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HYDRANAUTICS

Technical Service Bulletin

April 2024 TSB341.09

Commissioning Procedure for HYDRAcapMAX™ Modules and Elements

This Technical Service Bulletin provides information for commissioning a system using HYDRAcapMAX™ UF modules and elements. This applies to both HYDRAcapMAX™ modules (either with a conventional rack or using HYDRAcube skids) as well as elements used in pressure vessels.

Modules and Elements

The HYDRAcap™ MAX product line is offered in either a module or element form. Modules are self-contained, low pressure units, while elements need to be installed in separate pressure vessel housings and can operate at higher pressures.

1. INTRODUCTION

The goal of this document is to outline the general procedures for commissioning HYDRAcapMAX™ UF system(s),"System". The document should provide sufficient information to aid in the planning and sequencing of the commissioning process. For specific projects, an independent assessment must be carried out as to this document's suitability. This document specifies the various implementation procedures including installing, cleaning, and testing the System. A typical P&ID of a HYDRAcapMAX™ System can be provided upon request as a guideline for System configuration and for determining the recommended amount of equipment and instruments needed to fully automate the System. The details of construction, equipment manufacturers, model numbers, and site specific drawings are to be provided by the System supplier(OEM/System Manufacturer).

The procedures discussed within this document are to be read in conjunction with the System supplier's commissioning procedures. Completion of the System construction must be verified as finished before commissioning can start. Commissioning is carried out by functionally testing each main process component of the HYDRAcapMAX™ plant

offline. This document is designed to be included in the overall commissioning plan for for the plant.

2. PRE-COMMISSIONING ACTIVITIES

Immediately following the construction of the System, the following items must be checked prior to commissioning:

- *Tanks*: Construction (i.e. installing connections, tapping, installing tank vents, or any other related activity) should be completed to all tanks involved in the membrane system including, but not limited to:
    - Feed Tank, if required
    - Filtrate Tank, if required
    - Recovery Clean (RC) Tank
    - Neutralization Tank, if required

  A visual inspection for internal cleanliness must be made to all the tanks listed above.
- *Power and Electrical Components*: Test all pumps, electrical connections, inputs and outputs of each instrument, level switches, and motor rotation to ensure proper installation and functionality. This check must be done prior to introducing water into the system.
- *Other Equipment and Instrumentation*: Pressure transmitters, flow meters, pumps, valves, and all measuring devices must be installed. Some systems may require a ventilation or air conditioning system to keep instrumentation cool.
    - Check timing of valves to both open and close for all automatic valves. Valves should be optimized to prevent water hammer and pressure spikes, and to avoid loss of production time while valves open and close. Each valve should be checked to ensure that they are properly fastened.
    - All instrumentation used for analysis must be calibrated and ranges set. Instrumentation and equipment test sheets should be completed and validated by a representative of the System Supplier.
    - When water can be introduced to the system, all flow control valves should be throttled a minimum of 3 times to ensure reproducibility of the flow set point.

- Sequences of each operating mode (Filtration, Air Scour, Maintenance Clean, Recovery Clean, Membrane Integrity Test) must be checked before commissioning and introducing water.
- Alarms modes need to be verified.
- All pipework, couplings, fittings, and other connections must be both visually checked and leak tested to ensure there are no loose components or leakages.
- All chemical, coagulant, and other dosing systems should be ready for use, as applicable to the specific system design.
- All piping such as the feed, maintenance clean, air scour, air integrity, and recovery clean must be checked and compared to the P&ID of the system / plant.
- The air scour blower should be ready for use.
    - A pressure regulator should be installed to prevent the air supplied for scouring from exceeding 1.5 bar g(~22 psi g).
    - A safety release valve should be installed to prevent the air being supplied to the module or element from ever exceeding 5 bar g if a compressor is considered instead of a blower to deliver air for air scour.
- The compressed air system should be ready for use.
    - A minimum pressure of 6 bar g (87 psi g) is recommended for valve actuation; however, this pressure should be confirmed with the selected valve manufacturers requirements.
    - The compressed air supply should be checked.
    - Hydranautics recommends the receiver be equipped with a low and high pressure detector. When the pressure in the air receiver drops to a preset level, the compressor should be started automatically until the pressure reaches a cut-off point, e.g. 10 bar g (145 psi g). Care should be taken to avoid exceeding 10 bar g (145 psi g).
    - Ensure that the air is oil free.
    - The air pressure relief valve for the air integrity line must be calibrated at 1.4 bar g (20 psi g).
    - The pressure regulator for the air integrity line needs to be adjusted to be 1 bar g (14.5 psi g) - 1.4 bar g (20 psi g) max.

- To avoid over pressurization the module or element, a safety release valve should be installed to prevent the air pressure from ever exceeding 5 bar g.

All construction activities of the System should be completed prior to delivering and installing the modules or elements to prevent foreign matter (i.e. debris, dust, shavings, etc.) from entering the System. If there is a pre-treatment system prior to the HYDRAcap™ MAX System, it must be commissioned and optimized **before** the membrane system is commissioned in order to ensure that the expected feed water quality is provided to the System.

