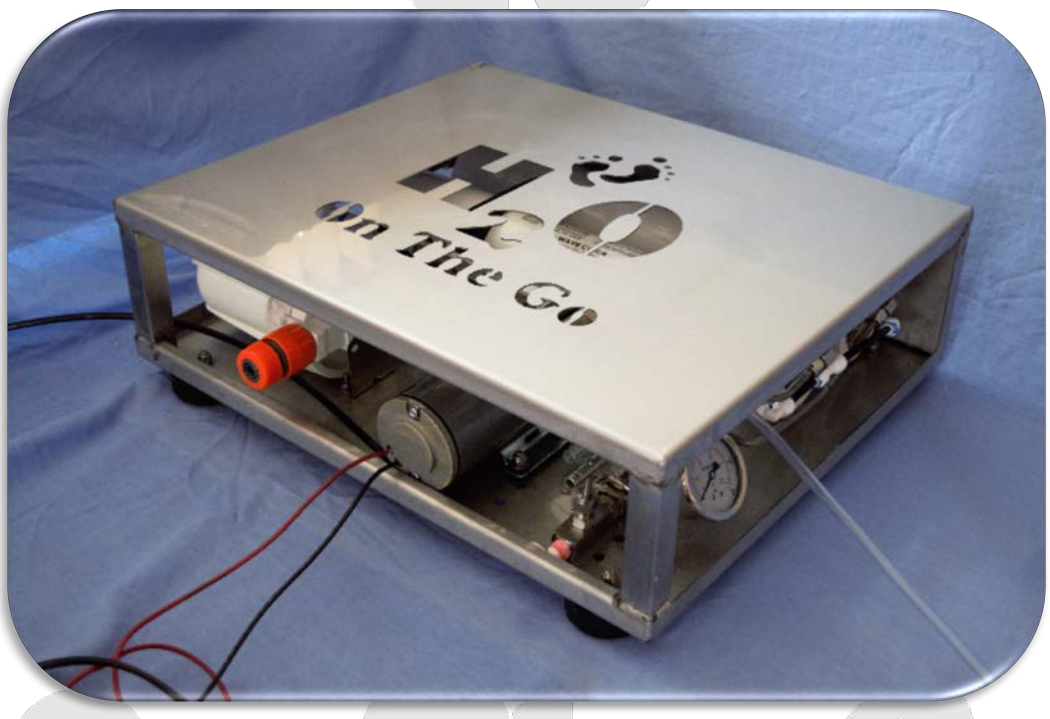
H2O On The Go ®



Operation and Maintenance Manual

12/24volt (15/7.5a) Double Membrane System

Contents

Introduction

The team at H2O on the Go thanks you for your purchase of an affordable, portable, double membrane reverse osmosis water maker. The water maker design is based on real world product testing and engineering, and we trust that you will be completely satisfied with your water maker.

Our water makers have been designed and built for easy operation and maintenance, but we strongly encourage our customers to spend time reading through our operation and maintenance manual before using their water maker and contacting us via email, phone, or even Skype for support if they have any questions. Spending some time talking to the people that actually designed and built your water maker can quickly help answer any questions regarding operation and maintenance.

At first glance through this manual you may find that the operation and maintenance of your water maker seems quite complicated; be assured that once you have used your system a few times you will become confident in operating the system and will find that it is in fact very simple to operate and maintain.

H2O on the Go ®
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Warranty

H2o On The Go (The Windmill Foundation) guarantee their water makers will be free of manufacturer defects and to perform within the stated specification for a period of one year (12 months) from the date of shipment.

In the event of a defective component or failure during the term of the warranty, H2O on the Go Go (The Windmill Foundation) will inspect the defective part and repair or replace at our discretion, with all the shipping charges being the responsibility of the purchaser to and from their location to our premises in Mandurah, Western Australia.

As a condition of the warranty, the purchaser is responsible for conducting the recommended maintenance according to H2O on the Go's (P.D Davis & P.J Davis) stated maintenance schedule and operating their unit within the operational parameters outlined in this manual.

The warranty does not extend to parts that have failed due to misuse, improper installation, modification, and operations outside of those defined by H2O on the Go (P.D Davis & P.J Davis).

The warranty does not cover parts where the serial number has been removed or defaced and the warranty does not apply to the normally recurring consumables or wear and tear items as defined below:

- Pre-filter elements 5 and/or 20 micron
- Activated carbon back-flush filter elements

H2O on the Go's (The Windmill Foundation) liability under this warranty is limited to repair or replacement of the H2O on the Go water maker to the original purchaser. Under no circumstances shall H2O on the Go (The Windmill Foundation) be liable for consequential damages arising out of or in any way connected with the failure of the system to perform.

Warning! We will not be held responsible for shortages and/or freight damage where you have selected not to insure the product during transport or that are not reported within fourteen (14) days of the ship date.

Understanding Totally Dissolved Solids (TDS) Readings

You will use your TDS meter to test the water often throughout the water making process. This informs you weather the machine is working as intended and whether the water is suitable for drinking or not.

A TDS meter indicates the Total Dissolved Solids (TDS) of a solution, i.e. the concentration of dissolved solids in it. Since dissolved ionized solids such as salts and minerals increase the conductivity of a solution, a TDS meter measures the conductivity of the solution and estimates the TDS from that.

Dissolved organic solids such as sugar and microscopic solid particles such as colloids, do not significantly affect the conductivity of a solution so a TDS meter does not include them in its reading.

A TDS meter typically displays the TDS in parts per million (ppm). For example, a TDS reading of 1 ppm would indicate there is 1 milligram of dissolved solids in each litre of water.

A slightly elevated total dissolved solids (TDS) concentration is not a health hazard. The TDS concentration is a secondary drinking water standard and therefore is regulated because it is more of an aesthetic rather than a health hazard. Water with a TDS reading between 800 and 1200 may begin to have a bitter taste; water with a TDS reading of ≥4000ppm will taste salty. Water taste is a personal preference. The World Health Organisation recommends a TDS reading of ≤500ppm.

An undamaged membrane removes all pathogens and cysts, so when using fresh water as the water source there is no requirement to test the water other than out of interest. When using sea or brackish water as source water we use the TDS meter to test how much totally dissolved solids remain in the fresh water to ensure that an adequate amount have been removed.

Sea water has an initial TDS reading of approximately 36,000ppm, (this is above the testing range of your TDS meter), and we recommend that before you send water to your tanks that the TDS reading should be ≤500ppm.

Water Classifications

- Fresh water < 1,000 mg/L TDS
- Brackish water 1000 to 10,000 mg/L TDS
- Saline water 10,000 to 30,000 mg/L TDS
- Brine (Sea water) > 30,000 mg/L TDS

Understanding Water Temperature Effects on Reverse Osmosis Systems

Reverse osmosis systems are generally rated at 25°C. Variations in temperature have an effect on the system for two reasons.

1. Water viscosity changes at different temperatures; the cooler water gets the viscosity (stickiness) of the water increases. The reverse happens when the water is warmed.
2. The water temperature has an effect on the membrane element. Cold water causes the pores in the membrane to shrink, where as warm water caused the pore size to increase.

