

## **Guide to Use and Maintenance of RO System**

The three critical factors that ensure the long-term consistent operation include: RO membrane element with superior performance; proper design of RO system; and correct operation and maintenance of system.

The operation and maintenance of RO system include: the initial adjustment of system, the routine operation and maintenance; and cleaning of system.

### **4-1 Initial Adjustment of RO System**

#### **4-1.1 Installation and Disassembly of Membrane Element**

##### **4-1.1.1 Items for Inspection before Installation of Membrane Element**

For any new engineering project, following items must be inspected before the membrane elements are fixed into pressure vessel:

- ✧ Glycerin for lubrication, fixing tools, water-proof rubber shoes, gloves and other safety devices are ready for use.
- ✧ All tables and charts for recording the position, adjustment and operation of membrane element are ready for use.
- ✧ Make sure that the pretreatment device in preceding position (quartz sand or activated carbon filter) has been rinsed cleanly.
- ✧ Inspect the feedwater piping preceding RO membrane element, and make sure that it is free from any sludge, oil or metal scrap, etc. and that the preceding pipe, pressure vessel and high-pressure piping have been rinsed cleanly.
- ✧ Check and make sure that the pretreatment system runs normally and that the SDI, turbidity, residual chlorine, temperature, pH value and ORP, etc. of pretreated water satisfy the feedwater requirements for membrane element.
- ✧ A clean filtering element has been installed inside the safety filter preceding the high pressure pump.

##### **4-1.1.2 Installation of Membrane Element**

- ✧ Take out a membrane element carefully from the package, record its serial number, check to make sure that the Y-seal (brine water seal) of it is in correct position and direction (the opening of Y-seal must be directed toward the

feedwater), and apply a little bit of glycerin to the internal wall of central pipe of the first membrane element.

- ✧ Installation of the membrane element must start from the water inlet end of pressure vessel, where the first membrane element must be pushed horizontally into the pressure vessel, with the end without Y-seal going first until 1/5 of membrane length (20 cm) left outside. Apply a little bit of glycerin to the Y-seal and O-ring of connector, and insert the connector into the central pipe of the first membrane element.
- ✧ Take out the second membrane element, and inspect the position and direction of Y-seal. Apply a little bit of glycerin to the internal wall of central pipe at both end of the second membrane element. Fasten the first membrane element to prevent it from being pushed into the pressure vessel. Support and lift up the second membrane horizontally so that another end of the connector inside the central pipe of the first membrane element can be inserted into the central pipe of the second membrane element, while the connector and the central pipe shall be kept in parallel so that the connector bears no weight of the membrane element, and the second membrane element shall be pushed into the pressure vessel until 1/5 of membrane length (20 cm) left outside. Apply a little bit of glycerin to the Y-seal and O-ring of connector, and insert the connector into the central pipe of the second membrane element.
- ✧ Repeat the above-mentioned step till all membrane elements are installed inside the pressure vessel. Be careful that it is not required to insert a central pipe connector to the last membrane element.
- ✧ Return to the product water side of pressure vessel, install the thrust ring, and install the sealing assembly of end plate at product water side of pressure vessel.
- ✧ Return to the feedwater side of pressure vessel, push the membrane fully into the pressure vessel so that the sealing assembly of end plate at product water side keeps in tight contact with the first membrane element, then install the sealing assembly of end plate at feedwater side of pressure vessel.
- ✧ Repeat the above mentioned steps, and install other pressure vessels.

- ✧ After all membrane elements have been installed in all pressure vessels, install the outside pipes for feedwater, rejected water and pure water.

#### **4-1.1.3 Dismantling of Membrane Element**

- ✧ First dismantle the external pipings connected to both ends of pressure vessel, then dismantle the end plate sealing assemblies at both ends of pressure vessel, number all the components dismantles, and keep them in orderly place.
- ✧ Push one by one the membrane element out of the feedwater end of pressure vessel. Only one membrane element is allowed to be pushed out at one time. When the membrane element is pushed out of the pressure vessel, receive the membrane element carefully and keep it in horizontal to prevent the central pipe connector from being damaged owing to gravity. It is advisable to rotate the membrane element so as to make it separate from central pipe connector.

