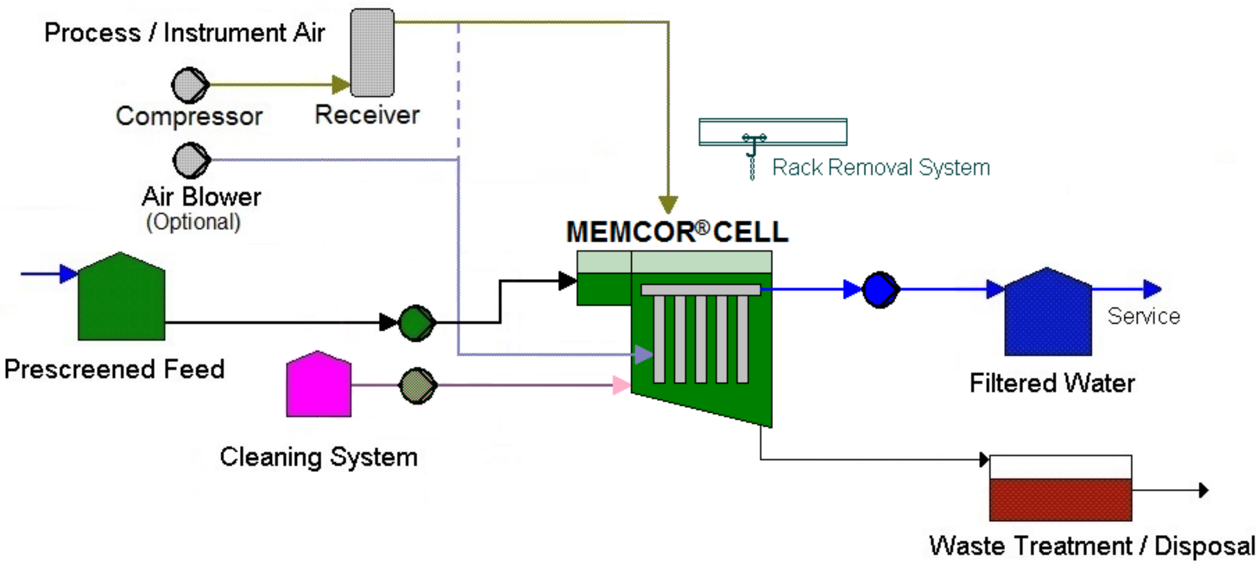


Figure 2

Typical Memcor XS, CS or CSII submerged membrane filtration system components

Feed System

Raw water must be screened to remove large solids before it enters the Cell. Some systems include other raw water pre-treatment, such as coagulant dosing or pH correction.

Some limitations on feed quality apply for Memcor Modules, typically including the allowable feed temperature, pH range and exposure to oxidants, such as chlorine. Please refer to the relevant Membrane Filtration Module specification sheet for details.

Typically, a feed tank holds raw water that is then either pumped or flows by gravity to the Cell. Feed flow into the Cell or Cells may be controlled by a positioning valve which regulates Cell level. A level transmitter is generally used to monitor the level in the feed tank and to place the Unit into standby if the level is low.

Filtrate System

Filtrate flow rate from the submerged MF Unit is typically controlled by a variable speed drive on the filtrate pump. Filtrate usually flows to a local filtered water tank or direct to a service outlet pipe. Available filtrate discharge pressure from the Unit may be limited so please contact DuPont Water Solutions if further process design assistance is required.

A level switch or level transmitter in the filtrate storage tank is generally used to monitor the level in the filtrate storage tank. This is used to place the Unit into standby when the tank is full and, when the stored filtrate level drops again, to return the Unit to service.

During the backwash process, filtrate is pushed through the membranes for a short time in the reverse direction to flush solids from the membrane filtration modules. Unlike some other membrane filtration systems that require a filtrate backwash pump, Memcor submerged MF Units can use the filtrate that is stored within the Unit for backwash. Use of external pumped or air driven filtrate backwash is also possible.