The effect of water temperature changes on the permeate flow are as follows:

- For every 3 degrees the temperature drops below 25°C the permeate output will decrease by 10%, so if you have a 100lph system, at 22°C you can expect the permeate flow to drop to 90lpm. If the water temperature drops to 19°C you can expect a permeate flow of 80lpm.

- For every 3 degrees the temperature rises above 25°C you will get a 10% increase in permeate flow, but also a 10% increase in TDS readings. So more output but due to the expanded pore size of the membrane the removal of dissolved solids is decreased.

There is very little you can do about an increase in water temperature, an increase in TDS between 10 and 30% will still produce acceptable drinking water.

The drop in flow rate due to cold water temperatures can be offset to some degree by increasing the running pressure of the system.

For every 5°C drop in water temperature you will need a 15% increase in running pressure to obtain the system rated permeate flow.
For example in an 180lph system if the water temperature is 20°C, you can add 15% (120psi) to the normal 800psi running pressure and continue to receive a permeate flow of 180lph.

As the system is only rated up to 1000psi and the pressure relief valve is set to release at 950psi, this is the maximum offset that can be achieved on our systems.

Once the water drops below 20°C you will need to take into account that a longer running time will be required to achieve the system rated permeate output.

Note:

Membrane elements have a +-10% variation in different running environments as no membrane is the same and small variations may occur from week to week.

General Cautions and Warnings

There are several things which the operator of the water maker can do incorrectly, which can lead to serious damage of the water maker, dramatically shorten the operational life span of the various system modules and in some cases cause personal injury.

- **Never allow chlorinated water to come in contact with the membranes. Oxidants such as chlorine and bleach will permanently destroy the RO membrane.**
- **Never run the water maker in oily water, as oil will permanently destroy the RO membrane.**
- **Never run the high pressure pump dry or operate it outside the inlet supply pressure and flow design parameters.**
- **In brackish water, such as in an estuary or river, never allow the product water production flow rate to exceed the units rated output. In such cases, simply turn down the system pressure or RO membrane damage will occur.**
- **Never exceed a pressure of 950 PSI.**
- **Do not allow the RO Membrane Module to become heat soaked to temperatures above 48°C while in operation and 60°C while not in operation, doing so will cook and destroy the RO Membrane.**
- **The RO Membrane Module is shipped containing a storage/preservative metabisulphite solution; allow a minimum of 30 minutes of initial operation before sampling the product water in order to properly flush out the preservative.**
- **The high pressure pump is capable of creating a stream of pressurized sea water up to 1000 PSI. Under no circumstances should the high pressure pump be operated without the supplied pressure relief valve in place or with the high pressure lines not properly connected.**
- **While performing a system freshwater rinse, be sure that the pressure regulating valve is in the completely open position, which can be verified by turning the pressure regulating valve counter clockwise until it physically stops. Running fresh water or brackish water at elevated pressures through the RO membranes will permanently destroy the membrane.**
- **Remember that water and power do not mix so take all precautions to ensure you operate your water maker in a safe manner.**

Normal Water Maker Operation Procedure Using Sea Water

Before starting your water maker:

• Oil, chlorine and other chemicals will do permanent damage to your water maker membrane. Always confirm that your feed water source is free of chemicals before starting the system.

• If the water maker has been in storage and this is the first start-up since pickling the unit, or it is your first time operating your unit. follow the normal start-up procedure, but discard all product water for the first 30 minutes of operation to ensure that the storage solution has been completely flushed from the system. Ingestion of the solution will cause gastrointestinal issues. The following steps should be followed for operating the water maker using ***Sea Water.*** Failure to follow these steps can result in serious damage to the RO Membranes and the High Pressure pump.

CAUTION: Starting the water maker without the pressure regulating valve in the fully opened counter clockwise position will result in a surge of high pressure water going to the RO Membrane this can cause catastrophic failure and tearing of the membranes.
Note: Due to design parameters there may be 100 to 200 PSI even with the pressure regulating valve fully open in the counter clockwise direction. This is acceptable for start-up.

1. ***Ensure*** the 5 Inch 5-micron sediment filter is placed inside the prefilter housing.

2. Connect a hose between the prefilter housing and the submersible pump. Verify that the submersible pump has been placed in the water and that is free of debris and not sitting on sand or mud. The pump ***must be*** placed under the surface of the water but not resting on the bottom. For example, attach the pump to a float, star picket or piece of tubing.

3. Fully ***open*** the bleed valve. Located on the left side of your system next to the prefilter housing.

4. Fully open the pressure regulating valve next to the pressure gauge by turning it ***counter clockwise*** until fully open.

5. Ensuring a ***5 AMP*** fuse is in place in the submersible fuse holder, turn on the submersible pump and run it until all the air has been purged from the system. When all air is purged you will see that the water is now running smoothly through the bleed valve. The system is now free of any air

6. Once air has been purged turn the bleed valve ***off,*** water will now begin to flow through the system and be observed exiting the brine discharge (the black hose located after the pressure gauge/pressure regulator) which runs underneath the high pressure pump and exits the system underneath the prefilter.

7. Ensuring a ***20 AMP*** fuse is in place in the high pressure pump fuse holder. Turn on the high pressure pump and let it run for 5 minutes to ensure that air bubbles have been flushed from the system.

8. Slowly increase the system operating pressure by turning the pressure regulating valve in a clockwise direction. Slowly increase the system pressure up to 600 PSI. Allow the pump and motor assembly to run at 600 PSI for a ten-minute break-in period. ***NOTE: You will observe fresh water starting to flow through the flowmeter once you reach approximately 600-650 PSI.***

9. Once the system is stable at 600 PSI for ten minutes, ***slowly*** increase the pressure up to the standard system pressure of 800 PSI. ***NOTE: Only increase pressure in Sea Water, refer below for operation in Brackish/fresh water.***

CAUTION: Never operate the water maker at a system pressure above 950 PSI. While the pressure relief valve will bleed off the pressure, damage to the RO membranes can occur. Normal operating pressure is 800 psi (for sea water).

CAUTION: Please note that the pressure relief valve can move very slightly during transport, please run a check to ensure the valve is still set at 950 psi after transporting the system. Refer below to **'**Testing Your Relief Valve'

10. You are now making fresh water! Collect a sample of the fresh drinking water from the clear fresh water hose that exits the top of the flow meter. Check the TDS using the hand held TDS meter. Once the TDS reading is acceptable (below 500 ppm) the water is ready to be sent to a tank. A normal initial TDS reading will range from 400 to 500 ppm (for sea water). ***REMEMBER! To discard the first 15-20 minutes or product water if you are using it after pickling or for the first time*** Continue to monitor the systems pressure and adjust if necessary to maintain the system pressure at 800 PSI. ***DO NOT*** leave system unattended the pressure regulator can move due to vibration etc**.**

Normal Water Maker Operating Procedure Using Brackish or Fresh Water

Before starting your water maker:

• Oil, chlorine and other chemicals will do permanent damage to your water maker membrane. Always confirm that your feed water source is free of chemicals before starting the system.

