PRODUCT OVERVIEW DWRO

water | wastewater | treatment | recycling

Clearmake
a mak water company

makwater.com.au

WA Perth +61 8 9249 8007 Karratha +61 8 9159 0068 SA +61 8 8395 6122 VIC +61 3 4367 7055 QLD +61 7 5455 6822

DWRO Overview

MAK Water's Demineralised Water Reverse Osmosis (DWRO) Plants are designed to treat fresh water, with < 1,000 mg/L of dissolved solids (TDS) and < 30 mg/L of suspended solids (TSS), to produce high purity demineralised water with TDS < 1 mg/L.

MAK DWRO plants are available as skid mounted or containerised systems.

MAK Skid Mounted 10 m^3/day DWRO Plant

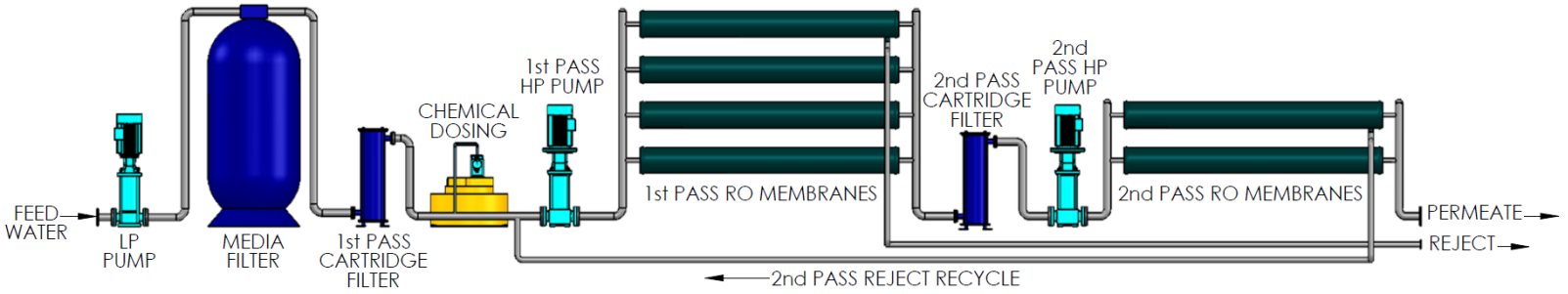
The MAK Advantage:

- High quality Australian designed and built systems
- Experienced team with >100 RO plants operating nationally
- Nationwide service & maintenance capabilities
- Remote monitoring for expert process support
- Fully automated systems minimise operator attendance
- MAK standard designs for fast lead times
- Optimised designs to suit client's objectives
- Fully customisable to accommodate client specific engineering standards, vendor data requirements and site preferred electrical equipment
- Extensive hire fleet available for rapid deployment

MAK Containerised 25 m^3/day DWRO Plant

Clearmake
a mak water company

DWRO Overview



The standard treatment process involves pre filtration (auto backwashing multimedia filters and cartridge filters), anti-scalant dosing to prevent membrane scaling, two pass RO desalination and a CIP system for membrane cleaning; with the inclusion of optional mixed bed ion exchange or continuous electro deionization (CEDI), TDS < 0.1 mg/L can be achieved.

Additional pre-RO and post-RO treatment steps (such as chemical dosing, iron & manganese removal, pH correction etc) may be added as required to suit feed water conditions and/or treated water quality requirements.

MAK DWRO plants are available as skid mounted or containerised systems for easy deployment to remote locations.

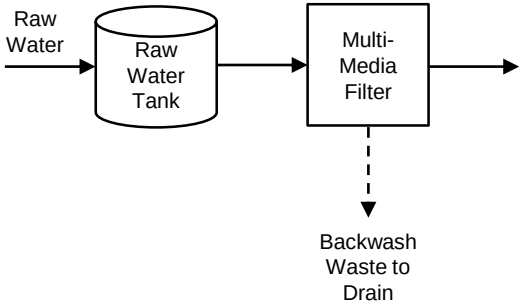
DWRO Overview

The following table summarises typical raw water and treated water values:

Parameter	Unit	Raw Water (typical)	Treated Water (typical)
Recovery Rate	%	-	50~75% (varies according to feed water quality and RO configuration)
Total Dissolved Solids	mg/L	< 1,000	0.1~1
Total Suspended Solids	mg/L	< 30	< 0.1
Particle Size	-	95% > 10 µm, 5% > 1 µm	-
Total Recoverable Hydrocarbons	mg/L	0	-
Temperature	°C	15 to 35	-

NOTE: MAK Water recommends a water analysis be carried out prior to detailed design.

