PuROmax™

HP, LP, And M Series
Operation Manual

LP-2,800

LP-5,000

LP-7,500

LP-11,500

Rev 4.0

Table Of Contents

PuROmax

HP, LP, And M series
RO Manual

1.0 INTRODUCTION

Reverse Osmosis systems from FSHS produce high quality permeate water from municipal and well water . The basic FSHS unit is designed to produce fresh water at the capacities indicated by the suffix in the model number. For example, the FSHS - 2,200 will produce 2,200 gallons per day (GPD). This production rate is accurate plus or minus 15%. Each unit has a specific operating pressure. Units that start with HP are high pressure. Units that start with LP are low pressure. Operating pressure for your unit can be found on page 9.

2.0 MOUNTING

The FSHS reverse osmosis systems are free standing and require no special mounting. They are lightweight and portable. Wall mount units are available upon request.

3.0 INSTALLATION

FSHS water systems are designed for portability and easy installation. However, compliance with the following guidelines will help insure successful operation of the systems:

3.1 PLUMBING

A. The membranes and high-pressure pumps used on the FSHS water systems will require continuous and smooth flow of water to the unit. As a minimum, a flooded inlet should be provided, but a constant, non-turbulent flow of 50 psi see chart on page 9 for required flow.

B. The concentrate outlet is located on the top of the larger flow meter. The tubing used for discharge of the concentrate should be run to an open drain in a free and unrestricted manner. Any restrictions or blockage in the drain could cause back pressure. On the M-1000 this is located on the flow meter with a control valve.

C. The Permeate connection is located on the top of the smaller flow meter. Again, care should be taken to ensure that backpressure is not induced. Excessive permeate back pressure can damage the reverse osmosis membrane.

D. Temperature of the feed water must not exceed 113 degrees F. To reach stated flow a temperature of 77 degrees is optimal.

3.2 ELECTRICAL

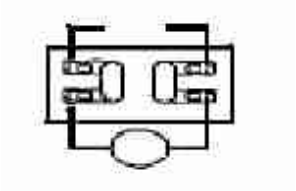
All motors on the FSHS units are open drip-proof (ODP) type. Single-phase motors are supplied on most models. The standard motors are 60 Hz, but 50 Hz motors are supplied as requested. Voltage will be either 110V or 220V (for 60 Hz and most 50 Hz frequencies) or 190V (for some 50 Hz models). Refer to the systems specifications on the motor and data sheet for the particular electrical requirements of a given model.

Insure that the electrical circuit supplying the system is compatible with the requirements of the specific FSHS R/O unit. All PuROMax units should also have a float switch that will turn the unit on and off. Incoming power connections on units without a control box should be made through the low pressure safety switch. This is a gray switch located on the side of the unit. (See diagram 1). If your unit is equipped with a control panel, power is connected at the on/off switch located on the side of the control box (wire diagram 2). The M-1000 has an optional high pressure switch for use with a pressure tank. You should always consult a qualified electrician.