Compressed Air System

Clean, dry compressed air is required for the operation of pneumatically actuated valves and for backwash, integrity testing and draining filtrate from the inside of the Membrane Filtration Modules.

In many systems, cell filtrate manifolds are primed during startup using a compressed air powered ejector. Process air that enters the Membrane Filtration Modules must be oil free.

DuPont recommends the use of quality compressed air filters, typically cartridge type filter/coalescer units. On larger systems, refrigerated air dryers are recommended. Air lubricators are not necessary. Air receivers should be fitted with automatic drains to remove condensate.

In some systems, including smaller Memcor XS Submerged MF Units (typically fewer than about one hundred Membrane Filtration Modules), the compressed air supply may also be used to provide the air for aeration in the backwash process. Above this number of Membrane Filtration Modules, it may be more economical to provide a separate air blower system for the backwash aeration air supply.

Optional Air Blower System

In the backwash process, low pressure air is blown into the Rack and distributed down and into the bottom of each Membrane Filtration Module then released up into the fibre bundle. This is the Aeration step of the backwash sequence. In many systems air blowers are used for this part of the backwash process.

The blower system must be able to deliver air at the required flow rate, at a pressure that can displace water from the Rack so that it reaches the bottom of the Membrane Filtration Modules. The bottom ends of XS and CS Modules are usually submerged in a Cell to a depth of around 1.4 to 1.5 metres (55 to 60 inches), while CSII Modules are usually submerged to a depth of around 2.0 to 2.1 metres (78 to 83 inches). Depending on the Cell arrangement, an aeration air delivery pressure at the Rack of from 20 to 40 kPa or 3 to 6 psi will usually be required. Delivery line losses must also be taken into account, so blowers should be located as close as possible to the Cell or Cells.

Typically, the air for this purpose is supplied by a system of one or more air blowers, typically rotary lobe (Roots) type oil-free positive displacement blowers. Usually where multiple blowers are installed, a duty blower provides the necessary flow to backwash a single Cell then duty is rotated to the next available blower.

The air blower system should be fitted with appropriate air inlet filter(s) and discharge relief valve(s). In some plants variable speed drives on air blowers are used to regulate flow and reduce running costs. An actuated blower exhaust valve may also be fitted to prevent blower discharge against a closed head.

Backwash Waste Disposal System

When the filtrate backwash and aeration steps of the backwash sequence have been performed, the solids that have been loosened from the Membrane Filtration Modules need to be drained from the Cell. This “high solids” backwash waste usually drains by gravity to a low tank or sump near the Unit. The draining process should be quite rapid since the longer it takes, the longer the Unit is off-line and not producing filtered water.

Depending on local requirements, backwash waste usually needs further treatment before disposal or re-processing.

Cleaning System

Clean water is required for the preparation of cleaning solutions and for system rinsing after a cleaning cycle, and should preferably be from the cleanest water source available at the site. In surface water and similar applications the water can usually be MF Unit filtrate. For high TDS (Total Dissolved Solids) applications such as sea water, brackish water, bore water or waste water, a separate clean water supply is recommended for use during cleaning cycles. This fresh water may be from a town water supply or RO (Reverse Osmosis) permeate, if available, or similar good quality water for cleaning solution make-up. Heating of the water may be recommended in cold climates to improve cleaning efficiency (please refer to the “Water Heating System“ section below)

The cleaning system typically includes concentrate storage and a concentrate transfer pump for each cleaning chemical, so that concentrate dosing can be automated. Container and pump sizes will vary depending on the volume of each concentrate type to be transferred. Each pump should have some means of calibration or flow measuring instrumentation to ensure accurate control of cleaning solution concentration. If concentrations are too low, cleaning will be less effective. If concentrations are too high, concentrate is wasted and equipment may be damaged.