Process Steps

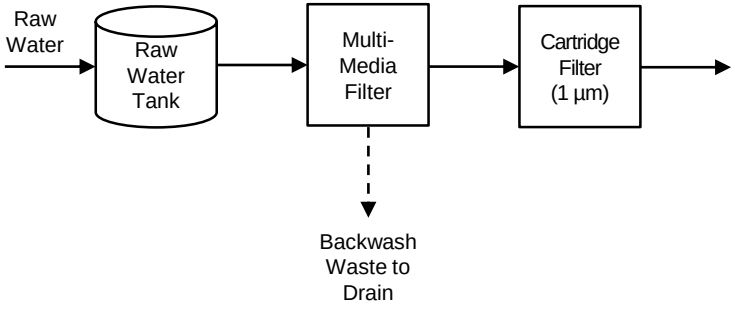


Pre Treatment – Media Filtration

The low pressure pump takes flooded suction from the raw water tank and supplies raw water to the multimedia filter(s), which remove suspended solids (20 micron or greater) from the water. The filter is periodically backwashed with raw water, based on operator adjustable time clock setting, via an electrically actuated multi-port control head.

Where ClearAccess™ remote monitoring is installed, pressure transmitters continuously monitor the differential pressure across the media filter; the filter is automatically backwashed when the differential pressure set point is triggered.

Process Steps

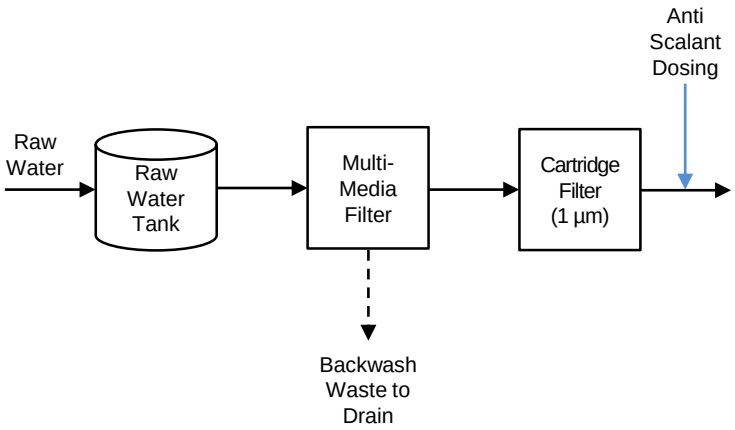


Pre Treatment – Cartridge Filtration – Pass 1

The water then passes though a 5 and/or 1 micron cartridge filters, which trap any remaining sediment/suspended solids. The cartridge filter elements are typically replaced on a monthly basis as part of routine planned maintenance procedure.

Where ClearAccess™ remote monitoring is installed, pressure transmitters continuously monitor the differential pressure across the cartridge filter; an alarm is generated on high differential pressure, to alert the operator that the filter elements require replacement.

Process Steps

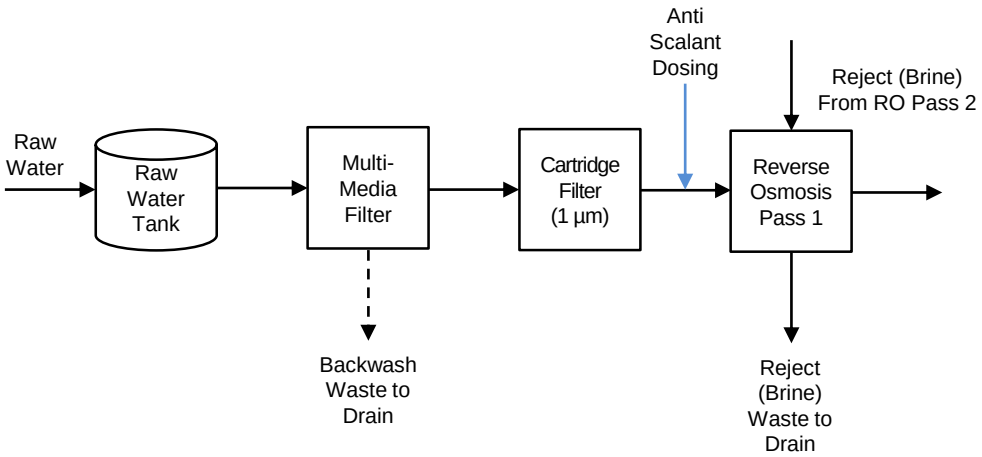


Pre Treatment – Anti-scalant Dosing

Anti scalant is dosed into the filtered feed water to inhibit the formation of scales on the RO membranes. The dose rate is pre-set and should not be varied.

The anti scalant storage tank is fitted with a low level switch to alert the operator of a low level condition; the level should be checked regularly and topped up as required.