### **Operating Steps and Methods for Initial Running of RO System**

#### **(1) Inspection Items before Startup**

- ✧ All pipings, equipment and connectors shall be in conformity with designed pressure.
- ✧ The pretreatment equipment has been rinsed and backwashed cleanly to ensure that the product water can reach the designed requirement, with SDI less than 5, turbidity less than 1 NTU, residual chlorine less than 0.1 ppm, temperature lower than 45°C, pH value within 3~10, containing no other oxidant (ORP less than 200).
- ✧ Make sure that all valves used in the system are in correct status of opening or closing, and the product water discharge valve, the rejected water discharge valve, the rejected water pressure regulating valve and the bypass valve for regulating the flow rate of high-pressure pump shall be fully opened.
- ✧ All dosing boxes contain correct chemicals with accurate concentration. All dosing devices are set in correct conditions and kept in correct running state.
- ✧ All pipings and equipment shall be in conformity with the pH range of 2~12 (including that in cleaning) as designed.

- ✧ All meters have been installed and calibrated correctly.
- ✧ The device for preventing the occurrence of back pressure has been installed and set correctly.
- ✧ The device for preventing hydraulic shock (electrical slow door) has been installed and set correctly.
- ✧ The high-pressure and low pressure protection devices have been set correctly.
- ✧ The RO vessel and relevant pipings have been fixed on machine as per the manufacturer's requirements.

## **(2) Steps of Initial Startup**

- 1) Before starting the high-pressure pump, inspect item by item according to the contents of pre-start inspection so as to make sure that the pretreated water contains no other oxidant (ORP less than 200), with SDI less than 5, turbidity less than 1 NTU, residual chlorine less than 0.1 ppm, temperature lower than 45°C and pH to be within 3~10.
- 2) Check all valves and make sure that all of them are in correct position and the product water discharge valve, the feedwater bypass control valve, rejected water control valve and rejected water discharge valve have been fully opened.
- 3) Fill the RO pressure vessel with qualified pretreated water in low pressure and low flow rate, and then flush the membrane element. The feedwater pressure shall be restricted within 30~60 psi in this moment, and the flow rate shall be equal to 60~70% of maximum feedwater flow rate for relevant membrane element. The rejected water and product water shall be discharged completely. No antiscalant shall be added in flushing.
- 4) Observe carefully to make sure there is no seepage in piping and connected components of system, especially in the high-pressure section.
- 5) For initial flushing of membrane element, whether dry type or wet type, it is recommended that the membrane element shall be flushed for 4~6 hours under low pressure, or be flushed for 1~2 hours, immersed in flush liquid and then flushed again for 1 hour. It is not allowed to add any antiscalant during flushing.
- 6) For the small-sized RO system without electrical slowly-opened gate, the

pressure vessel shall be filled with pretreated water (for air exhausting) before the high-pressure pump is started in order to prevent the membrane element from being impacted by water hammer. For large-sized RO system, electrical slowly-opened gate (electrical butterfly valve) or frequency-variation startup is generally used.

- 7) Start the high-pressure pump. Slowly regulate the bypass control valve of high-pressure pump, and gradually increase the feedwater flow rate of RO pressure vessel. In the meantime, slowly close the rejected water control valve to increase the pressure till the system recovery rate and water yield reach the designed values. The duration of pressure increase shall not be shorter than 30~60 seconds, and the duration for increase of feedwater flow rate shall not be shorter than 20~30 seconds. Check and make sure whether the operating pressure of system and pressure drop of membrane elements exceed the limits.
- 8) Check and make sure whether the amount of chemicals dosed is in conformity to the designed value.
- 9) Measure the conductivity respectively of the RO feedwater, the product water of each pressure vessel and the total product water, and compare the conductivity of product water among the pressure vessels in parallel to determine whether there is leakage or other failure in membrane element, connector and sealing ring of pressure vessel. Detect the pH value, conductivity, calcium hardness and alkalinity, etc. of rejected water, calculate the LSI and S&DSI indexes of rejected water, and judge whether the  $\text{CaCO}_3$  fouling will be formed in RO system under this condition.
- 10) Keep the system in continuous running for 1~2 hours, and record all running data. After the system is put into regular running continuously for 24~72 hours, record again all the running data and keep them on file. Said data include feedwater pressure, pressure difference, temperature, flow rate and conductivity of feedwater, flow rate and conductivity of rejected water, flow rate and conductivity of product water, and system recovery rate, and are the basis for future standardized comparison of operating parameters of system.