The cleaning system may include bunded (containment) areas for this equipment, and possibly a delivery area set aside for transfer of concentrate from delivery vehicles to concentrate storage containers. Cleaning solution concentrates should be stored securely, out of direct sunlight and protected from the weather and extremes of temperature. Care should also be taken to ensure adequate separation of concentrates that may react dangerously with each other.

During a cleaning cycle, the concentrate transfer pump draws the required volume of cleaning solution concentrate from storage and injects it into water that is recirculated through the Membrane Filtration Modules and pipework by the Filtrate Pump on the Unit. The MF Unit is usually fitted with instrumentation on the discharge of the Filtrate Pump, such as a conductivity meter, that may be used to monitor the concentration of the recirculating solution and verify that it is within the required range. It can also be used to confirm complete rinsing after each cleaning cycle and for monitoring water quality in normal service.

Most Memcor MF Units operate with a cleaning regime that uses cleaning solution once only. This prevents the build-up of contaminants that can occur in cleaning solutions if they are used more than once.

Before using cleaning system equipment, operators should be provided with safety equipment and trained in its use. This includes Personal Protective Equipment (PPE) such as boots, overalls, aprons, gloves and face-shields and should include an eye bath and safety shower near chemical handling areas. Material Safety Data Sheets for all chemicals used should be readily accessible.

Cleaning Solution Waste Disposal System

On completion of the MF Unit cleaning cycle, the used cleaning solution is typically drained by gravity from the Unit to a waste disposal system. In many cases, this is the same disposal system that collects backwash waste. In some systems, a separate cleaning solution waste disposal system may be required.

The cleaning solution waste disposal system typically provides a means to neutralise the cleaning solution prior to further treatment or disposal. Additional chemical concentrate storage and transfer equipment may be necessary for this. Appropriate instrumentation is usually also required to monitor and control the neutralisation process.

Water Heating System

Warm cleaning solution has been found generally to provide improved cleaning effectiveness for membrane filtration systems. The preferred cleaning solution temperature range for Memcor MF Unit chlorine cleaning cycles is from 10 °C to 30 °C with an optimum of around 25 °C. For acid cleaning cycles it is from 15 °C to 35 °C with an optimum of around 30 °C.

Where cleaning solution temperature is likely to be much below 10 °C or 15 °C, a water heating system may be recommended. This is usually in the form of a Warm Water Tank with electric heating, that stores and heats clean water that is used for MF Unit cleaning cycles. Tank insulation and pipe lagging can reduce energy costs in these systems.

Other heating options include an electric immersion heater in the storage tank, or the use of heat tracing on insulated recirculation piping to provide in-line heating during cleaning solution recirculation.

The water used in the warm water system should be from the cleanest water supply that is available, as previously described in the “Cleaning System“ section above.

Appropriate instrumentation and controls should be fitted to the water heating system to regulate heating and to prevent water exceeding the allowable temperature from coming into contact with the Membrane Filtration Modules. Please refer to the relevant module specification sheet for temperature limits.

Instrumentation and Control System

Memcor Submerged Membrane Filtration Units are normally fitted with pressure, flow, temperature, level sensing and other instruments which are used to monitor operation of the Unit.

Larger multi-unit systems typically have additional instrumentation for system monitoring and control, including flow, pressure, feed channel level and tank level transmitters, and water quality instrumentation, such as turbidity, pH or conductivity meters.

A Programmable Automation Controller (PAC or PLC) controls all MF Unit functions. This may be included in the MF Unit control panel (where fitted), or may be external to the Unit. Where a local programmable controller is not supplied with the MF Unit, the Unit inputs and outputs may be provided in the form of a remote I/O system that can be networked to an external control system. An operator interface provides operators with the means to monitor and control the system.

The Memcor system control philosophy recommends process validation to ensure that the MF Unit is operating within recommended guidelines. If the Unit operates outside normal limits, a warning is typically generated. Operation outside wider limits can generate a shutdown alarm which stops the Unit, reducing the risk of damage to system components. A detailed troubleshooting guide is usually provided to help operators pinpoint problems within the system.

