MEMCOR® CPII

PROCESS DESCRIPTION

Evoqua Water Technologies

Document MAS00trp05_01e_CPII.docx
Issue 1
Issue Date 13 May 2015

MEMCOR® CPII LOW PRESSURE MEMBRANE FILTRATION SYSTEMS

Typical MEMCOR® CPII MemRACK installation

INTRODUCTION

Evoqua Water Technologies 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.

After a number of years of extensive research, development and testing MEMCOR® CPII (pronounced *see-pee-two*) was released by Evoqua in 2014. The CPII system is the sixth generation of the Memcor low pressure membrane filtration product line and provides significant reductions in filtration system footprint, capital cost and operating costs compared to older membrane systems.

A MEMCOR® CPII Low Pressure Membrane Filtration (MF) Unit typically includes:

- MEMCOR® L40 Membrane Filtration Modules using proven PVDF homogeneous asymmetric ultrafiltration hollow fibre membranes with a nominal pore size of 0.04 µm;
- MEMCOR® L40 Module Housings, made from proprietary moulded Nylon components which form the pressure casing for each pair of Membrane Filtration Modules in the MemRACK;
- The MemRACK™ Module Rack, formed by assembling Module Housings in a line with process connections, typically at one end, for feed and air at the bottom, and for filtrate and waste at the top. Connections at the other end are normally blanked. Grooved pipe-end coupling adapters provide termination points on the MemRACK for each process connection to the Pipe, Valve and Instrumentation Skid. The MemRACK is normally mounted on a steel frame or skid;
- A Pipe, Valve and Instrumentation Skid mounted on a steel frame. The skid is fitted with piping manifolds, valves and fittings, pneumatics, instrumentation and control components for each MemRACK that is connected to it, and provides interconnection points to the main system piping.

A typical MemRACK is made up of fourteen, sixteen or eighteen L40 Module Housings holding twenty eight, thirty two or thirty six L40 Modules. Smaller MemRACK sizes are available to suit site requirements. This assembly is typically supplied from the factory fitted with the Membrane Filtration Modules. Alternatively, Modules may be easily fitted to the MemRACK later during filtration system commissioning.

Each MemRACK skid installed on site is connected to a factory assembled Pipe, Valve and Instrumentation Skid. There are a number of standard Pipe, Valve and Instrumentation Skid system designs to cater for one or multiple MemRACK skids.

TYPICAL SYSTEM COMPONENTS

One or more MEMCOR® CPII MemRACK™ Low Pressure Membrane Filtration Units 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 on the Pipe, Valve and Instrumentation Skid(s). 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 1 below shows the equipment in a typical Low Pressure Membrane Filtration process. The main parts of the system are described in the following section.