- 11) Refer to the operating parameters and the data for analysis of water quality, inspect the equipment to make sure that it works regularly, and determine whether the designed requirements are satisfied.
- 12) Within the first week after the system is put into operation, inspect periodically the performance of system and record carefully the operating parameters so as to ensure the regular running of equipment.

#### **4-2.1 Records of Running of RO System**

All information and data relating to the operation of system covering the adjustment and stable running of system shall be recorded and kept on file for the purpose of analyzing the running conditions of the whole system. Besides, the records of operating data is one of the effective means for seeking and solving the system failure, and is one of evidences to apply for quality guarantee.

Following data must be kept in record:

Operation of pretreatment; operation of membrane system; operation of reagent dosing system; chemical cleaning.

##### **4-2.1.1 Records of Operation of Pretreatment System**

Different water sources require different pretreatment, therefore there is no uniform form to record the data. However, following contents shall be included in the records of regular pretreatment:

- ✧ Pressure drop of all filters, in order to determine whether it requires backwash, flush or air cleaning.
- ✧ Pressure, residual chlorine concentration, pH value, temperature and microbe of feedwater.
- ✧ Time recording of backwash, flush and air cleaning of filter.
- ✧ SDI value, residual chlorine, turbidity, pH value and microbe of product water
- ✧ Consumption of chemical substances (such as flocculant, coagulant aid, acid, etc.)
- ✧ Any failure or breakdown.

Record Table of Running of RO System							
Date	Date						
	Time						
Feedwater	Temp (°C)						
	SDI <sub>15</sub>						
	Turbidity (NTU)						
	Residual chlorine (mg/L)						
Pressure (bar)	First-pass Feedwater						
	Second-pass feedwater						
	Concentrate						
	Product Water						
Pressure Difference (psi)	Safety Filter						
	First Pass						
	Second Pass						
Flow Rate (m <sup>3</sup> /h)	Feedwater						
	Product Water						
	Concentrate						
	Recovery						
Conductivity (ms/cm)	Feedwater						
	1st-pass product						
	2nd-pass product						
	Total product						
	Concentrate						
pH Value	Feedwater						
	Product Water						
Corrected Data	Permeate						
	Rejection						
	Operating Pressure						
Remarks	(Explanations of system failure, shutdown, chemical cleaning, etc.)						
Recorded by:		Shift No.:		Reviewed by.:			

### 4-2.1.3 Records of Running of Chemicals Dosing System and Chemical Cleaning

Refer to the following table in preparing the records of running of chemicals dosing system.

Records of Running of Chemicals Dosing System						
Date	Date					
	Time					
Flocculant	Liquid Level of Chemicals Tank					
	Quantity Added					
	Concentration					
	Measuring Pump Knob					
	Quantity Dosed (ppm)					
Acid added	Liquid level of chemicals tank					
	Quantity Added					
	Concentration					
	Measuring Pump Knob					
	Quantity Dosed (ppm)					
Reductant	Liquid level of chemicals tank					
	Quantity Added					
	Concentration					
	Measuring Pump Knob					
	Quantity Dosed (ppm)					
Anti-scalant	Liquid level of chemicals tank					
	Quantity Added					
	Concentration					
	Measuring Pump Knob					
	Quantity Dosed (ppm)					
Remarks	(Explanations of system failure, shutdown, etc.)					
Recorded by:		Shift No.:		Reviewed by::		



Refer to the following table in preparing the records of chemical cleaning.

Records of Chemical Cleaning							
Date	Composition and Concentration of Cleaning Solution	Volume of Cleaning Solution	PH / pH of Cleaning Solution	Temp of Cleaning Solution	Time Cleaning starts	Time cleaning ends	Remarks
Recorded by:		Shift No.:		Reviewed by.:			