DuPont also produces its proprietary MEMLOG® data logging system that can be supplied for Memcor Membrane Filtration systems. These data logging systems collect detailed MF Unit operating data in a standard format that can be quickly and easily collected, either locally or remotely, and analysed using proprietary software. The data can be displayed and analysed to assess MF Unit condition and to optimise operating performance and maintenance requirements.

Module Maintenance Equipment

Memcor Submerged Membrane Filtration Units have built-in Integrity Test routines that can be initiated either manually or automatically at predetermined intervals. If system integrity loss is detected, suspect modules identified by the test can be isolated for later removal from the Cell for individual inspection and testing.

DuPont can supply all the tools and equipment necessary for Rack and Module maintenance and for operation of Module filtrate isolation valves (where fitted). Most submerged MF plant installations are provided with equipment that can be used to remove a Rack from the Cell and to hold the Rack while individual Membrane Filtration Modules are accessed.

On smaller Units, a Rack Removal mechanism is usually supplied. On larger Units and for multiple Cell plants, an overhead crane or hoist, for example the Memcor Service Access Platform or MEMSAP®, is usually employed. The hoist system is used to lift Racks out of the Cell and move them to a location where Membrane Filtration Modules can be maintained before being returned to the Cell.

Membrane Filtration Modules that have been removed from the Rack can be integrity tested one at a time in a Test Vessel that DuPont Water Solutions can also supply. The Test Vessel allows a

Membrane Filtration Module to be tested and “pin-repaired” if necessary to restore integrity prior to return to service.

Please consult DuPont Water Solutions for details of module maintenance equipment, such as standard tools, test vessels and repair pins.

MEMCOR SUBMERGED UNIT OPERATION

A Memcor XS, CS or CSII Submerged Membrane Filtration Unit operates automatically to produce high quality treated water and at the same time, concentrates removed solids for further processing or disposal.

Memcor has developed industry leading controls and process monitoring functions to enable fully automatic operation with sophisticated alarming functions and troubleshooting guidance for operators.

The main operating states or sequences of the Unit are described below. Please consult the relevant MF system operating manual for detailed operating instructions.

Figure 3

CSII Display Unit showing a cutaway view of the upper Filtrate and Aeration Air manifold and the two lower Filtrate Manifolds, a sectioned L20 Membrane Filtration Module (on the left), and Centre Tubes fitted around the right hand Modules.

Shutdown

Shutdown is the normal power-up state of the Unit and the state entered when the Unit is stopped and alarms are cleared. In Shutdown, the Unit is ready to start.

Startup

When the Unit is started from Shutdown, and feed is available, the inlet valve opens to allow screened feed to enter the Cell. When the Cell is full and the modules are covered with water, a vacuum priming system is typically used to fill the modules, racks and filtrate pipework in preparation for the filtrate pump to operate. A Filtrate Manifold Level High Switch is usually used to monitor liquid level during priming.

