

MONITORING



PERFORMANCE

**Monitoring of Reverse
Osmosis System
Performance**

X Lewabrane®

LANXESS
Energizing Chemistry

Index

- 1. Inspection and monitoring..... 3
 - 1.1 Handling of new elements 3
 - 1.1.1 Storage of original packaged RO elements 3
 - 1.1.2 Packing..... 3
 - 1.2 Initial start- up checks of a plant..... 3
 - 1.2.1 Preparation Start-up..... 4
 - 1.3 Regular start-up checks in daily operation 4
 - 1.4 Monitoring and recording..... 5
 - 1.5 Logbook 5
 - 1.5.1 Routine monitoring and critical check points to be recorded in the Logbook 7
 - 1.5.2 Monitoring of the Pretreatment..... 7
 - 1.5.3 Recording the maintenance of the RO system 7

Notice: Please note that the information and recommendations provided in this technical brochure do not claim to be universally valid; in particular, they are not meant to substitute, amend or supplement the information and/or instructions provided by the OEM of the RO membrane system and/or the facility operator. In fact, LANXESS strongly recommends to obtain written confirmation from the OEM of the RO system and/or the facility operator before using the chemicals described in our technical brochure, installation of the RO elements and operation of the RO membrane system, and to verify the advice and information provided herein in each case as to its compatibility with the overall water treatment facility and RO membrane system.

1. Inspection and monitoring

1.1 Handling of new elements

1.1.1 Storage of original packaged RO elements

Lewabrane® RO membrane elements can be stored for a maximum of one year in the original packaging, unopened and sealed.

Storage temperature must be maintained between 5°C and 35°C. Humidity must be lower than 70%. Exposure to direct sunlight or any ultraviolet sources may deteriorate components of the element. Therefore, the RO elements must be stored in the dark. The elements must be kept wet, and sealed in the original oxygen barrier bag.

1.1.2 Packing

The RO element is packed in a cardboard carton box which is labeled to identify the element type and serial number.

Inside the carton box the RO element is protected by cardboard cushions to avoid mechanical damage of the element. The RO element is sealed in an oxygen barrier plastic bag. On the plastic bag is printed safety information about the preservation liquid in the RO element. Please read it carefully.

Inside the RO element box are placed the following parts:

- 1 x interconnector with O-rings
- 1 x brine seal for the ATD (fixed on the ATD)
- 1 x end plug with O-rings (supplied under separate request from purchaser)

Prior to installation please inspect the packaging and confirm that the carton box and interior oxygen barrier bag are not damaged, and the RO element remains in a wet condition. We strongly recommend that the user confirm that the supplied RO element type corresponds to the purchase order and

receiving documentation. Please confirm that the box contains all listed parts.

1.2 Initial start-up checks of a plant

Before installation and start up, it is strongly recommended that all people involved with the start-up read all safety instructions, and meet all safety requirements.

It is strongly recommended that the installers wear:

- Safety shoes
- Protection glasses (safety glasses)
- Gloves

It is recommended to assure that all connections and fittings are tight. Please check the integrity of all instruments and components.

It is also necessary that the pretreatment is working properly, and that the quality of the raw water complies with the given specifications. It is strongly recommended to check the following parameters to ensure suitable feed water quality to the RO system before the first start-up:

- Turbidity (NTU)
- Fouling Index (SDI)
- Flow rate
- Temperature
- pH
- Total dissolved solids (TDS) or conductivity
- Absence of oxidants like chlorine
- The filter cartridges for pretreatment are free of surfactants, lubricants and textile aides.
- Absence of substances which causes heavy fouling like cationic compounds or flocculants
- Bacterial counts

1.2.1 Preparation Start-up

The preparation for start up requires attention to many details. First confirm that the RO units and auxiliary equipment comply with system design specifications (materials of construction, pressure range, pH range, etc.). The following checklist is important:

- Pressure test of the membrane unit has been conducted
- All instruments are installed and calibrated
- Chemical dosing units are ready for operation with sufficient quantity of chemicals
- Alarms and time relays are operational and set to the correct range
- Chemical dosing points are in proper locations
- Chemical dosing units are interlocked with high pressure pump(s) to ensure dosing of chemicals when RO unit is in operation
- Pressure relief protection valves are installed and correctly set
- Feed, concentrate and permeate valves are open at design settings
- Provision is made for gradual feed pressure increase (< 0,7 bar/sec. or 10 psi/sec.)
- Before system pressurization, ensure that the feed water lines are flushed, and cleaned
- If required, flush the pretreatment cartridges according to the guidelines of the manufacturer

1.3 Regular start-up checks in daily operation

It is recommended to keep the RO system in operation as long as possible under constant condition after the start-up. If not possible, the below mentioned guidelines are recommended. These guidelines do not substitute the general instructions of the plant builder (OEM). It is only a recommendation, and should be followed if a manual for the plant is not available or as additional information.