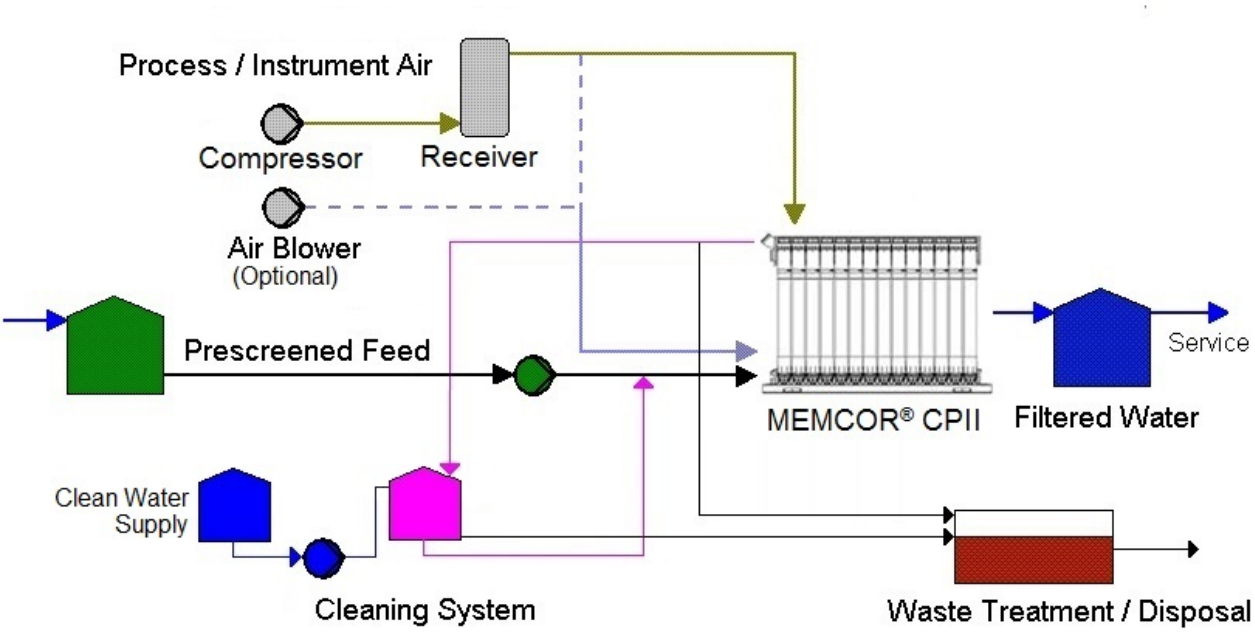


Figure 1

Typical MEMCOR® CPII Low Pressure Membrane Filtration System Process

Ultrafiltration Membrane Filtration Unit(s)

Each MEMCOR® Membrane Filtration Module contains thousands of hollow fibres surrounded by a protective plastic mesh screen and sealed with polyurethane “pots” at the top and bottom. The pots allow filtered water to pass from the hollow inner core, or lumen, of all the membrane fibres to the filtrate manifold at the top of the MemRACK. Each Membrane Filtration Module is a serviceable filter element that is easily removed from its Module Housing for repair or replacement.

Feed enters the MemRACK through the bottom (large diameter) connection. Waste air and water leave the MemRACK through the lower (also large diameter) connection at the top. Filtrate leaves the MemRACK through the upper (also large diameter) connection at the top.

An air manifold is provided at the bottom of the MemRACK assembly. This provides low pressure process air into the bottom feed side of each Membrane Filtration Module. Openings in the lower Module pot distribute the air within the Module to scour the entire membrane fibre bundle during the aeration step of each backwash.

For further MF Unit details please refer to drawings including the MF Unit Process and Instrumentation Diagram and General Arrangement and to the relevant specification sheets for the L40 Membrane Filtration Modules, the L40 Module Housings and the MemRACK skid.

Feed System

Raw water to be filtered must be screened to remove large solids before it enters the MF Unit. 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 and pH ranges 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 Unit. A level switch or level transmitter is used to monitor the level in the feed tank.

Filtrate System

Filtrate flow rate from the MF Unit is typically controlled by a variable speed drive on the feed pump, or by a positioning valve in the feed line.

Filtrate from an MF Unit usually flows to a local filtered water tank or direct to a service outlet pipe. Available filtrate discharge pressure from the MF Unit is limited to ensure the feed pressure does not exceed 500 kPa. This high pressure rating makes CPII ideally suitable to close coupling applications such as seawater or brackish water desalination.

A level switch or level transmitter in the filtrate storage tank is generally used to monitor the maximum level in the filtrate storage tank and place the Unit into standby until 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, MEMCOR® CPII Low Pressure Membrane Filtration Units offer the flexibility to use either filtrate that is stored within the Unit for backwash, or to use an external pressurised or pumped filtrate supply for this purpose.

Compressed Air System

Clean, dry, oil-free compressed air is used in the process for backwash, integrity testing and draining of the MemRACK and for the operation of pneumatically actuated valves.

Evoqua 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.

Optional Air Blower System

In the backwash process, low pressure air is blown through connections in the bottom of the MemRACK and distributed into all the module housings, flowing up into the fibre bundle of each membrane module. This is the aeration step of the backwash sequence. In larger systems, substantial power savings can be realised by using air blowers for this aspect of the backwash process.

The air used in this aeration process must vent freely to atmosphere at a point as close as possible to the waste outlet termination point on the MF Unit. An open discharge into a large diameter pipe or drain, or alternatively, a vertical tee vent with the top open to atmosphere, is recommended. Please refer to the Typical System Process and Instrumentation Diagram and the MF Unit Termination Point Schedule for further information on the design of this critical outlet.

The blower system must be able to deliver air at the required flow rate, at a pressure that can displace water from the air manifold so that it reaches the bottom of the membrane filtration modules (typically an inlet pressure at the module housing of about 35 – 50 kPa or 4 – 7 psi is required).

Typically, the air for this purpose is supplied by a blower 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 for a single backwash then duty is rotated to the next 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. A 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 removed from the shell side (feed side) of the MF Unit. This backwash waste liquid is discharged via one or more waste outlet termination points on the MF Unit, and should flow freely by gravity from the outlet, usually to a low tank or sump near the Unit.

In most CPII systems, this “high solids” backwash waste is flushed out through the upper waste connection by supplying raw feed into the bottom connection.

Note that the MF Unit waste outlet must also provide venting for the aeration step of the backwash sequence as detailed in the air system descriptions above.

Depending on local requirements, backwash waste may need 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 be MF Unit filtrate. For high TDS (Total Dissolved Solids) applications such as sea water, brackish 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.