Wiring Diagram 1

without control box

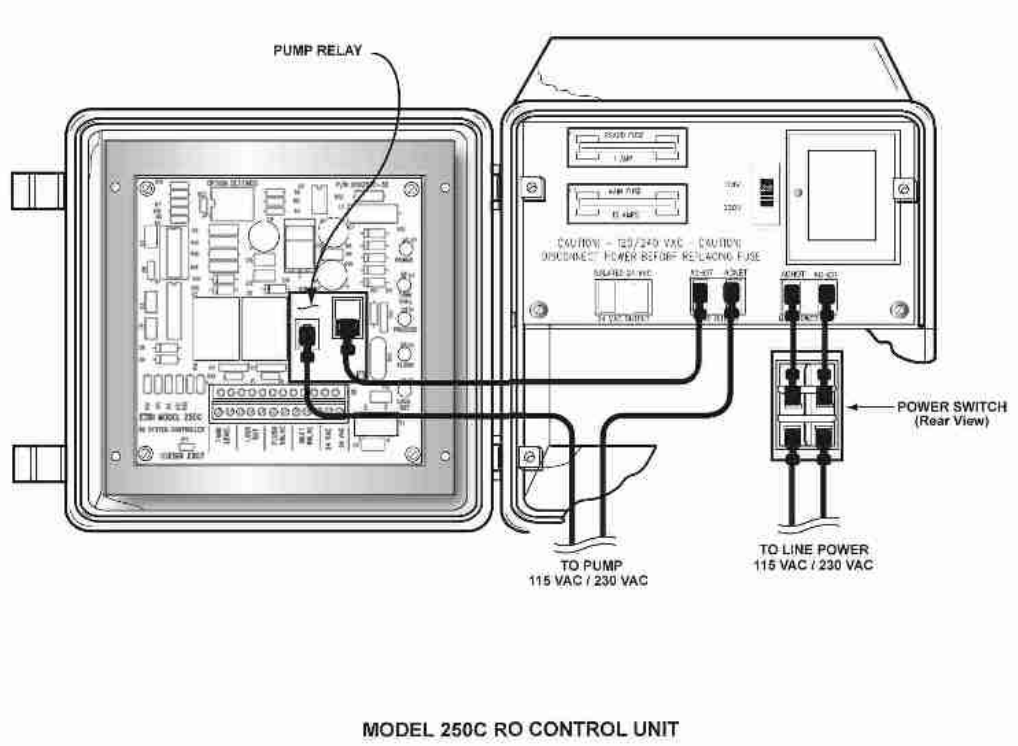
Top
Line



Bottom
Load

Wiring Diagram 2

with control box



MODEL 250C RO CONTROL UNIT

4.0 PRE-FILTRATION

FSHS reverse osmosis systems are supplied with a sediment pre-filter intended to provide 5 micron pre-filtration prior to the reverse osmosis system membranes. It is recommended that the pre-filter cartridge be checked periodically. Although once a month is a recommended interval between filter cartridge changes, the filter should be checked whenever feed water conditions change, previous experience dictates that more frequent changes are required, or if the pressure drops across the pre-filter exceeds 15 psi. The M-1000 is equipped with dual pre filters.
If the pre filter becomes clogged and water flow to the pump is reduced or interrupted, pump hammering will occur. This will damage the pump and/or reduce the performance of the system. A water analysis should be done for every unit. Water conditions vary and some containments such as chlorine and Iron will damage membrane and will not be covered under manufacturers warranty.

5.0 PUMP

The pumps supplied with the FSHS- 2,200 through 17,000 reverse osmosis systems are multistage centrifugal type. The M-1000 and units under 2200 gpd are a rotary style pump. It is essential that the following guidelines be followed:

A. The pump must NEVER be run dry. Operating the pump without sufficient feed water will cause damage to the pump and will void the warranty.

B. ALWAYS feed the pump with filtered water. Loss of performance and damage can result from sediment and debris in the feed water.

6.0 START-UP

The following start-up procedure should be performed to ensure proper operation of the system:

1. Attach feed water pipe to the inlet of the FSHS system . Plumbing should be installed in a manner, which ensures that smooth and sufficient flow of feed water can be maintained. The M-1000 is equipped with a 1/2 feed line.

2. Connect permeate and concentrate tubes to the unit. Special care must be taken on the permeate line to ensure that back pressure on the membrane does not result. Fill RO completely with water before starting. Open the solenoid valve, (by turning handle on solenoid valve), to allow the unit to fill with water.

3. Turn the machine on by connecting the electrical cord to the electrical supply. Allow the system to run for about three minutes with the concentrate valve fully open and the recycle valve, if equipped, fully closed to purge air from the system.

4. Turn the concentrate control valve until the correct pressure is displayed on the concentrate pressure gauge. Refer to the System Specifications Table for the correct concentrate pressure for your unit. Most units have a SS valve located on the side of the unit. The M-1000 has a control knob on the front of the drain flow meter.

