Technical Service Bulletin

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Commissioning Procedure for HYDRAcap® MAX Modules

This Technical Service Bulletin provides information for commissioning a system using HYDRAcap® MAX modules. This applies to both conventional HYDRAcap® MAX racks as well as HYDRAcube skids.

1. INTRODUCTION

The goal of this document is to outline the general procedures for commissioning HYDRAcap® MAX and HYDRAcube system(s). The document should provide sufficient information to aid in the planning and sequencing of the commissioning process. For specific projects, an independent check must be carried out as to its suitability. It specifies the various implementation procedures including installing, cleaning, and testing the system. A typical P&ID of a HYDRAcap® MAX and HYDRAcube system can be provided upon request as a guideline for system configuration and for determining the recommended amount of equipment and instruments needed for a fully automated HYDRAcap® MAX and HYDRAcube system. The details of construction, equipment manufacturers, model numbers, and site specific drawings are to be provided by the System Supplier.

The procedures discussed within this document are to be read in conjunction with the System Supplier commissioning procedures. Construction completion activities must be verified as complete before commissioning can start. Commissioning is carried out by functionally testing each main process component of the HYDRAcap® MAX and HYDRAcube plant offline. This document is designed to be included in the overall commissioning plan for the plant.

2. PRE-COMMISSIONING ACTIVITIES

Immediately following the construction activities, 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
    - Filtrate Tank
    - Recovery Clean (RC) Tank
    - Sewage/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.
    - With the rack full of water, 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.
    - 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 (~22 psi).
    - A safety release valve should be installed to prevent the air being supplied to the module from ever exceeding 5 bar.
- The compressed air system should be ready for use.
    - A minimum pressure of 6 bar (87 psi) 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 is less than 9 bar (132 psi), the compressor should be started automatically until the pressure reaches 10 bar (145 psi). Care should be taken to avoid exceeding 10 bar (145 psi).
    - Ensure that the air is oil free.
    - The air pressure relief valve for the air integrity line must be calibrated at 1.4 bar (20 psi).
    - The pressure regulator for the air integrity line needs to be adjusted to be between 1.4 bar (20 psi) max.

- To avoid overpressurizing the module, a safety release valve should be installed to prevent the air pressure from ever exceeding 5 bar.

All construction should be completed prior to delivering and installing the modules to prevent foreign matter (i.e. debris, dust, shavings, etc.) from entering the modules. If there is a pre-treatment system prior to the HYDRAcap® MAX and HYDRAcube 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 modules.

3. PHASE 1 - FLUSHING AND TESTING THE SYSTEM

It is important to clear all lines of any particulates that may enter into the module and cause fiber damage. To do so, 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. Flushing the system prior to installation of the modules is critical for several reasons:

- To clear tanks and lines of debris and particulates that can get trapped into the module and cause fiber damage.
- To check the performance of the pumps before start up.
- To check seals of valves, flanges, and various other connections and components.
- 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.
- 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 HYDRAcube systems will not need multiple individual piping as shown in the above pictures.

3.1 Cleaning and Disinfection

Ensure that the tanks are empty by cleaning the inside thoroughly and removing any large items. Make sure to rinse and fill the feed tanks with clean water (i.e. potable or city water). This will then 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 HYDRAcap® MAX and HYDRAcube 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 both the feed tank and filtrate/RC tank. It is recommended to initially flush the system from the feed side using the feed tank and 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 rinsed.

3.2 Testing the automation of the rack

Testing the automation with dummy modules 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. They are specific to the tests done with the dummy modules. 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 0.25 bar/sec (3.6 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. 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

4.1 Analysis of the feed water

Preliminary samples will be taken 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

4.2 Receipt and Installation of Modules

All modules are tested at Hydranautics facility prior to shipping to determine the module permeability and integrity. Modules are shipped with acceptable permeabilities and free of integrity defects. Once the modules pass inspection, they are filled with a 30% calcium chloride solution and ports are capped to retain the preservative. The modules are then packed in wooden crates and shipped to site.

After completion of system testing, install modules according to TSB 332 for HYDRAcap® MAX or TSB 352 for HYDRAcube.

4.3 Membrane Integrity Testing (MIT)

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

4.4 Preserving the modules and/or system

If necessary, racks and/or modules may be stored by following TSB 331 for HYDRAcap® MAX or TSB 351 for HYDRAcube.

Clean Water Flux Profile Test

A clean water flux profile test is performed when the membranes are new or at any point to test the permeability or temperature corrected specific flux (TCSF) of the membranes. Please follow the procedures listed below to perform this test:

1. Supply clean tap water to the HYDRAcap® MAX and HYDRAcube system. This can be done by filling a feed tank or making the the proper connections for lines/piping.
2. For new or “long-term” stored membranes, flush the modules with the clean water to remove the preservatives. The modules 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 modules 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 modules have been flushed, it is time to begin the clean water flux profile test. Each rack should be individually tested. Run filtration cycles with the clean water at 25%, 50%, 75%, and 100% of the design flow rate. Record the feed pressure, concentrate pressure, filtrate pressure, trans-membrane pressure (TMP), filtrate flow, and water temperature during each filtration cycle. It is recommended to take at least four readings at various flow rates, but more can be conducted if desired.

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

4. Calculate the TCSF at 20°C at each data point according to TSB 339. For new, unused membrane modules, 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, the modules 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 may need to be cleaned either with a MC or RC as described in TSB 340 depending on the permeability found. If the module 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, pleast 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 toTSB 339.

5. PRECAUTIONS

In addition to other precautions given in the “notes” throughout the document, please consider the following as well when operating a HYDRAcap® MAX and HYDRAcube system:

1. 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.
2. The maximum applied pressure rating for a HYDRAcap® MAX module is 5 bar (73 psig) at 20°C (68°F).
3. The maximum transmembrane pressure (TMP) is 2 bar (30 psig).
4. The maximum instantaneous feed turbidity is 300 NTU.
5. The maximum instantaneous chlorine exposure is 5000 ppm.

6. The operating pH range is 4 – 10, while the cleaning pH range is 1 – 13.
7. The maximum temperature rating of a HYDRAcap® MAX module is 40°C (104°F). To avoid thermal shock, temperature increases should be limited to a rate of change of 1°C per minute.
8. Emulsified oil and grease should be < 2 ppm in the feed, free oil and grease must be < 0.1 ppm.
9. Avoid handling and rotating the feed end adapter whenever possible.
10. A ≤120 µm screen filter is required directly ahead of the HYDRAcap® MAX module(s) 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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