The cleaning system includes a concentrate storage container and a concentrate transfer pump for each cleaning chemical, so that concentrate dosing can be automated. Container and pump sizes may 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.

Some MEMCOR® CPII systems have a separate tank that is used to store the cleaning solution while it is recirculated through the Unit during a cleaning cycle. Others may have a clean water storage tank that provides water for cleaning cycles, warmed if necessary in cold climates, and a closed recirculation system to help minimise the cleaning system volume, thereby reducing cleaning concentrate volumes and cleaning cycle waste volumes.

The cleaning system usually includes one or more 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.

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 by a pump through the membrane filtration modules and MF Unit pipework. In most systems, instrumentation is fitted to monitor the concentration of the recirculating solution and verify that it is within the required concentration range. It can also be used to confirm complete rinsing after a cleaning cycle.

Most MEMCOR® CPII Low Pressure Membrane Filtration Units use a cleaning regime that uses cleaning solution once only and is then discarded. 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 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 drained from the Unit, the pipe manifolds and the cleaning solution storage tank (where used), 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 is provided.

The cleaning solution waste disposal system typically provides a means to neutralise the cleaning solution waste 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 often provides improved cleaning effectiveness for membrane filtration systems. The preferred cleaning solution temperature range for Memcor MF Unit chlorine cleaning cycles is from 10 ^{O}C to 30 ^{O}C with an optimum of around 25 ^{O}C. For acid cleaning cycles it is from 15 ^{O}C to 35 ^{O}C with an optimum of around 30 ^{O}C.

Where cleaning solution temperature is likely to be much below 10 ^{O}C or 15 ^{O}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 cleaning solution 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 high temperature water coming into contact with the membrane filtration modules (water in contact with the membranes should never exceed 35 ^{O}C). Please refer to the relevant module specification sheet for exposure limits.

Instrumentation and Control System

Standard MEMCOR® CPII Low Pressure Membrane Filtration Units are supplied with a feed and a filtrate pressure transmitter and may also have other local instruments such as flow, temperature and pH sensors, 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 and tank level transmitters, and water quality instrumentation, such as turbidity, pH or conductivity meters.

A Programmable Automation Controller (PAC or PLC) controls all Membrane Filtration 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, necessary to monitor and control the system, is typically supplied by others as part of the external control 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 should be provided to help operators pinpoint problems within the system.

Evoqua also produces its proprietary MEMLOG® and MEMULATOR® data logging systems that can be supplied for most 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 operating performance and to confirm operation of mechanical components in the system.

Please review the relevant MF Unit specification sheet to determine instrumentation and control system inclusions and options.

Module Maintenance Equipment

MEMCOR® CPII Low Pressure Membrane Filtration Units have built-in integrity test routines that can be initiated either manually or automatically. If system integrity loss is detected, individual Modules can be identified and removed from the MemRACK for inspection and testing.

In most plants, an overhead hoist or crane is recommended for removal and installation of membrane modules. Evoqua can supply other standard equipment necessary for MemRACK maintenance, including Module cap removal and lifting tools and a filtrate isolation valve tool.

Membrane filtration modules that have been removed from the module array may then be integrity tested one at a time in a module test vessel that Evoqua can also supply. The test vessel allows membrane filtration modules to be tested and “pin-repaired” if necessary to restore integrity prior to return to service.

Please consult Evoqua Water Technologies for details of module maintenance equipment (such as standard tools, test vessels and pin repair kits) if required.

MEMCOR® CPII UNIT OPERATION

A Memcor CPII Low Pressure 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.

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 feed pump starts and pumps screened feed into the bottom of the MF Unit. Once the feed side of the Modules has been filled, the feed outlet valve at the top of the Unit is closed. This pressurises the MF Unit, causing the filtrate side of the filtration modules and the filtrate pipework to be filled with filtered water. On some MF Units, a filtrate manifold level high switch may be used to monitor liquid level in the filtrate side.

Filtration

Once the startup sequence has finished and the Unit has been filled, the feed pump continues to operate, forcing water through the hollow fibre membranes and discharging filtrate to service at

the required flow rate. For Units with modulating flow control, the filtration flow rate is measured by a flowmeter on the Unit.

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. It then triggers backwash requests and cleaning cycle requests as required based on these and other calculations.