5. Discard the permeate water from the first 15 minutes of system operation to ensure that all the bactericide and preservatives have been flushed from the membrane. Slowly open recycle valve (if equipped). If feed water TDS is extremely low or if multiple membranes are included in the system, higher recovery may be achieved. **NEVER EXCEED 75% RECOVERY!** Premature element fouling usually occurs at high recovery rates. Please see data sheet page 11.

NOTE: As the recycle valve is opened, the pressure will drop. This can be compensated for, by further adjustment of the control valve.

6. Connect the permeate line to the point-of-use. Again, no back pressure must exist on the permeate line.

7. Ensure that the water flow through the system ceases when the system is turned off. This will prevent premature fouling of the reverse osmosis membrane.

7.0 TROUBLESHOOTING

If the system production declines or the unit ceases to operate, it is probably due to failure of one of the mechanical components of the system, or membrane damage. Refer to the RO Troubleshooting manual if membrane damage or fouling is suspected. Listed below are the items to check for. Two of the most commonly encountered problem conditions are LOW PRESSURE and ABNORMAL PERMEATE FLOW:

7.1 LOW PRESSURE (system cycles on/off or hammers)

Low pressure is defined by the inability of the high-pressure RO pump to achieve the proper concentrate pressure. Failure to operate at the proper pressure will result in low production and poor rejection. If your system turns on and off rapidly (hammers), it is due to lack of inlet pressure. Check to make sure that you have proper flow for the system using the chart in table 1.

1. PUMP: Isolate the pump and determine how much pressure can be achieved. Check flow rates at the recommended operating pressure.

2. PRE-FILTER: Examine the pre-filter cartridge to make sure that it is not clogged and restricting feed flow to the pump.

3.FEED WATER FLOW RATE: Check if the unit is getting sufficient volume of feed water. Refer to the System Specifications for the required feed flow on page 9.

4. INLET SOLENOID VALVE: The system can be operated without the solenoid for troubleshooting. Remove the solenoid to see if it is contributing to the problem. Normally, cleaning of the solenoid diaphragm will correct any malfunctioning of the solenoid.

5. ELECTRIC: Check to be sure that there are no electrical fuses blown and that the motor is getting sufficient power.

6. PERMEATE FLOW RATE: This should be within 15% of the rated production, after correcting the feed water temperature. This can be checked by measuring the length of time required for the permeate output to fill a one gallon container.

7. PRESSURE GAUGE: Check for foreign matter on the gauge fitting. Remove any visible matter and replace the fitting. Verify that the tube is not pushed too far inside the fitting. This could restrict the flow and cause an inaccurate display. If the fitting and tube are fine and the pressure gauge is still malfunctioning, the gauge should be replaced.

7. PRESSURE GAUGE: Check for foreign matter on the gauge fitting. Remove any visible matter and replace the fitting. Verify that the tube is not pushed too far inside the fitting. This could restrict the flow and cause an inaccurate display. If the fitting and tube are fine and the pressure gauge is still malfunctioning, the gauge should be replaced.

7.2 ABNORMAL PERMEATE FLOW

Low permeate flow is often an indication of a problem with the reverse osmosis membrane. High permeate flow can also suggest membrane problems, but for different reasons.

1. Excessive Permeate flow: An unusually high amount of permeate production can be an indication of membrane damage. Check the following on the membrane:

a. A product O-ring may be cut or otherwise defective. O-rings on the product tube must be free of nicks and cuts and must be lubricated.

b. The reverse osmosis membrane may be channelized. This defect is often the result of chlorine contamination. If the membrane has had an excessive cumulative exposure to chlorine, the permeate flow will be abnormally high and the permeate quality will be reduced.

c. The membrane may have freeze damage. Preservative should be used to protect the membrane when exposed to temperatures below freezing. Check the specifications for the membrane manufacturer for more detailed instructions for preservation of the membrane.