• If the water maker has been in storage and this is the first start-up since pickling the unit, or it is your first time operating your unit. follow the normal start-up procedure, but discard all product water for the first 30 minutes of operation to ensure that the storage solution has been completely flushed from the system. Ingestion of the solution will cause gastrointestinal issues. The following steps should be followed for operating the water maker using ***Brackish or Fresh Water***. Failure to follow these steps can result in serious damage to the RO Membranes and the High Pressure pump.

CAUTION: Starting the water maker without the pressure regulating valve in the fully opened counter clockwise position will result in a surge of high pressure water going to the RO Membrane this can cause catastrophic failure and tearing of the membranes.
Note: Due to design parameters there may be 100 to 200 PSI even with the pressure regulating valve fully open in the counter clockwise direction. This is acceptable for start-up.

1. ***Ensure*** the 5 Inch 5-micron sediment filter is placed inside the prefilter housing.

2. Connect a hose between the prefilter housing and the submersible pump. Verify that the submersible pump has been placed in the water and that is free of debris and not sitting on sand or mud. The pump ***must be*** placed under the surface of the water but not resting on the bottom. For example, attach the pump to a float, star picket or piece of tubing.

3. Fully ***open*** the bleed valve. Located on the left side of your system next to the prefilter housing.

4. Fully open the pressure regulating valve next to the pressure gauge by turning it ***counter clockwise*** until fully open.

5. Ensuring a ***5 AMP*** fuse is in place in the submersible fuse holder, turn on the submersible pump and run it until all the air has been purged from the system. When all air is purged you will see that the water is now running smoothly through the bleed valve. The system is now free of any air

6. Once air has been purged turn the bleed valve ***off,*** water will now begin to flow through the system and be observed exiting the brine discharge (the black hose located after the pressure gauge/pressure regulator) which runs under the high pressure pump and exits the system under the prefilter.

7. Ensuring a ***20 AMP*** fuse is in place in the high pressure pump fuse holder. Turn on the high pressure pump and let it run for 5 minutes to ensure that air bubbles have been flushed from the system.

8. Slowly while carefully watching your flowmeter increase the system operating pressure by turning the pressure regulating valve in a clockwise direction until a flow rate of 10 Litres per hour (2.5GLPH) is achieved. The pressure required to achieve this flow rate will vary depending on the salinity of the feed water. ***Note: In fresh water it may be above this flow rate and very close to the maximum flow rate of 20 litres per minute without making any adjustment - in this circumstance leave the pressure regulating valve fully open.***

9. After about 10 minutes of the system being stable at 10 litres per hour flow rate, slowly increase the pressure up to the flow rate up to 20 litres per hour.

CAUTION: Never operate the water maker at a flow rate above 20 litres per hour. Fresh water requires far less pressure than saltwater to achieve this flow rate, operating the water maker beyond this flow rate will cause catastrophic failure of the RO Membrane.

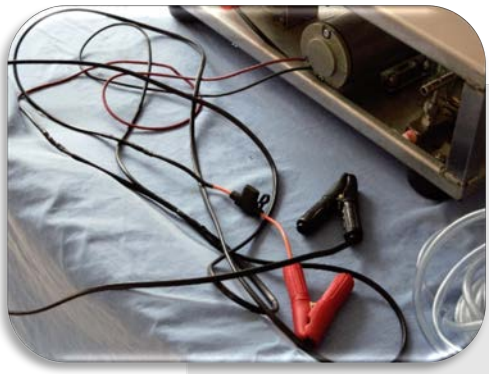
10. You are now making fresh water! Collect a sample of the fresh drinking water from the clear fresh water hose that exits the top of the flow meter. Check the TDS using the hand held TDS meter. Once the TDS reading is acceptable (below 500 ppm) the water is ready to be sent to a tank. A normal initial TDS reading will range from 400 to 500 ppm (for sea water). ***REMEMBER! To discard the first 15-20 minutes of product water if you are using it after pickling or for the first time***

CAUTION: Continue to monitor the system pressure and adjust if necessary to maintain the system pressure at 20 LPH. DO NOT leave system unattended, the pressure regulator can move due to vibration etc.

Normal Shut Down Procedure

CAUTION: The following instructions must be followed each time the water maker system is shut down. Failure to follow these steps can result in serious damage to the RO Membranes and the High Pressure pump.

1. Slowly lower the system operating pressure by turning the Pressure Regulating valve counter clockwise until the valve is completely opened. This should take about 30 seconds



2. Turn off the high pressure pump by unplugging the unit from your 12v power supply.

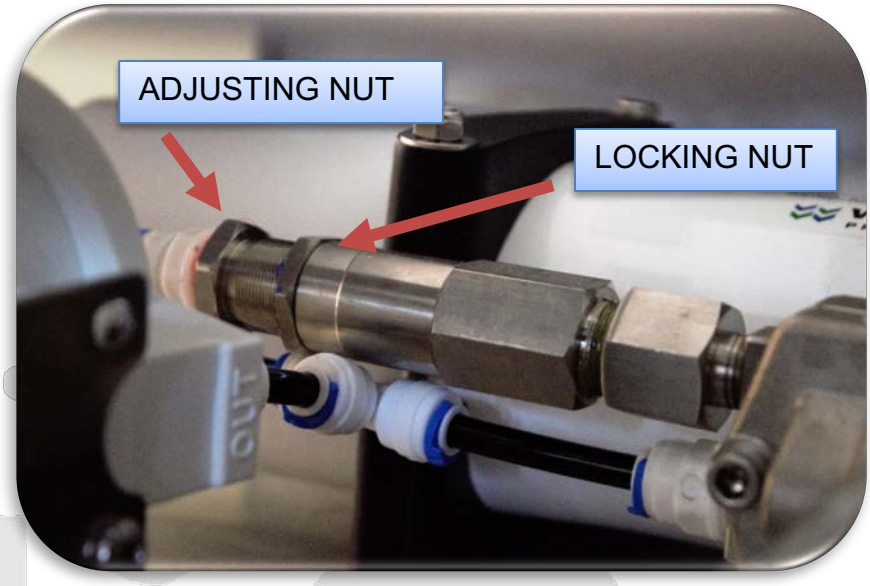
3 Turn off the submersible pump.

4 Leaning unit on its side unscrew the filter housing and empty water from the housing and from the hoses.

5. Carefully pack the unit away ensuring that no water is spilt on the motor and pump

Testing Your Relief Valve

To check the valve, raise the pressure to 955psi and observe if the relief valve releases the pressure at this level. ***Do not*** go above 955psi, if the relief valve does not release at 950psi or releases prematurely prior to reaching 950psi, it will need to be adjusted very slightly until it is once again set at 950psi.