3. PHASE 1 - FLUSHING AND TESTING THE SYSTEM

It is important to clear all lines of any particulates that may enter the HYDRAcapMAXUF System and cause fiber damage. For racks and Systems with HYDRAcap™ MAX modules, dummy modules may be installed or alternatively flexible hosing or rigid piping can be connected from the feed to both permeate ports and the concentrate port in place of the modules (see Figure 1 for HYDRAcap™ MAX example). For HYDRAcube Systems, you may connect hose or piping directly from feed header to concentrate/filtrate/drain headers.

For elements, the Systems can be flushed with pressure vessels in place with no elements installed.

Flushing the System prior to installation of the HYDRAcap™ MAX modules or elements is critical for several reasons:

a. To clear tanks and lines of debris and particulates that can get trapped in the UF and cause fiber damage.
b. To check the performance of the pumps before start up.
c. To check seals of valves, flanges, and various other connections and components.
d. To check the automation and sequences of the different modes of operation without the risk of damaging the membranes as a result of programming error or mechanical failure of equipment.
e. To disinfect the System with the addition of a chemical to the feed, if needed.

Figure 1: Examples of rigid and flexible piping used for commissioning phase 1.

If the plant has more than one rack, the flexible hoses and/or pipes must be used for each rack. It is necessary to place the hoses at both extremities of each rack to ensure an efficient rinse of the all the lines. Note HYDRAcapMAX™ Systems will not need multiple individual piping as shown in the above pictures.

3.1 Analysis of the feed water

Preliminary samples will be taken of the feed water to the UF System to check the following parameters to see if they are in line with the expected values: temperature, turbidity, total suspended solids, COD, BOD, TOC, iron, manganese, aluminum, hardness, alkalinity, and pH.

3.2 Cleaning and Disinfection

Ensure that the tanks are thoroughly cleaned by filling and rinsing all tanks with clean water (i.e. potable or city water). Pretreated feed water can also be used if clean water is unavailable provided it meets the feed water specification. This will be used to flush the pipes and common headers. Rinse/flush the System for approximately 30 minutes at a feed piping velocity of 2.5 – 3.0 m/s (8.2 – 9.8 ft/s) to remove any debris trapped in the UF System before fully draining down System.

For disinfection, a 10 ppm chlorine solution rinse can be performed (minimum contact time of six hours, but 24 hours is recommended). This disinfection is intended to eliminate any bacteria that may have formed after installation of the racks. It is best for this solution

to be prepared in either the feed tank and/or filtrate/RC tank. It is recommended to initially flush the System from the feed side using the feed tank, if available, then again from the filtrate side with the filtrate/RC tank. The solution will need to travel through all the piping, connections, and headers within the system. Once the soaking time has elapsed, the System should be drained and rinsed using pretreated feed water.

3.3 Testing the automation of the rack

Testing the automation without UF modules or elements loaded verifies that correct valves and pumps begin when called upon by the operator or program. It is important to also check pump speeds, air flow rates, dosing pump rates, etc. at this time. The opening and closing of valves will need to be physically verified for every sequence. Before beginning any tests, timers and setpoints need to be set in the PLC. Please contact Hydranautics to determine these values where necessary. The following sequences should be tested:

- Filtration
    - Feed pump settings
    - Valve positions
    - Flow and flow transmitter values
    - Pressure and pressure transmitter values
- Filtration with concentrate (if applicable)
- Air scour
    - Blower settings
    - Feed pump settings
    - Valve positions
    - Flow and flow transmitter values
    - Pressure and pressure transmitter values
- Maintenance clean with chlorine (MC1)
    - Dosing pumps injection settings
    - Cleaning pump settings
    - Valve positions
- Maintenance clean with caustic soda, if applicable (MC2) (same checks as MC1)
- Maintenance clean with acid, if applicable (MC3) (same checks as MC1)
- MC1 + MC2, if applicable (same checks as MC1)
- Recovery clean with chlorine (RC1) (same checks as MC1)

- Recovery clean with caustic soda , if applicable (RC2) (same checks as MC1)
- Recovery clean with acid, if applicable (RC3) (same checks as MC1)
- Neutralization (if applicable)
- Membrane Integrity Test
    - Valves positions
    - Pressure and pressure transmitter values

NOTE: It is important to ensure that valves are opened prior to starting any pump and pumps are stopped prior to closing any valves. Also, pressurization rates during any sequence should be slowly ramped up and down at a rate of no more than 0.34 bar/sec (.5 psi/sec).

Once the sequences above have been checked and optimized, the sequencing cycles should be tested. Check the recommended number of filtration and air scour cycles prior to conducting a MC1, MC2, MC3, and/or MC1+MC2 are correct. Note: not all chemical cleans may be required for every system. Check design for suggested cleaning protocol. Any failure should be noted and addressed immediately.

The following readings should be noted when testing the feed pump: pressure at the discharge of the feed pump by reading the pressure transmitter value and flow rate given by the filtrate flow transmitter.