First of all, the start-up staff should keep in mind that the RO elements are sensitive to:

- shock pressures (water hammer)
- extreme temperature
- high concentration of solid matter in feed water
- extreme feed water pH
- rapid changes of cross flow velocity and excessive pressure drop.

Therefore, the following steps are recommended:

Check feed water quality to meet the required specifications for the membrane elements. Ensure that the feed pressure valve and concentrate valve are set to the designed position. It is important that there is always a slow and smooth increase of pressure in the system (< 0,7 bar/sec. or 10 psi/sec.). Flush the RO system with pretreated feed water.

During the flushing only low pressure should be applied, and the permeate and concentrate streams should be sent to drain or waste according to individual permit or legislation for the state, or country.

Increase the feed pressure and feed flow rate gradually, while throttling the brine flow rate. Avoid excessive flow rates and high differential pressures across RO banks during start up.

The maximum pressure drop across any vessel must not be above 350 kPa (3.5 bar or 50 psi). Check the max pressure details according to the specification for each type of elements on the datasheet.

Adjust the RO operating parameters to the designed conditions. During this process, it is recommended not to exceed the design recovery ratio (= permeate flow rate/feed flow rate) during any stage of operation.

Make sure the permeate back pressure never exceeds feed pressure during operation, and remains lower than 0,5 bar during standby of the RO system. Otherwise membrane delamination may occur.

1.4 Monitoring and recording

The process of RO membrane desalination is an established and well known process. Therefore, it is possible to anticipate most operational issues early enough before a situation becomes critical. It is essential that a sufficient monitoring and recording of relevant data is conducted on a routine basis. It helps to prevent from an irreversible performance deterioration if the plant operator monitors the system parameters on regular basis, and submits them for troubleshooting or, if necessary, for warranty claims.

Since every plant configuration and water composition are unique, the following documents are necessary to characterize the performance of an RO membrane system:

A flow diagram or P&ID of the plant, including information on major equipment and process parameters. Documentation of calibration curves of relevant instruments. Records of the initial performance of the RO system (and the pretreatment section). Recent feed water and product water analyses.

The safe operation of RO membrane elements requires that the below mentioned pH and temperature limits must be followed:

	Continuous operation			Cleaning (short time)		
	≤ 35 °C	≤ 40 °C	≤ 45 °C	≤ 35 °C	≤ 40 °C	≤ 45 °C
Temperature	≤ 35 °C	≤ 40 °C	≤ 45 °C	≤ 35 °C	≤ 40 °C	≤ 45 °C
pH range:	2 – 11	2,5 – 10	3 – 9	1 – 12	1,5 – 11	2 – 10

Table 1.1: Temperature and pH limits

The table on next page presents some required and recommended analytical values of a RO feed water.

1.5 Logbook

It is recommended that a Logbook is used to record all relevant events during the operating of the plant with time, date and operator. Especially important are factors, which are influencing the key RO system parameters, namely permeate quality and permeate flow rate, and these must be observed, and recorded. These factors are:

Permeate flow rate and quality:

- Ionic composition of the feed water
- Feed water pH (see Table 1.1 for the limits)
- Feed water temperature (see Table 1.1 for the limits)
- Pressure (Feed, Concentrate and Permeate)
- Recovery (conversion) ratio
- Feed water quality (total ions, colloids and suspended solids; fouling index (SDI₁₅) and turbidity)
- Differential pressure across the RO system (pressure feed – pressure concentrate)
- Permeate conductivity, pH and ionic composition

Water analysis	Feed Monitoring
Conductivity ($\mu\text{S/cm}$)	required
Total dissolved solids (TDS)	recommended
Temperature ($^{\circ}\text{C}$, F)	required
pH	required
Chloride (Cl^{-})	required
Nitrate (NO_3^{-})	recommended
Bicarbonate (HCO_3^{-})	required
Sulfate (SO_4^{2-})	required
Phosphate (PO_4^{3-})	recommended
Fluoride (F^{-})	recommended
Sodium (Na^{+})	recommended
Potassium (K^{+})	recommended
Ammonium (NH_4^{+})	recommended
Calcium (Ca^{2+})	required
Magnesium (Mg^{2+})	recommended
Strontium (Sr^{2+})	recommended
Barium (Ba^{2+})	recommended
Iron as ion (Fe^{3+})	recommended
Manganese (Mn^{2+})	recommended
Silica (SiO_2)	required
Boron (B)	recommended
Hydrogen Sulfide (H_2S)	recommended
Chemical oxygen demand (COD)	recommended
Biological oxygen demand (BOD)	recommended
Total organic carbon (TOC)	recommended
Carbon Dioxide (CO_2)	recommended
Fouling Index (SDI_{15})	required
Turbidity	required
Microorganisms (unit/cc)	recommended