2. Insufficient Permeate Flow: High organic or inorganic concentrations will lead to scaling or fouling of the membrane, causing poor rejection of impurities. Cleaning of the membranes will sometimes improve performance of the membranes. Check with your dealer for the cleaning instructions and proper cleaning solutions.

8.0 CLEANING ELEMENTS

Frequent cleaning is not required for a properly designed and a properly operated RO system, but because of the membrane combination of pH stability and temperature resistance, cleaning can be accomplished very effectively.

In normal operation, the membrane can become fouled by mineral scale, biological matter, colloidal particles, and insoluble organic constituents. Deposits build up on the membrane surfaces during operation until they cause loss in water output, loss of salt rejection or both.

Temperature & Pressure Correction

Temperature of the feed water and the net driving pressure across the element must be taken into account before comparing or evaluating the performance of a membrane element or a reverse osmosis system.

Temperature Correction Factor

The water temperature is one of the key factors in the performance of the reverse osmosis membrane element. The higher the temperature, the more the product flow, and vice versa. All reverse osmosis membrane elements and systems are rated at 77° Fahrenheit (25° Celsius). To find the membrane permeate rate at a different temperature, follow these steps:

Find the temperature correction factor (TCF) from the below table. Divide the rated permeate flow at 77° Fahrenheit by the temperature correction factor. The result is the permeate flow at the desired temperature.

EXAMPLE
QUESTION: For a thin-film membrane permeate rated at 1800 gallons per day at 77° Fahrenheit, what is the actual permeate rate at 59° Fahrenheit?
ANSWER: Temperature correction factor (from below table) for 59°F = 1.47
Permeate flow at 59 degrees Fahrenheit = 1800 ÷ 1.47 = 1224 gallons/day

Feed Water Temperature °C	°F	TCF for Thin Film	TCF for CTA/CAB
1	33.8	3.64	2.23
2	35.6	3.23	2.15
3	37.4	3.03	2.08
4	39.2	2.78	2.00
5	41	2.58	1.93
6	42.8	2.38	1.87
7	44.6	2.22	1.80
8	46.4	2.11	1.74
9	48.2	2.00	1.68
10	50	1.89	1.63
11	51.8	1.78	1.57
12	53.6	1.68	1.52
13	55.4	1.61	1.47
14	57.2	1.54	1.42
15	59	1.47	1.38
16	60.8	1.39	1.33
17	62.6	1.34	1.29
18	64.4	1.29	1.25
19	66.2	1.24	1.21
20	68	1.19	1.17
21	69.8	1.15	1.13
22	71.6	1.11	1.10
23	73.4	1.08	1.06
24	75.2	1.04	1.03
25	77	1.00	1.00

Feed Water Temperature °C	°F	TCF for Thin Film	TCF for CTA/CAB
26	78.8	0.97	0.97
27	80.6	0.94	0.94
28	82.4	0.91	0.91
29	84.2	0.88	0.89
30	86	0.85	0.86
31	87.8	0.83	0.83
32	89.6	0.80	0.81
33	91.4	0.77	0.79
34	93.2	0.75	0.76
35	95	0.73	0.74
36	96.8	0.71	0.72
37	98.4	0.69	0.71
38	100.4	0.67	0.68
39	102.2	0.65	0.66
40	104	0.63	0.65
41	105.8	0.61	
42	107.6	0.60	
43	109.4	0.58	
44	111.2	0.56	
45	113	0.54	
46	114.8	0.53	
47	116.6	0.51	
48	118.4	0.49	
49	120.2	0.47	
50	122	0.46	

TEMPERATURE & PRESSURE CORRECTION

NET PRESSURE CORRECTION

The higher the net pressure on a membrane element, the higher the permeate rate. A rough value of osmotic pressure of water can be calculated roughly by the following rule:

Osmotic pressure (PSI) = Total Dissolved Solids / 100

To estimate the effect of net pressure, follow these steps:

1. Calculate the net pressure at which the membrane element is rated (P_r)
   P_r = Rated pressure - Osmotic pressure of test solution

2. Calculate the net pressure under operating conditions (P_{op})
   P_{op} = Average applied pressure - Average osmotic pressure of the feed water

3. Expected permeate flow at operating conditions = (Rated permeate flow) x P_{op} / (P_r)

EXAMPLE

QUESTION:
For a thin-film membrane, 4 × 40" membrane element, using a 2000 ppm, sodium chloride solution at 225 psi and 77 degrees Fahrenheit, the permeate rate is 1800 gallons/day. What is the permeate rate at 150 psi, feed water with 1000 TDS and temperature of 59 degrees Fahrenheit?