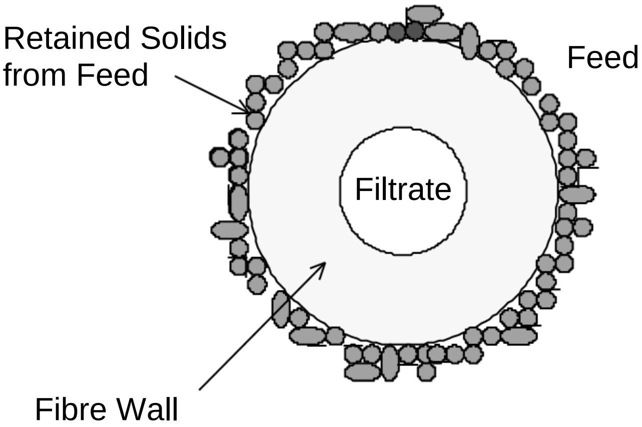
Filtration

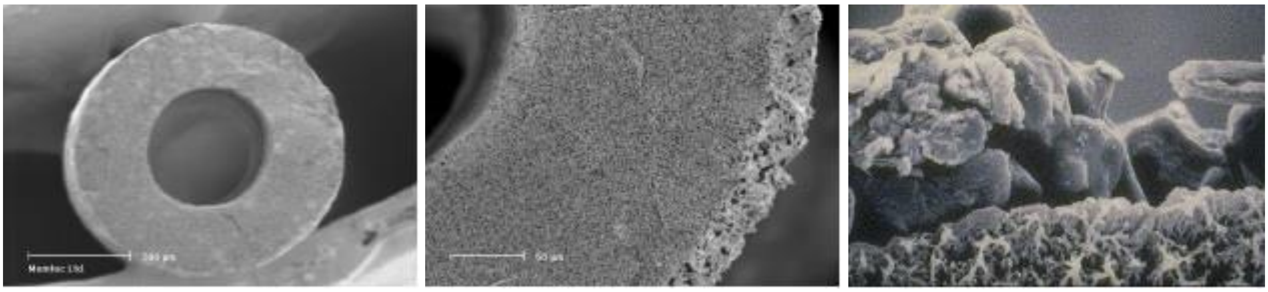
Once the system has been primed, the Filtrate Pump operates to draw water through the hollow fibre membranes, discharging filtrate to service at the required flow rate. Filtration flow rate is usually controlled by means of a variable speed drive on the Filtrate Pump and measured by a flowmeter on the discharge of the pump. A feed inlet valve typically modulates to maintain the level in the Cell or Cells.

Filtration performance is monitored by the control system, which uses Unit instrumentation to calculate the Trans-Membrane Pressure (the TMP, or pressure difference across the membrane required to produce filtrate flow) and Resistance to flow in filtration. It then triggers backwash requests and cleaning cycle requests as required based on these and other calculations.

Figure 4

A sectional view through a typical hollow fibre membrane during filtration.





(a) (b) (c)

Figure 5

Electron micrographs of a typical MEMCOR® *hollow fibre membrane: (a) sectional view enlarged about 200 times, (b) close-up of membrane cross-section with outer fouling layer visible, (c) enlargement of interface between fouling layer and membrane.*

Standby

If feed water is not available or if treated water storage level is high, the Unit can be configured to enter the standby state automatically. In standby, the Unit waits for the feed supply to return or the treated water storage level to drop. When this happens, the Unit can usually return directly to filtration without the need for a startup sequence.

Backwash

As feed passes through the membrane barrier, a filter cake builds up on the membrane surface, increasing the resistance to flow. The key to the efficient operation of submerged membrane filtration systems is the patented Memcor backwash process. This process uses low pressure aeration to scour and agitate the hollow fibre membranes and, when combined with a short reverse flow of filtrate, removes the retained solids from the membrane fibre surfaces. Liquid backwash waste is then drained by gravity from the Cell to the backwash waste disposal system. The Cell is then refilled with feed in a process similar to startup, and the Unit then returns to filtration service.

The control system normally initiates an automatic backwash when resistance to flow reaches a preset level, typically after 20 to 60 minutes of filtration (depending on feed quality). The backwash cycle typically takes about two to three minutes to complete.

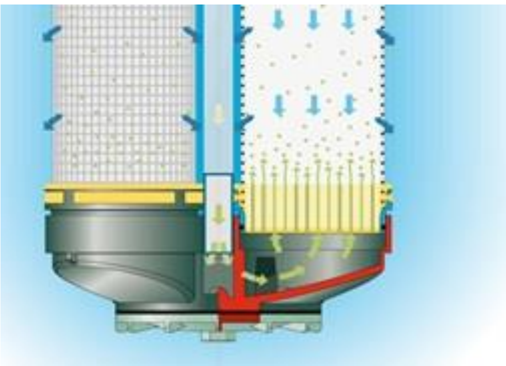


Figure 6

Cutaway view of an XS or CS rack showing the path of air during backwash aeration, from the rack air manifold through the air sub-manifold (or bottom clover) upwards through slots in the bottom pot and into the fibre bundle.