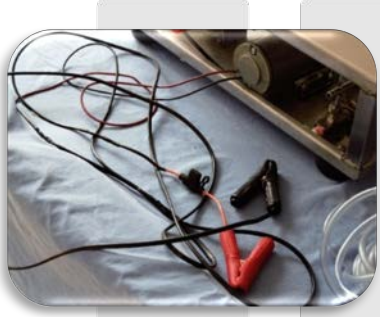
To adjust the setting on the valve, loosen the ***locking nut*** and turn the ***adjusting nut*** clockwise to increase the pressure or anticlockwise to decrease the pressure, make only small ¼ turn adjustments before retesting.
Once the setting is correct tighten the locking nut.

NOTE: that when the pressure relief valve releases water will shoot out of the valve, this will drop the pressure of your system

Normal Shut Down Procedure with Fresh Water Flush

It is recommended you do a freshwater flush if the unit has been used in seawater, brackish water or dirty fresh water. If you do not intend to operate your water maker for **another** 3 to 5 days or longer the following instructions must be followed when the water maker system is shut down. If you were using the machine in fresh clean water, then this step is not required. Failure to follow these steps can result in serious damage to the RO Membranes and the High Pressure pump

1. Slowly lower the system operating pressure by turning the Pressure Regulating valve counter clockwise until the valve is completely opened. This should take about 30 seconds.



2. Turn off the high pressure pump by unplugging the unit from your 12v power supply.

3. Turn off the submersible pump.

4. Place your submersible pump into a small bucket or drum of fresh water, preferably water that has been made by your water maker as this is chlorine free. ***Ensure*** you can see the water level in the bucket or drum to ensure the water does not run out and the system is run dry.

CAUTION: Never allow chlorinated water to come in contact with the membranes, oxidants such as chlorine and bleach water will permanently destroy the RO membrane. If your fresh water source may have even a small chlorine content i.e. a mixture of town water and water from your water maker, you must run this water through a carbon block filer to remove the chlorine, you can use your primary filter housing for this purpose by removing the 5-micron filter and replacing it with a carbon block filter.

5. Follow the steps in the "**Fresh Water Flush Procedure**" to carry out a fresh water flush

6. Once your freshwater flush is complete, continue with a normal shut down

7. Turn off the high pressure pump by unplugging the unit from your 12v power supply.

4. Turn off the submersible pump.

CAUTION: Ensure that both the high pressure pump and the submersible pump are turned off prior to your bucket or drum becoming empty.

Freshwater-Flush Procedure

After using your water maker in either sea water or brackish water it can sit idle for up to 3 to 5 days before its next use. If your next use is beyond this time frame a freshwater flush is required.

The 3 to 5-day window exists because the rate of biological growth varies with seawater composition and temperature, so you will need to monitor the system and adjust the time period accordingly.

The freshwater flush inhibits biological growth which could lead to membrane and pre-filter element fouling.

If the water maker has not been operated for more than three to five days since its last fresh water flush, the system may need an additional freshwater flush, or what we have found is it may just need to be run for a few minutes longer before the water is collected for drinking. You will be able to tell when the water is ready to be sent to a tank by smelling the water, and ensuring it does not have a rotten-egg type odour.

If left unchecked, these organisms could lead to membrane and pre-filter element fouling and a rotten-egg smell in the product water. (The rotten-egg smell comes from the waste product (hydrogen sulphide) of the anaerobic biological organisms).
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If your system has this unmistakable rotten-egg smell, that cannot be flushed, don't panic, it's just time for a system sanitising which is explained in the next section **"Pickling your Water maker to Sanitise or for Long Term Storage"**.

During a freshwater flush you are running your system as normal with the pressure pump running but with the pressure regulator valve fully open and the submersible pump in a fresh water source

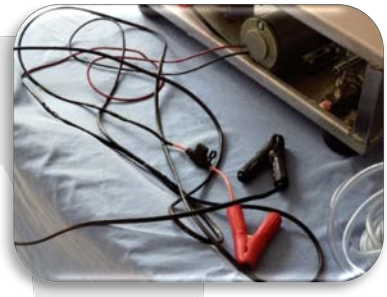
1. Place your submersible pump into a bucket or drum of fresh water, preferably water that has been made by your water maker as this is chlorine free. Please ensure you can see the water level in the bucket or drum to ensure the water does not run out and the system is run dry.

CAUTION: Never allow Chlorinated water to come in contact with the membranes, oxidants such as Chlorine and bleach water will permanently destroy the RO membrane. If your fresh water source may have even a small chlorine content i.e. a mixture of town water and water from your water maker, you must run this water through a carbon block filer to remove the chlorine, you can use your primary filter housing for this purpose by removing the 5-micron filter and replacing with a carbon block filter.

2. Verify that the pressure regulating valve is completely open by turning the valve counter clockwise until it stops.

CAUTION: Do not run freshwater through the RO pressure vessel at high pressure; always make sure the pressure regulating valve is completely open (turn counter clockwise until the valve stops). Running fresh water through the RO membranes at high pressure will rupture the membrane and destroy it

3. Turn on the submersible pump and let run for at least 1 minute. (Verify freshwater flow by seeing water exiting the brine discharge).



4. After confirming water flow exiting the brine, turn on the high pressure pump for two to three minutes.

8. Turn off the high pressure pump by unplugging the unit from your 12v power supply.

5. Turn off the submersible pump.

CAUTION: Never let the system run dry, once water has reached a level where the submersible pump cannot remain fully submersed, immediately turn off the high pressure pump.

Pickling Your Water maker to Sanitise or for Long Term Storage

The introduction of a preservative material to the water maker can allow the system to sit unused for an extended period of time. Or if biological growth contamination has occurred, a preservative flush can sterilize the system.

The preservative chemical is Sodium Metabisulphite and is commonly used in the beer and wine industries to sterilize equipment. The following procedure should be followed to prepare a 10 litre batch of preservative solution and introduce it into the water maker.

1. Fill a 10 litre bucket with RO quality water and add five tablespoons of the Sodium Metabisulphite and stir to dissolve the chemical.

CAUTION: Never use chlorinated water, bleach water, or water containing an oxidant to flush your water maker, as it will destroy the RO Membrane.

2. Using this solution follow the instruction above in '**Fresh Water Flush Procedure**'

CAUTION: Do not run the preservative through the RO pressure vessel at pressure, always make sure the pressure regulating valve is completely open (turn counter clockwise until the valve stops). Running the preservative water through the RO membranes at high pressure will rupture the membrane and destroy it.

CAUTION: Do not drink water that contains the sanitizing solution, ensure it has been fully flushed from the system for at least 30 mins, by carrying out the Initial Operating Procedure

Membrane Cleaning Procedures

DO NOT clean a new H2O on the Go system, it is unlikely that problems with product or flow in a new system is due to fouling.

In normal operation, the membrane in reverse osmosis elements may occasionally 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 normalized permeate flow, loss of normalized salt rejection, or both.

Elements should be cleaned when one or more of the below mentioned parameters are applicable:

- Fresh flow drops by 10%
- TDS increases by 5 to 10%

If you wait too long, cleaning may not restore the membrane element performance successfully. In addition, the time between cleanings becomes shorter as the membrane elements will foul or scale more rapidly.