ANSWER:
From the above example for the temperature correction, the permeate rate at 59 degrees Fahrenheit is 1224 gallons/day.

Using the steps above, the effect of net pressure is:
1224 x (150 - 10) / (225 - 20) = 1224 x (140) / (205) = 835.9 gallons/day

NOTE

When designing a system additional detailed calculations are necessary to take into account the effect of pressure drop and variation in total dissolved solids (TDS) throughout the system. Please contact us if you require further information.

PuRoMax Reverse Osmosis Units

Model	Membranes	Product GPD	Product GPM	Reject GPM	Total GPM	Rec	Oper PSI	Motor HP	Motor Volts	Motor Amps	Connection Sizes Feed	Product	Reject	Pump Model	Filter Size	Size WxDxH
M-300P No Pump	1 3x14	300	0.2	0.2	0.4	50%	65	NA	24	NA	1/2	3/8	3/8	NA	3x14	28x7x23
M-600P No Pump	2 3x14	600	0.41	0.41	0.82	50%	65	NA	24	NA	1/2	3/8	3/8	NA	3x14	28x7x23
M-1000	2 3x14	1000	0.69	0.69	1.38	50%	90	1/4	115	375 W	1/2	1/2	1/2	CMP-100	3x14	22x14x27
LP-400	1 2.5x21	400	0.27	0.98	1.25	21%	175	1/4	115	375 W	3/4	3/8	3/8	CMP-60	2x20	20x13x46
LP-760	1 2.5x40	766	0.55	0.95	1.5	36%	115	1/4	115	375 W	3/4	3/8	3/8	CMP-80	2x20	20x13x26
LP-1000	1 4x21	1050	0.7	0.96	1.6	43%	90	1/4	115	375 W	3/4	3/8	3/8	CMP-100	2x20	20x13x26
LP units are designed for properly pre treated water less than 2000 PPM.																
HP-2200	1 4x40	2200	1.52	3.48	5	30%	225	1	115/230	16.2/8.1	3/4	1/2	3/4	7GBS10	2x20	18x23x55
LP-2800	1 4x40	2800	2	6	8	25%	115	1.5	115/230	10.8/5.4	3/4	1/2	3/4	7GBS05	2x20	18x23x55
HP-4400	2 4x40	4400	3	7	10	30%	225	1.5	115/230	21.4/10.7	3/4	1/2	3/4	10GBS15	2x20	22x23x64
LP-5000	2 4x40	5000	4	4	8	50%	115	1	115/230	16.2/8.1	3/4	1/2	3/4	7GBS10	2x20	22x23x64
HP-6600	3 4x40	6600	4.56	5.44	10	45%	225	1.5	115/230	21.4/10.7	1	3/4	3/4	10GBS15	4.25x20	22x23x64
LP-7500	4 4x40	7500	5.2	6.8	12	43%	115	1.5	115/230	21.4/10.7	1	3/4	3/4	10GBS15	4.25x20	22x23x64
HP-8800	4 4x40	8800	6.11	7.89	14	43%	225	3	230		1	3/4	3/4	18GBS30	4.25x20	26x28x64
LP-11500	4 4x40	11500	7.63	7.63	15	50%	115	1.5	115/230	21.4/10.7	1	3/4	3/4	18GBS15	4.25x20	26x28x64
LP-17000	6 4x40	17000	11.97	13.01	25	47%	115	3	230		1	1	1	25GBS30	4.25x20	36x30x74
LP-15	8 4x40	23000	15.97	15.97	32	50%	115	5	230		1	1	1	45HB2501	4.25x20	
Specifications are based on a 2000 mg/l solution at 115 psig on LP units and 225 psig on HP units operating pressure. 77 F, 15% recovery, ph 7.5 after 24 hours. Individual flux may vary +15% / -15%.																