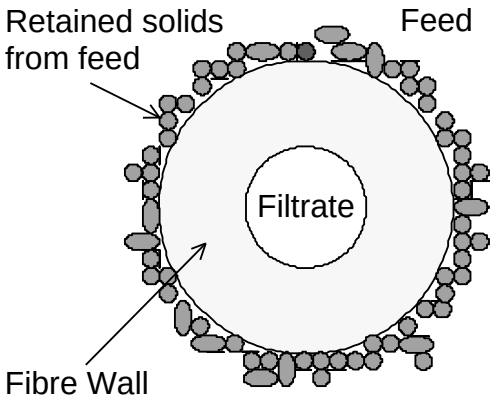
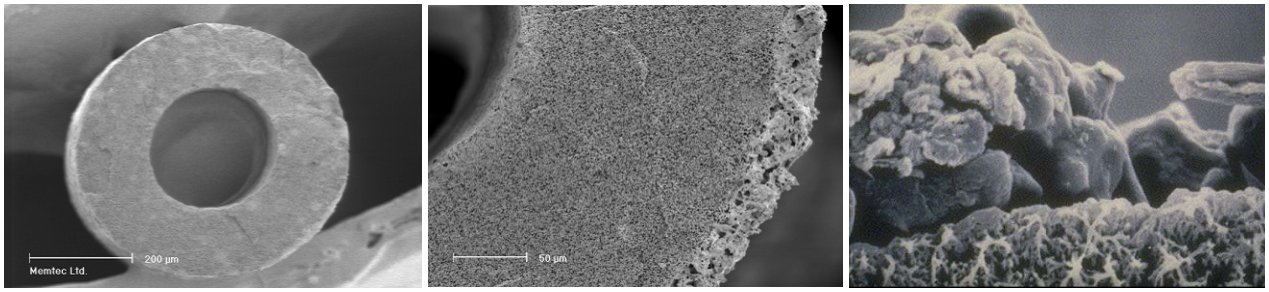


Figure 2 (Right)

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



(a) *(b)* *(c)*

Figure 3

Electron micrographs of typical MEMCOR® hollow fibre membranes: (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 low pressure membrane filtration 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 or flushed from the Unit to the backwash waste disposal system. The feed and filtrate sides of the Unit are then refilled in a process similar to startup, and the Unit then returns to service.

There are two processes available for the filtrate backwash component of the backwash cycle to assist with foulant removal. The most common uses a low pressure air driven liquid backwash (ADBW) or air backwash (ABW). In this process compressed air is introduced to the filtrate side of the MF Unit to drive the filtrate already in the pipework and Modules backwards through the membrane. In some systems, such as system retrofits that already have provision for a pumped liquid backwash or those with a pressurised filtrate manifold (say, above 150 kPa or about 22 psi operating pressure), a liquid driven backwash (LDBW) or liquid backwash (LBW) may be used.

The control system typically initiates an automatic backwash every 20 to 60 minutes of filtration (depending on feed quality). The backwash cycle typically takes about two to three minutes to complete.

Maintenance Wash (MW) Cleaning Cycle

The MEMCOR® CPII 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. In this process, a low concentration of cleaning solution makes contact with the membrane modules for a short time. This reduces resistance to flow, decreasing operating energy requirements and greatly extending 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 takes 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 an unacceptable level, or if the trans-membrane pressure in filtration has reached a high level, or after a preset number of hours of filtration, a Clean-In-Place or CIP cleaning cycle is usually required. 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 standard L40 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, an additive such as EDTA (ethylenediaminetetraacetic acid, a chelating agent) 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, the cleaning cycles can be configured to be initiated manually or automatically.

A CIP cleaning cycle is usually initiated automatically or may be initiated manually. The Unit is typically off-line for approximately two and a half hours while cleaning and rinsing takes 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 Unit is initially backwashed to remove excess solids and maximise cleaning efficiency. This initial backwash cycle may be terminated when wastewater has been drained from the Unit in systems that use gravity drain from the MF Unit.

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

The Unit is then filled with water from the clean water or cleaning solution storage tank. Water used is typically Unit filtrate for surface water filtration systems but, depending on process requirements, may be from another source, such as town water or Reverse Osmosis (RO) permeate.

The water is then circulated around the MF Unit by a 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 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 or flushed from the MF Unit to the cleaning solution waste outlet for further processing and disposal.

7. Rinse Backwash

The Unit then 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 (where fitted) may 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 the MEMCOR® CPII Low Pressure 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. 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 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 Sonic Test can then be performed to determine the location of any integrity loss. The sonic test is manually initiated, and allows the MEMCOR® Sonic Analyser to be used to help localise a problem membrane module, or a leaking seal, valve, pipe or fitting, by amplifying and filtering the sound of bubbles within the Unit. If necessary, individual membrane filtration modules in areas of suspect integrity may be isolated using the two (upper and lower) filtrate isolation valves fitted to every module housing. The Unit may then be returned to service with improved integrity. The module in the area containing a damaged or leaking component can then be removed at some later time for inspection and testing.

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;
- that it is independent of feed quality, including feed water particle count or turbidity;
- 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 was used as the basis for integrity testing as defined by the USEPA Membrane Filtration Guidance Manual.