RO cleaning frequency due to fouling will vary by site. A rough rule of thumb as to an acceptable cleaning frequency is once every 3 to 12 months in agricultural systems and 1 to 5 years in seawater systems, this of course can vary greatly.

It is important to clean the membranes when they are only lightly fouled, not heavily fouled. Heavy fouling can impair the effectiveness of the cleaning chemical by impeding the penetration of the chemical deep into the fouling and in the flushing of the fouling out of the elements. If normalized membrane performance drops 30 to 50%, it may be impossible to fully restore the performance back to baseline conditions.

Biological (organic) and Mineral (Inorganic) Fouling

Biologic fouling is normally the first fouling to occur, if not promptly address the membrane may become unclean able and unusable. Following the correct maintenance procedures (see Operation and Maintenance Manual) will avoid biological fouling for many years. Biological fouling can occur quickly if system is left for a period of time with seawater still in the membranes.

Mineral Fouling occurs much slower over a longer period of time and its effects are gradual.

Biological Fouling

Biological cleaning is carried out by soaking membranes in an alkaline cleanser, we recommend that you use a cleaning cartridge to carry out chemical cleaning and follow the safety direction carefully.

Cleaning cartridges are simple and easy to use, all it involves is removing the primary filter and replacing with a cleaning cartridge, running the system to pull the chemical into the system and then leaving the system sit overnight. In the morning the system is then flushed under no pressure to remove the chemical from the system

Mineral Fouling

Mineral fouling is a slow gradual process in seawater systems but can occur much faster in groundwater systems that have high mineral content. In this situations it is advised to have a regular cleaning schedule to ensure that the fouling of the membranes is kept in check. Depending on your site this may be as often as fortnightly or quarterly.

If fouling is minimal and the performance drop is 10% or less

We recommend cleaning with Citric acid, Citric acid is also a good choice for using in a cleaning schedule that promotes cleaning prior to heavy fouling.

This is a low pH cleaning solution of 2.0% (w) citric acid ($C_6H_8O_7$). It is useful in removing inorganic scale (e.g. calcium carbonate, calcium sulphate, barium sulphate, strontium sulphate) and metal oxides/hydroxides (e.g. iron, manganese, nickel, copper, zinc), and inorganic-based colloidal material. Citric acid is available as a powder in bulk form. (we get of eBay or the brew shop)

The procedure to clean the membranes is as follows.

- Make a large drum of cleaning solution, you will pump this under 0 pressure through the system for a minute or so and send the waste and permeate both to waste.
- After a minute the system will be flushed of your source water and you will now recycle the cleaning solution and run the system for 30 minutes under 0 pressure. Source, waste and permeate lines are all placed in the drum of cleaning solution so the solution does not run out.
- After 30 minutes turn the system off and leave the solution to soak for 24 hours.
- After 24hours run the system at 0 pressure for 10 mins, drawing water from your normal water source and then at half normal pressure for your system for a further 10 mins, followed by a further 10 mins at your normal full operating pressure (this will vary on each system and situation)
  During this 30 minutes of flushing time send the permeate to waste, so the citric acid is fully removed before sending to tank.

This should restore your system to normal operation, if you only achieve a partial increase in performance and still not getting the full performance you can repeat this process a second time.

If performance cannot be normalized, you will need to try a harsher cartridge clean to restore your membranes or replace then with new membranes and adjust your cleaning and maintenance procedures as required.

Mineral Fouling Cartridge Cleaner

If you are experiencing a drop in performance greater than 10% we recommend that you use a chemical cleaning cartridge to clean your membrane. This cleaning is carried out the same as the biological cartridge cleaning.

If both biological and mineral cleaning are to be carried out the order of cleaning is Acid (Mineral) cartridge first, once fully flushed the next morning you may carry out the Alkaline (Biological) cleaning.

Other Membrane Problems

Damage to membrane spacers (more than one membrane in 1 pressure vessel) by permeate reversal.

Seawater flows along the membrane, creating a salt concentration gradient along the membranes length, the last element having the most concentrated brine bulk.

When the RO is stopped or in stand-by, natural osmosis will happen between the permeate side and the concentrate side containing high salinity brine. This can damage the feed spacers by creating a vacuum in the permeate line, as water will naturally flow back to the concentrate side, driven by osmotic pressure.

This damage can be avoided by flushing the system with RO quality water after each use.

Membranes Drying Out

If membranes are allowed to dry out they need to be re-commissioned. To re-commission your membrane, run RO quality water through the membrane vessel under no pressure for 4 hours, then turn off the source water. Insure no water can escape from the membranes and leave them sit overnight, in the morning the system will need to be run a further 4 hours under no pressure.

Permeate Backpressure

Never run your water maker with the permeate line closed or blocked, this will build up a differential pressure on the permeate side of the system and cause glue line leaks in the membrane causing the permeate salinity to greatly and permanently increase. This damage is not repairable and the membranes will need to be replaced.

O-Ring Slip

The internal brine ring on the membrane may slip or become crushed, this is rare once the membrane is installed and tested as working correctly. If this does happen, you will notice an increase in salinity and will need to reseat or replace the brine ring.

Winterising the Water Maker System

Use this procedure if you water maker will be stored in an environment where the temperature will drop to a level that will cause the liquid in the membranes to freeze and damage your membrane.

The entire system can be preserved in place by using antifreeze. The procedure that is used for this is the same as the sanitising process, except antifreeze is introduced to the solution in place of the sanitising agent.

You can purchase antifreeze typically in ranges of 25 to 60%.
Check the temperature rating of the antifreeze and make sure that it will be sufficient for the low temperatures that your system may encounter. Use the entire 20 litre bucket of solution to ensure the entire system is completely saturated with antifreeze.

Use only freshwater Propylene Glycol antifreeze. Do not use Ethylene Glycol which is automotive antifreeze

CAUTION: Do not run the antifreeze solution through the RO pressure vessel at high pressure, always make sure the pressure regulating valve is completely open (turn counter clockwise until the valve stops). Running antifreeze solution through the RO membranes at high pressure will rupture the membrane and destroy them.

Follow the "**Initial Water Maker Commissioning Procedure**" to return the system to normal water production mode.

What is Reverse Osmosis?

Semipermeable Membranes and Osmotic Flow

So what's Osmosis Anyway?