4. PHASE 2 – INSTALLATION AND TESTING WITH MODULES OR ELEMENTS

4.1 Receipt and Installation of Modules or Elements

All modules and elements are tested at Hydranautics facility prior to shipping to determine the permeability and integrity. UF modules and elements are shipped with acceptable permeabilities and free of integrity defects. Once these pass inspection, they are filled with a 30% calcium chloride solution. Module ports are capped to retain the preservative, while elements will retain preservation with a plastic cap. They are then packed in wooden crates and shipped to site.

After completion of System testing, install modules according to TSB 332 (or 352 if using HYDRAcube™) and elements according to TSB 346.

CAUTION: WEAR PERSONAL PROTECTIVE EQUIPMENT WHEN HANDLING CALCIUM CHLORIDE. $CaCl_2$ CAN CAUSE SKIN AND EYE IRRITATION. 30% CALCIUM CHLORIDE IS ALSO CORROSIVE TO METALS. RINSE ANY SOLUTION OFF METALS .

4.2 Membrane Integrity Testing (MIT)

After installing the modules/elements, perform a MIT according to TSB 333.

4.3 Preserving the modules/elements and/or system

If necessary, racks and/or modules/elements may be stored by following TSB 331 for HYDRAcapMAX™.

Clean Water Flux Profile Test

This consists of the following test:

1. Supply clean potable quality service water to the HYDRAcapMAX™ System whenever possible. This can be done by filling the feed or RC tank to deliver water into the rack from either the feed or filtrate-side, as appropriate. Otherwise, pretreated feed water can be used provided it meets the feed water specification.
2. For new or “long-term” stored membranes, flush the modules/element’s with the clean or pretreated feed water to remove the preservatives. The UF membranes should be flushed at a flux rate of 60 LMH (35 GFD) for 30 min to drain. For Systems that cannot supply the recommended flux rate above, longer flushings may be required. The UF membranes will need be flushed for 10 mins from feed to concentrate, 10 mins from feed to filtrate + concentrate, and the last 10 mins from feed to filtrate.
3. Once the UF membranes have been flushed, it is time to begin the clean water flux profile test. Each rack should be individually tested. Run in filtration with the clean or pretreated feed water at 25%, 50%, 75%, and 100% of the design flow rate based on all racks in filtration. If feed water is used, the data for each condition should be recorded within 2 minutes of setting the flow rate. Record the feed

pressure, concentrate pressure, filtrate pressure, trans-membrane pressure (TMP), filtrate flow, and water temperature at each filtration flow rate.

NOTE: The filtrate may also be sent at this time to the RC tank to check the water quality if available.

4. Calculate the TCSF at 20°C at each data point according to TSB 339. For new, unused UF membranes, the average TCSF over all data points should be > 300 LMH/bar (12.2 GFD/psi). If the minimum TCSF value is not reached for an unused module or element, the modules or elements may have dried out and need to be re-wetted as described in TSB 337 depending on the permeability found. For clean, used membranes, the average TCSF over all data points should be > 200 LMH/bar (8.1 GFD/psi). If the minimum TCSF value is not reached, the modules or elements may need to be cleaned either with a MC or RC as described in TSB 340 depending on the permeability found. If the module(s) or element(s) was used, it is possible that there may have been some irrecoverable fouling that occurred during operation. If the membranes still do not achieve the required TCSF in clean water, please contact the Hydranautics Capillary Technology Group.

After completion of the clean water flux profile test, data logging, normalization, and performance analysis should be performed according to TSB 339.

5. PRECAUTIONS

In addition to other precautions given in the “notes” throughout the document, please consider the following as well when operating a HYDRAcapMAX™ System:

1. The use of polymers must be avoided as irreversible fouling may occur. If required, testing should be completed to check chemical compatibility or discussion had with the chemical supplier to ensure the chemical will not adversely affect the membrane.

2. Do not use silicone grease for lubrication in areas where it may remain internally within the pipework, as the grease can irreversibly foul the membranes.
3. The maximum applied pressure rating for a HYDRAcapMAX™ module is 5 bar g (73 ps ig), while an element is 10 bar g (145 psi g) at 20°C (68°F).
4. The maximum transmembrane pressure (TMP) is 2 bar (30 psi).
5. The maximum instantaneous feed turbidity is 300 NTU.
6. The maximum instantaneous chlorine exposure is 5000 ppm.
7. The operating pH range is 4 – 10, while the cleaning pH range is 1 – 13.
8. The maximum temperature rating of a HYDRAcapMAX™ module or element is 40°C (104°F). To avoid thermal shock, temperature increases should be limited to a rate of change of 1°C per minute.
9. Emulsified oil and grease should be < 2 ppm in the feed, free oil and grease must be < 0.1 ppm.
10. Avoid handling and rotating the feed end adapter whenever possible.
11. A ≤120 µm screen filter is required directly ahead of the HYDRAcapMAX™ membranes regardless of pretreatment for seawater applications; a ≤500 µm screen filter is required directly upstream of the modules for other applications.

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