Maintenance Wash (MW) Cleaning Cycle

The Memcor backwash process is very efficient at keeping the membrane modules clean. However, depending on raw water quality, a small residual of organic and inorganic foulants tends to build up on the membrane, increasing the resistance to flow over time.

The rate of this build up can be reduced by the short duration Maintenance Wash or MW cleaning cycle. This process typically uses a low strength cleaning solution which makes contact with the membrane modules for a short time. This reduces resistance to flow, decreasing operating energy requirements and can greatly extend the operating interval between Clean-In-Place cleaning cycles.

A Maintenance Wash is usually initiated automatically after the Unit has performed a preset number of backwash cycles. The Unit is typically off-line for less than an hour while a Maintenance Wash and rinsing take place, after which, the Unit returns to service.

Clean-In-Place (CIP) Cleaning Cycle

When the build-up of foulants on the membrane modules increases the resistance to flow to a high level, or after a preset number of hours of filtration, a Clean-In-Place or CIP cleaning cycle is usually required. The Clean-in-Place process allows the system to be cleaned without the need to remove or disassemble equipment.

As the cleaning cycle also helps to reduce and minimise organic growth and helps to disinfect the system, cleaning may also be initiated simply on an elapsed time basis, such as once per month or every six weeks, even if Resistance or TMP values have not reached a high level. This is a particularly useful strategy to maintain cleanliness in potable water systems.

MF Units fitted with PVDF (polyvinylidene fluoride) membrane filtration modules are cleaned using sodium hypochlorite solution as the primary cleaning regime and acid as the secondary regime. Depending on the type of acid used in the application, a chelating or sequestering additive such as EDTA (ethylenediaminetetraacetic acid) or citric acid may also need to be added during an acid clean.

Cleaning cycles using the primary cleaning regime are most commonly performed. After a preset number of primary cleaning cycles have taken place, the control system is usually configured to perform the next cleaning cycle using the secondary regime. This cleaning cycle will usually be immediately followed by a cleaning cycle using the primary regime. This is referred to as a **Dual** cleaning cycle.

Depending on the equipment fitted in the system and on local requirements, cleaning cycles can be configured to be initiated manually or automatically. In a CIP cleaning cycle the Unit is typically off-line for about two to three hours while cleaning and rinsing take place, after which, the Unit returns to service. A dual cleaning cycle takes about twice this time.

Cleaning Cycle Operation

A CIP or MW cleaning cycle typically uses the following sequence of steps:

1. **Backwash**

   The Cell is initially backwashed to remove excess solids and maximise cleaning efficiency. This initial backwash cycle is terminated when the Cell has drained.

2. **Water Fill and Cleaning Concentrate Addition**

   The Cell is then filled with clean water. The water is then circulated around the Unit by the Filtrate Pump while cleaning solution concentrate is added. One or more concentrates may be added during a cleaning cycle, depending on the type of cleaning cycle being performed. Concentrate addition continues until the target cleaning solution concentration is reached.

3. **Cleaning Solution Recirculation**

   Recirculation of the cleaning solution continues for the preset time to ensure that it makes contact with all parts of the Unit, particularly the membrane modules and the filtrate pipework.

4. **Cleaning Solution Soak**

   Recirculation then stops and the Unit is left to soak in the cleaning solution for the preset time.

5. **Repeat Recirculation and Soak**

   In a CIP cleaning cycle, the previous two cleaning cycle steps (recirculation and soaking) are typically repeated a preset number of times (usually from four to six times) to enhance the effectiveness of the cleaning process. In MW cleaning cycles these steps are usually not repeated.