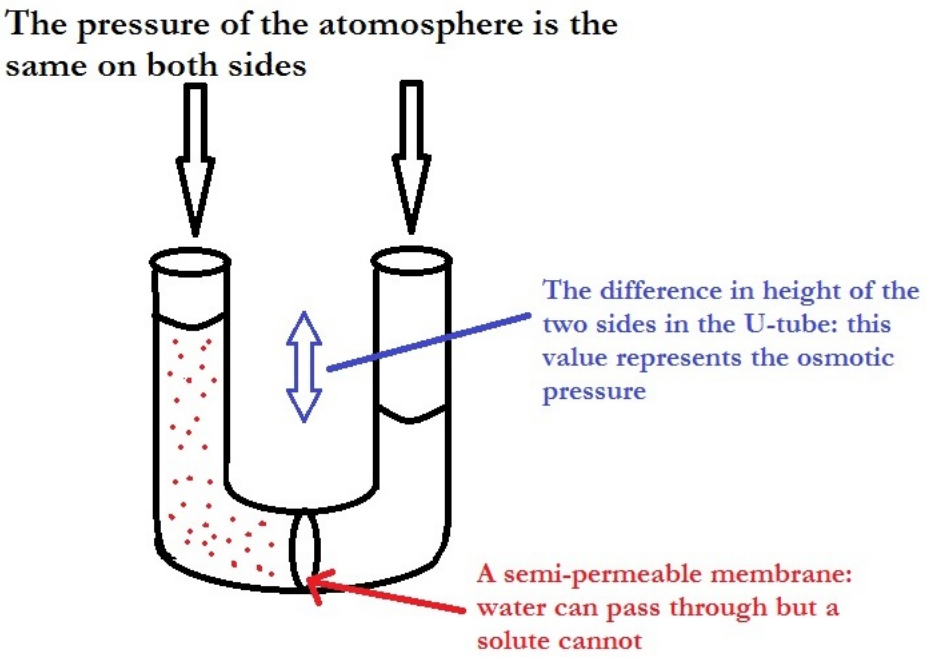
Osmosis is the process in which a liquid pass through a membrane whose pores permit the passage of solvent molecules, but are too small for the larger solute molecules to pass through.

Let's break osmosis down to its parts to get a grasp on it.

First, we'll make our solution. We start with a boring old cup of water. To spice things up, we'll call water the "solvent" -- which is convenient, because that's what it is. To make our solvent a little tastier, we'll dissolve in some delicious sugar. The sugar is the solute. Just to keep track, we now have water (solvent) that we've dissolved sugar (solute) in, to make sugar water (our solution).

Now that we have our solution of sugar water, we'll grab a beaker shaped in a U-shape. Right in the middle of the tube, imagine a bit of Gore-tex that cuts the U in half. Gore-tex is our "semipermeable membrane." Gore-tex is a thin plastic, dotted with a billion tiny little holes that allow water vapour to pass through, but liquid to stay out.

In one arm of the U-tube, we pour our sugar water mixture. In the other we pour our plain old water. That's when the magic of osmosis begins. The level of the liquid in the sugar water arm will slowly rise, as the solvent (water) moves through the Gore-tex, to make both sides of the arm more equal in a sugar-to-water ratio.



But why does that happen? What is the force that drives the molecules through the membrane? This is a misleading question, because there is no real “force” in the physical sense other than the thermal energies all molecules possess. Osmosis is a consequence of simple statistics: the

randomly directed motions of a collection of molecules will cause more to leave a region of higher concentration than return to it. Simply put, the molecules want to find equilibrium and because the one side of the arm is crowded with sugar, it has less water molecules than the other side. So water molecules from the other side decide to move on over to make the concentration of water on each side more equal.

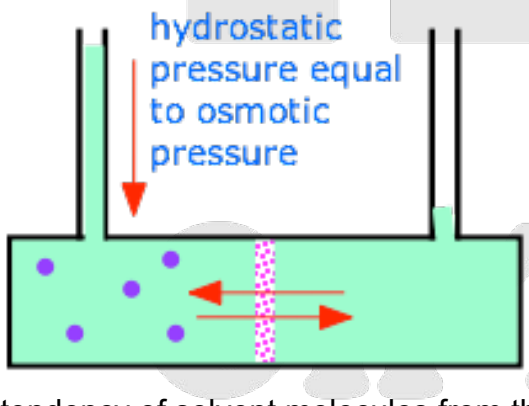
Diffusion and Osmotic Flow

Suppose you drop a lump of sugar into a cup of tea, without stirring. Initially there will be a very high concentration of dissolved sugar at the bottom of the cup, and a very low concentration near the top. Since the molecules are in random motion, there will be more sugar molecules moving from the high concentration region to the low concentration region than in the opposite direction. The motion of a substance from a region of high concentration to one of low concentration is known as diffusion. Diffusion is a consequence of a concentration gradient (which is a measure of the difference in escaping tendency of the substance in different regions of the solution).

You must clearly understand that there is really no special force on the individual molecules; diffusion is purely a consequence of statistics.

Osmotic flow is simply diffusion of a solvent through a membrane impermeable to solute molecules.

In the absence of the semipermeable membrane, diffusion would continue until the concentrations of all substances are uniform throughout the liquid phase.



Osmotic Equilibrium and Osmotic Pressure

One way to stop osmosis is to raise the hydrostatic pressure on the solution side of the membrane. This pressure squeezes the solvent molecules closer together, raising their escaping tendency from the phase. If we apply enough pressure (or let the pressure build up by osmotic flow of liquid into an enclosed region), the escaping tendency of solvent molecules from the solution will eventually rise to that of the molecules in the pure solvent, and osmotic flow will cease. The pressure required to achieve osmotic equilibrium is known as the osmotic pressure.

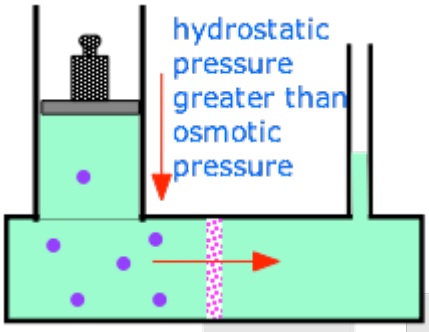
Note that the osmotic pressure is the pressure required to stop osmosis, not to sustain it.

It is common usage to say that a solution “has” an osmotic pressure of "x atmospheres". It is important to understand that this means nothing more than that a pressure of this value must be applied to the solution in order to prevent flow of pure solvent into this solution through a semipermeable membrane separating the two liquids.

Reverse osmosis

What is Reverse Osmosis?

So we learned that in osmosis, a lower-concentrate solution will filter its solvent to the higher concentrate solution. In reverse osmosis, we are (literally) just reversing the process, by making our solvent filter out of our high concentrate into the lower concentrate solution. So instead of creating a more equal balance of solvent and solute in both solutions, it is separating out solute from solvent.



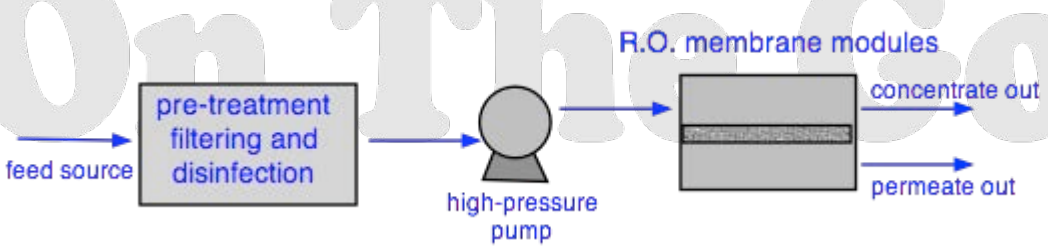
But as we've explored, that isn't something that solutions really want to do. How do we make reverse osmosis occur?