Table 1

Test Conditions
The stated performance is initial (data taken after 30 minutes of operation), based on the following conditions:

NaCl Solution,	PPM*	500
Applied Pressure**,	psig (MPa)	107 psi (1.05)
Operating Temperature,	°F (°C)	77° (25°)
Permeate Recovery 15%		
pH Range		6.5-7.0

Application Data

Maximum Applied Pressure,	psig (MPa)	150 (4.14)
Maximum Supply	TDS	2500 PPM
Maximum Operating Temperature,	°F (°C)	113° (45°)
Feedwater pH Range*		3.0-10.0
Maximum Feedwater Turbidity,	NTU	1.0
Maximum Feedwater SDI	(15 mins)	5.0
Maximum Chlorine Concentration,	PPM	<0.1

Industrial R/O Test Data					
Serial #:					
	Units	Sample	Before Install	After Install	Service
Permeate Rate	GPM	1			
Concentrate Rate	GPM	1			
Recovery		50%			
Inlet Pressure	PSI	50			
Membrane Pressure	PSI	115			
Feed TDS	PPM	500			
Well or Municipal		Municipal			
Iron	PPB	0.02			
Hardness	PPM	0			
Permeate TDS	PPM	10			
Water Temp.	F	77			
Rejection		98%			
Low Pressure		Y			
Solenoid		Y			
Pump Model #		7GBS10			
Pump Serial #					
Membrane size	Style	4x40 GE			
TDS Monitor		Y			
Recycle Valve		NA			
Pre & Post Pressure Gauge		NA			
Customer Name		FSHS Inc			
Test Date		10/1/2005			
Install Date		10/13/2005			
Tested By		Jeremy Greene			
Remarks					
Y is yes for function NA is used for not equipped					

The industrial R/O data sheet should be filled out before and after install. Any units that wish to be returned for service or repair must have a completed test data sheet for review.

SIX MONTH LIMITED WARRANTY

FSHS, Inc., warranties your commercial/ industrial Reverse Osmosis system, to be free of defects in material and workmanship, for a period of (6) six months, under normal use, within normal operating conditions. To resolve any warranty problems, you must **first** contact your local dealer, they in turn will contact the factory. Upon proof of purchase, ***FSHS, Inc.***, will repair or replace, at the factory, the defective part or unit, and return it to your local dealer. Freight to and from the factory is to be paid by the buyer.

The Pre and Post filter cartridges, if any, are warrantied for manufacturers defects only and not for taste and odor problems. The membrane is warrantied separately as stated below.

All parts, such as pumps, motors, electrical parts and flow meters, shall be warrantied by the manufacturer of these parts.

MEMBRANE LIMITED WARRANTY

The **REVERSE OSMOSIS MEMBRANE** will be warranted for a six month period. Warranty begins from the date of purchase from the manufacturer. Membrane is warranted against defects when used under standard operating conditions.

Membranes must be kept moist at all times. Defective membranes must be returned in a sealed bag and kept moist with an appropriate preservative solution or R.O. water. **Membranes returned dry, opened, or improperly packaged can not be evaluated for warranty and will be returned to the sender at your expense.**

Standard Operating Conditions for Membrane

	LP Model	HP Model
Maximum feed water pressure	115psi	215-225psi
Water temperature	40-100F	
TDS max	2000ppm	10,000ppm Brackish
pH	4-11	4-11
Hardness	10-12	10-12 grains

THERE ARE NO OTHER WARRANTIES EITHER EXPRESSED OR IMPLIED AND THERE IS NO LIABILITY FOR CONSEQUENTIAL DAMAGES OF ANY NATURE OR KIND.