6. **Cleaning Solution Drain**

   The used cleaning solution is then drained to the cleaning solution waste outlet for further processing and disposal.

7. **Rinse Backwash**

   The Unit is then refilled with water and performs one or more backwash cycles to rinse cleaning solution from the system. Depending on site requirements and system configuration, rinse backwash waste water may be directed to either the backwash waste disposal system or to the cleaning solution waste disposal system as appropriate.

8. **Rinse To Waste**

After completing the rinse backwashes, the Unit then filters to waste for a preset time. Instrumentation on the filtrate discharge (where fitted) can be monitored at this time to ensure that filtrate quality meets site requirements before the Unit is returned to service.

9. **Return To Service**

On completion of the cleaning cycle, the Unit is able to return to normal service. Depending on the equipment fitted in the system and on local requirements, return to service can be configured to occur manually or automatically. If manual restart is required, the Unit enters shutdown on completion of the cleaning cycle. If automatic restart is enabled, the Unit enters startup, then resumes filtration and normal service.

Where a secondary regime cleaning cycle has been performed as the first stage of a **Dual** cleaning cycle, the cleaning cycle is restarted at this time, using the primary cleaning regime.

Please refer to the MF Unit operating manual for further cleaning cycle details.

Cleaning Cycle Halted

If a shutdown alarm occurs, or if the MF Unit is stopped for any reason during a cleaning cycle, the cleaning cycle will be aborted, unless the sequence has reached or has passed the point at which cleaning solution concentrate has been added. This is intended to prevent the Unit from being returned to service with cleaning solution in it.

If the cleaning cycle is halted after cleaning concentrate addition, the MF Unit control system retains the cleaning cycle step and the elapsed time in that step, even if power is turned off. The cleaning cycle must then be resumed manually and will continue where it left off.

Integrity Tests

Integrity testing may be used to validate the membrane filtration barrier to ensure consistent treated water quality and maximum availability for a Memcor Submerged Membrane Filtration Unit.

All Memcor MF Units have a built-in integrity testing function called a Pressure Decay Test (PDT), which can usually be configured for automatic initiation at preset operating intervals if required. The Unit is typically off-line for about five minutes while this test takes place before automatically returning to service.

In a Pressure Decay Test, air is used to drain filtrate from the Membrane Filtration Modules and Racks and the filtrate side of the system is pressurised with low pressure air, typically to around 100 kPa or 14.5 psi. The low pressure air supply is then turned off and the rate of decay of filtrate side air pressure is monitored by the control system. System integrity can be related to the rate of pressure decay measured during this test.

If a higher than normal pressure decay rate is measured, a Leak Test can then be performed to determine the location of any integrity loss. The Leak Test is manually initiated, and helps to localise a problem membrane module, or leaking seal, valve, pipe or fitting, by the appearance of bubbles.

In XS and CS systems which use “single ended” Modules, and where Filtrate Isolation Valves are fitted, the Filtrate Sub-Manifold containing a damaged or leaking component may be isolated so that the Unit may be returned to service with improved integrity. The Rack containing the damaged component can then be removed at some later time for inspection and testing. CSII systems use “double ended” Modules so they do not have Filtration Isolation Valves.

Important features of the Memcor MF Unit Pressure Decay Test include:

- that it is sensitive to greater than LRV4 (Log Reduction Value) particle removal;
- that it measures actual filter performance, which is critical for control of chlorine tolerant pathogens in potable water systems;
- that it is independent of feed quality, including feed water particle count or turbidity challenge;
- that it provides a far more sensitive integrity monitoring method than filtrate particle counting;
- that the efficiency and accuracy of the test reduces the need for operator involvement and maximises membrane life;
- that it is the integrity test that has become the "industry standard" and through collaboration with Memcor through the 1990's, became the basis for integrity testing as defined by the USEPA Membrane Filtration Guidance Manual.

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