By applying a hydrostatic pressure greater than the osmotic equilibrium to the high solute side of an osmotic cell will force water to flow back into the fresh water side.

In reverse osmosis, we'd have ourselves a saltwater solution on one side of a tank and pure water on the other side, separated by a semi-permeable membrane. We would apply pressure to the saltwater side of the tank--enough to counteract the natural osmotic pressure from the pure water side, and then to push the saltwater through the membrane. (For saltwater this takes about 50-60 bars of pressure). But because of the size of the salt molecules, only the smaller water molecules would make it to the other side, thus adding fresh water to the water side, and leaving the salt on the other.

Where is Reverse Osmosis Used?

The most common uses of reverse osmosis is desalination of water. That includes large plants (there are over 100 countries using desalination) or smaller operations like your watermaker.



Pre-treatment commonly employs activated-carbon filtration to remove chlorine (which damages RO membranes by creating pinhole leaks) if this is present in the feed water and a primary sediment filter to remove organics larger than 5 microns.

Bacteria, pathogens and cysts are unable to pass through an undamaged semipermeable membrane.

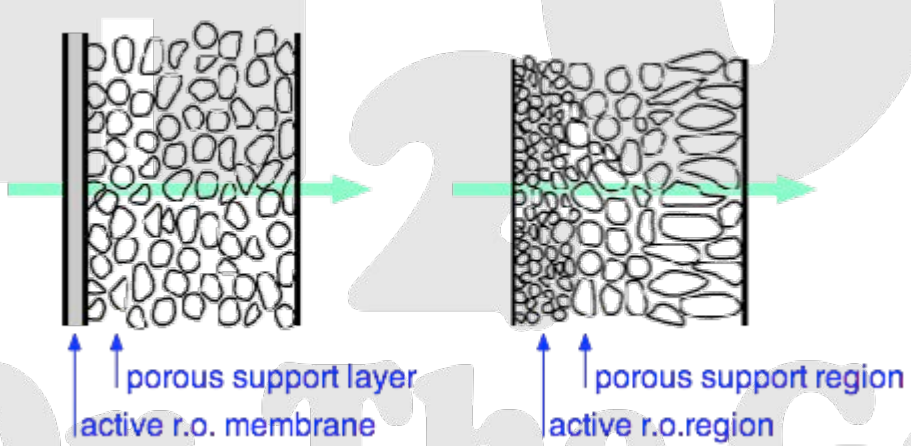
Reverse osmosis is also one of the few ways that we can take certain minerals or chemicals out of a water supply. Some water sources have extremely high levels of natural fluoridation, which can lead to enamel fluorosis (mottled teeth), or the much more severe skeletal fluorosis (an actual bending of a person's bones or skeletal frame). Reverse osmosis can filter out fluoride, or other impurities, on a large scale in a way that a charcoal based filter (like the one most commonly found in homes) can't.

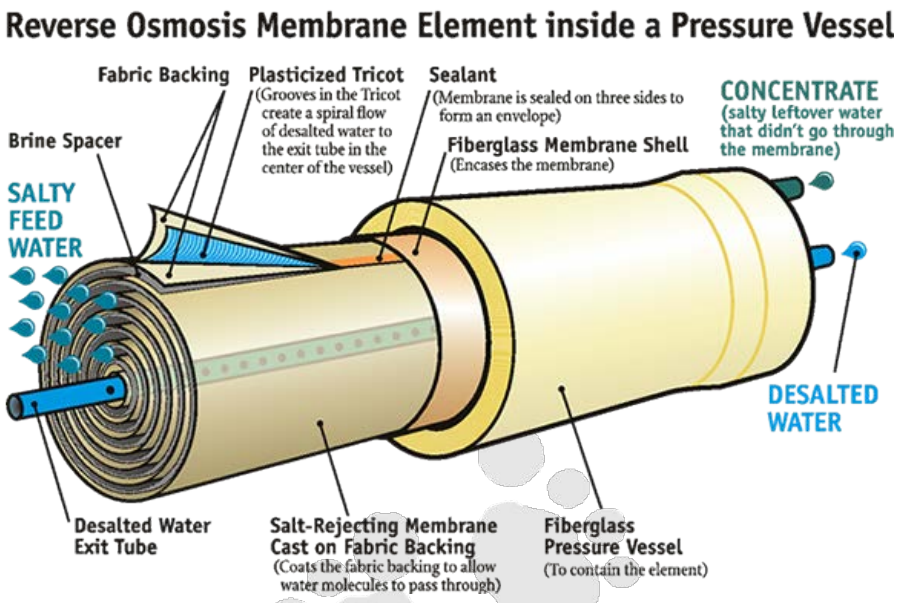
It's also used for recycling purposes; the chemicals used to treat metals for recycling create harmful wastewater, and reverse osmosis can pull clean water out for better chemical disposal.

But even more fun than recycling? Wastewater reverse-osmosis treatments, wherein wastewater goes through the process to create something drinkable. They've nicknamed it "toilet to tap" for a reason, and although it might give you pause, it's a promising way for developing nations to produce drinkable water.

Reverse Osmosis Membranes

The efficiency and cost of RO is critically dependent on the properties of the semipermeable membrane. Membranes intended for fresh water are different from membranes intended for brackish or salt water.





Salt Water vs Brackish Water vs Fresh Water in Reverse Osmosis

As concentration of solute particles increases, the concentration of water molecules per unit volume of solution decreases and vice versa. As solute concentration increases, the osmotic pressure will increase also.

Seawater is very high in total dissolved solids (TDS), approximately 36,000ppm (36,000mg per litre). Whereas the water from, say, the Gascoyne River near Carnarvon (when we were last there) tested at 1,298ppm (1,298mg per litre).

As you can see, the concentration of seawater is much higher than the water from the Gascoyne River and therefore the osmotic pressure is also a lot higher. So the hydrostatic pressure required to rise above the osmotic equilibrium is also much higher.

What this means in a reverse osmosis system, such as the H2O on the Go system, is that the pressure on the water going into the pressure vessel, will need to be adjusted according to the concentration of the solute (feed water).

To rise above the osmotic equilibrium of seawater a pressure of between 50 to 60 bars is required, we recommend using 55 bars (800psi) and you set this using your needle valve and pressure gauge.

Brackish water is less concentrated than seawater so has a higher concentration of water molecules therefore requires less hydrostatic pressure to rise above the osmotic equilibrium, as all brackish water has a different TDS level the pressure required will vary, it may be as low as say 150 psi or as high as 450 psi.

Water from the Gascoyne River with a low TDS is classed as fresh water so has a much higher level of water molecules compared to salt and brackish water. Therefore, it requires very little hydrostatic pressure to rise above the osmotic equilibrium.

As you can see, the hydrostatic pressure required will vary depending on the feed water concentration.

So how will you know what pressure is required?

Easy, you just look at your flow meter. Our one membrane system makes approximately 12 litres an hour regardless of the feedwater concentration and our 2 membrane system make up to 20 litres per hour again regardless of feedwater concentration.