Table 1.2: Critical RO feed water parameters

1.5.1 Routine monitoring and critical check points to be recorded in the Logbook

There are many different methods available to log the RO system operation. The most common one still remains data entry recorded (written) in an Operation Logbook. There are many examples of an Operating Logbook (in the form of MS Excel spreadsheet). Please check the Lewabrane® webpage (<http://lewabrane.com/>) whether the file is also available in your language.

1.5.2 Monitoring of the Pretreatment

The pretreatment section (and its technology) is an essential part of the RO membrane system. The performance and the lifetime of the RO elements depend strongly on the proper operation of the pretreatment system. Therefore, we strongly recommend discussing with your system builder (OEM) specific monitoring and recording characteristics of the pretreatment. If this information is not available, the following table may help provide guidance for recording the performance of the pretreatment:

Pretreatment recording

To Check	Frequency
Total chlorine concentration of the RO feed	Daily
Feed water turbidity	Daily
Feed water SDI ₁₅	1 – 7/week
Discharge pressure of wells and booster pumps	Twice a day
Consumption of all added chemicals	Daily
Pressure drop of all filters	Twice a day
Calibration of gauges and sensors	Given by the manufacturer or every six months
Recording of maintenance work, shut-downs etc.	When performed

1.5.3 Recording the maintenance of the RO system

The maintenance of the RO membrane system must be recorded in the Logbook. At least the following events should be recorded:

- Routine standard maintenance (what, who, when)
- Replacements (equipment or element)
- Mechanical failure
- Addition of new devices
- Calibration of gauges and sensors
- Cleaning of RO elements or the system

DISCLAIMER

Health and Safety Information: Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when handling the LANXESS products mentioned in this publication. For materials mentioned which are not LANXESS products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be followed. Before working with any of these products, you must read and become familiar with the available information on their hazards, proper use and handling. This cannot be overemphasized. Information is available in several forms, e.g., material safety data sheets, product information and product labels. Consult your LANXESS representative in Germany or contact the Regulatory Affairs and Product Safety Department of LANXESS Deutschland GmbH or - for business in the USA - the LANXESS Product Safety and Regulatory Affairs Department in Pittsburgh, PA, USA.

Regulatory Compliance Information: Some of the end uses of the products described in this publication must comply with applicable regulations, such as the FDA, BfR, NSF, USDA, and CPSC. If you have any questions on the regulatory status of these products, contact - for business in the USA - your LANXESS Corporation representative, the LANXESS Regulatory Affairs Manager in Pittsburgh, PA, USA or for business outside US the Regulatory Affairs and Product Safety Department of LANXESS Deutschland GmbH in Germany.

The manner in which you use and the purpose to which you put and utilize our products, technical assistance and information (whether verbal, written or by way of production evaluations), including any suggested formulations and recommendations are beyond our control.

Therefore, it is imperative that you test our products, technical assistance and information to determine to your own satisfaction whether they are suitable for your intended uses and applications. This application-specific analysis must at least include testing to determine suitability from a technical as well as health, safety, and environmental standpoint. Such testing has not necessarily been done by us. Unless we otherwise agree in writing, all products are sold strictly pursuant to the terms of our standard conditions of sale. All information and technical assistance is given without warranty or guarantee and is subject to change without notice. It is expressly understood and agreed that you assume and hereby expressly release us from all liability, in tort, contract or otherwise, incurred in connection with the use of our products, technical assistance, and information.

Any statement or recommendation not contained herein is unauthorized and shall not bind us. Nothing herein shall be construed as a recommendation to use any product in conflict with patents covering any material or its use. No license is implied or in fact granted under the claims of any patent.

© 2013 – All Rights Reserved
LANXESS Deutschland GmbH

CONTACT

LANXESS Deutschland GmbH
Business Unit Liquid Purification Technologies
Kennedyplatz 1
50569 Köln, Germany
E-mail: lewabrane@lanxess.com
Web site: <http://lewabrane.com/>

Edition: March 2017