So you begin operation, as usual, with the needle valve fully open and you gradually increase the pressure until you reach the correct litres per minute for your system. Once this volume has been reached, the system is applying the correct hydrostatic pressure for the concentration of the feedwater you are using.

Simple really!

References

Kershner, Kate. "How Reverse Osmosis Works" 08 May 2008. HowStuffWorks.com. http://science.howstuffworks.com/reverse-osmosis.htm 03 February 2015.

Submersible Pump Placement Tips

Careful placement of your submersible pump is key to successfully making water and ensuring irreparable damage is not caused to your high pressure pump, which is by far the most expensive part of your water maker to replace.

As you will be making water in many different environments you will need to be creative when getting your submersible pump set up correctly.

- The submersible pump should not be placed where it will suck up mud or sand, a small amount of mud and sand will be captured by your primary filter but too much will cause the filter to begin to clog and may result in a reduction in the water entering the system.

CAUTION: If the source water is very muddy, we recommend you protect your 5-micron filter by placing a 20-micron filter assembly in line in front of your 5-micron filter (sold separately). You may also need to SHUT DOWN the water maker and clean the filters during operation. You can do this with a brush and some fresh water. You can then place them back into the system and recommence watermarking. Once the filters can no longer be cleaned they should be replaced.

- Your submersible pump has a “head height” (the length it can pump directly up) of 4 metres. This head height combined with long hoses can cause the water amount pumping to the system to be greatly reduced. When using the pump at these extremes it is wise to measure the water coming from the pump and make sure it meets the minimum requirements of the system.

- You can measure the water amount coming to the system by filling a 1.5 litre container and recording the time it takes to fill the container. It should take no longer than one minute.

CAUTION: The high pressure pump requires a minimum of 1.5 (one point five) litres per minute to operate. This equates to 90 (ninety) litres per hour

This test should be completed twice if the amount is close to the minimum required amount to be sure that it is correct, and constant monitoring of submersible pump is required to insure nothing interrupts the flow. ***NOTE: Ensure you use an accurate time source when testing; most smart phones have a stop watch feature.***

- If you are unable to pump water at a sufficient rate for the water maker, it does not mean you cannot make water, but you will need to collect and store enough water in a water reservoir ahead of running the water maker.
  A small blow up kid's pool is perfect for this purpose; it folds up flat so takes up very little room. This inexpensive pool pictured can hold 1000 litres of water, which will allow you to make approximately 150 litres of water before it becomes too shallow for the submersible pump to remain submersed. Once the water reservoir is full of water you can then place the submersible pump into the reservoir and pump directly to your water maker.

CAUTION: Ensure the submersible pump does not float to the surface; you may need to weigh the pump down with something to ensure it remains submersed. Always monitor the water level in the reservoir to ensure the submersible pump remains submersed.

- The use of a reservoir may also be useful if the water is very sandy or muddy, filling the reservoir and letting it sit overnight will allow the mud and sand to settle.

- The use of a water reservoir may also be useful if you are pumping from the beach and the water is quite rough (surf). In this condition it can be difficult to keep the pump submersed correctly and can create a water source that has high sand and air content.

CAUTION: Although it may be tempting to use your water reservoir for swimming, please keep in mind that body oil and sunscreens will damage your membrane so these must be fully rinsed from the reservoir prior to using for water collection.

When using the submersible pump in rivers and creeks a star picket may be useful. This can be hammered into the ground in the river and you can then tie your submersible pump to the star picket below the water line. Using this method in a stationary or slow moving water source will allow you to pump water when the water is quite shallow.

CAUTION: When pumping from stagnant or slow moving water sources ensure that the submersible pump remains free of algae and weed. You may need to remove the weed from a small area prior to submersible pump placement.

Keep an eye on our website and YouTube channel for more ideas for Submersible Pump Placement, and please do share your ideas with others by emailing us photos and videos that we can upload to our site.

Troubleshooting Tips

Once your water maker is set up and running it should require no further intervention until shut down. Once you have used your system a few times you will become very confident in knowing when it is running smoothly and when it changes due to a problem.

CAUTION: Never leave your water maker unattended; keep your eye on the pressure gauge and the flow rate.

Normally when something is not working correctly, you will notice a distinct change in the sound the water maker is making. If you hear a change in sound investigate immediately.
If there is no water or greatly reduced water coming from the brine hose immediately turn off the high pressure pump. If there is still water coming through the system quickly lower the system pressure by fully opening the pressure valve (counter clockwise) and then immediately turn off the high pressure pump.

Most problems stem from no or inadequate water supply to the system due to blocked or semi blocked submersible pump or hose. This can be avoided with careful placement of your submersible pump. But debris floating by can cause unexpected semi or full blockages. Once the blockage has been rectified begin the start-up process once again and continue to make water.

NOTE: Refer to our website for ideas on submersible pump placement to help protect it from blockages.

Another cause of inadequate water flow is a clogged primary sediment filter. This can happen if the filter has not been changed for some time or the source water is dirty, as in very red muddy rivers etc.

NOTE: For this type of muddy source water a 20-micron filter place in front of the 5-micron filter may be useful.

The sediment filter can be cleaned many times by hosing and brushing them. If they become smelly you can give them a soak in a Sodium Metabisulphite solution.

NOTE: Please refer to manual for mixing measurements of the Sodium Metabisulphite solution.

TDS Readings

When the source water is Ocean/Sea water you should expect a TDS reading somewhere between 400 and 500. When the source water is brackish or fresh water you will get a TDS reading lower than the sea water reading, how low will depend on the freshness of the source water.

The World Health Organisation recommends a TDS reading of below 1500 for drinking water. An optimal reading is between 300 and 500.
Water with a TDS reading of 4000 or above will have a salty taste.

Weeping or Leaking Water

As this is a portable unit, the constant vibration of the vehicle may cause connections to come loose over time.

It is important to regularly check all the connections on the membrane. A visual check prior to each use is always a very important, and checking all connections are secure with hand tools regularly is also necessary.

Occasionally at low pressure you may see some water weeping/dripping from the connections to the membrane, this will not affect how the system performs and as long as the connections are in tight this is ok.

If the water maker leaks from a connection while at high pressure you will need to tighten the connections at the site of the leak to ensure the unit does not have a hose disconnect during operation.

If the pressure relief valve opens up, this is to protect the system and protect your membranes from damage. You should ***immediately*** lower the system pressure when this happens. Once the pressure is restored too normal the relief valve will close.

CAUTION: If any hose disconnects while the unit is in use, immediately turn off the high pressure pump and carry our repairs to the system.

CAUTION: You should not stand and place your face in front or near the water maker connections when the unit is running at high pressure. Always stand to the front or the back of the system to ensure you are well clear if a hose should disconnect.

To bring some context to the pressure that the water maker is running at; the water maker's operational pressure (when using seawater) is 800psi. The pressure relief valve is pre-set to 950 psi.
A small home and garden Karcher type pressure washer runs at approximately 1600 psi.