Process Steps



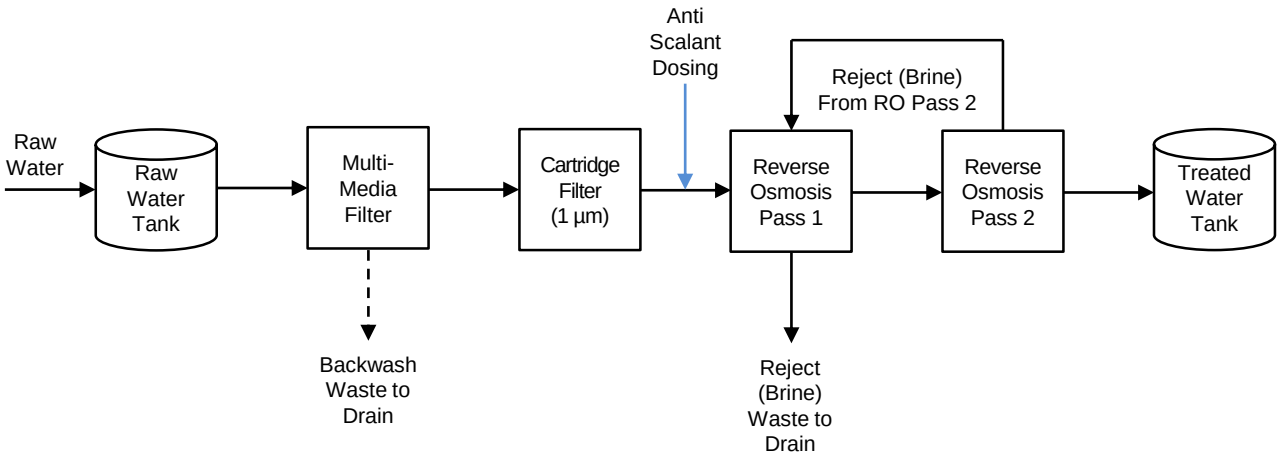
Desalination – Reverse Osmosis – Pass 1

The RO Pass 1 high pressure pump pushes the pre-treated feedwater (combined with reject from RO Pass 2) through the RO Pass 1 membrane system. The process produces permeate, which provides the feed water for RO Pass 2, and reject for disposal.

The inlet pressure to the RO Pass 1 high pressure pump is continuously monitored; a shutdown alarm is generated on low feed pressure, to prevent damage to the pump. The brine discharges at low pressure for disposal to drain.

Where ClearAccess™ remote monitoring is installed, the RO membrane feed pressure, brine discharge pressure, brine flow and permeate flow are continuously monitored; alarms are generated by any abnormal readings.

Process Steps



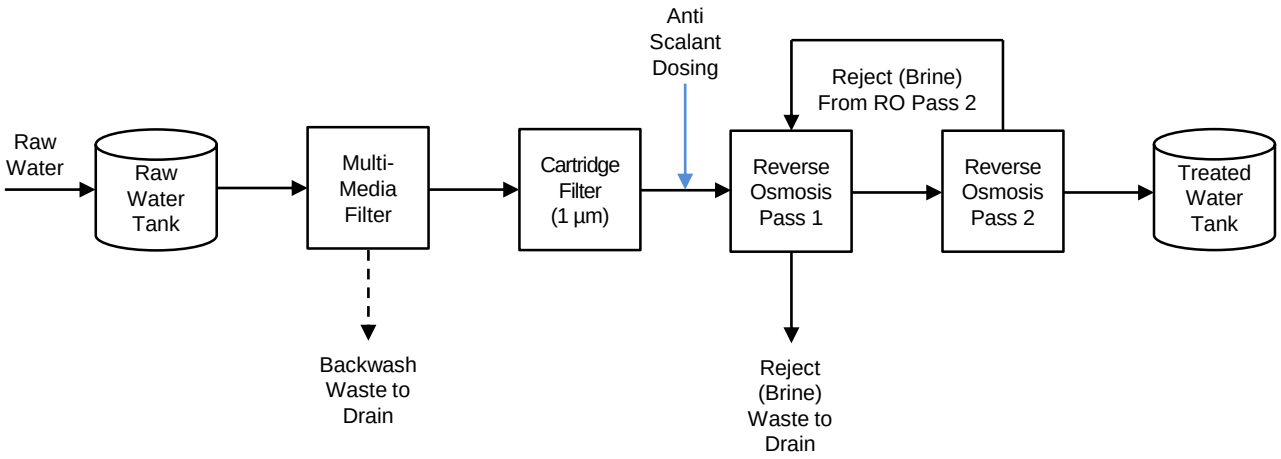
Desalination – Reverse Osmosis – Pass 2

The RO Pass 2 high pressure RO pump pushes the Pass 1 RO permeate through the Pass 2 RO membrane system. The process produces high quality permeate (TDS < 1 mg/L) and reject, which is recycled back to RO Pass 1.

The inlet pressure to the RO Pass 2 high pressure pump is continuously monitored; a shutdown alarm is generated on low feed pressure, to prevent damage to the pump. The permeate conductivity is continuously monitored; an alarm is generated by any abnormal readings.

Where ClearAccess™ remote monitoring is installed, the RO membrane feed pressure, brine discharge pressure, brine flow and permeate flow are continuously monitored; alarms are generated by any abnormal readings.

Process Steps



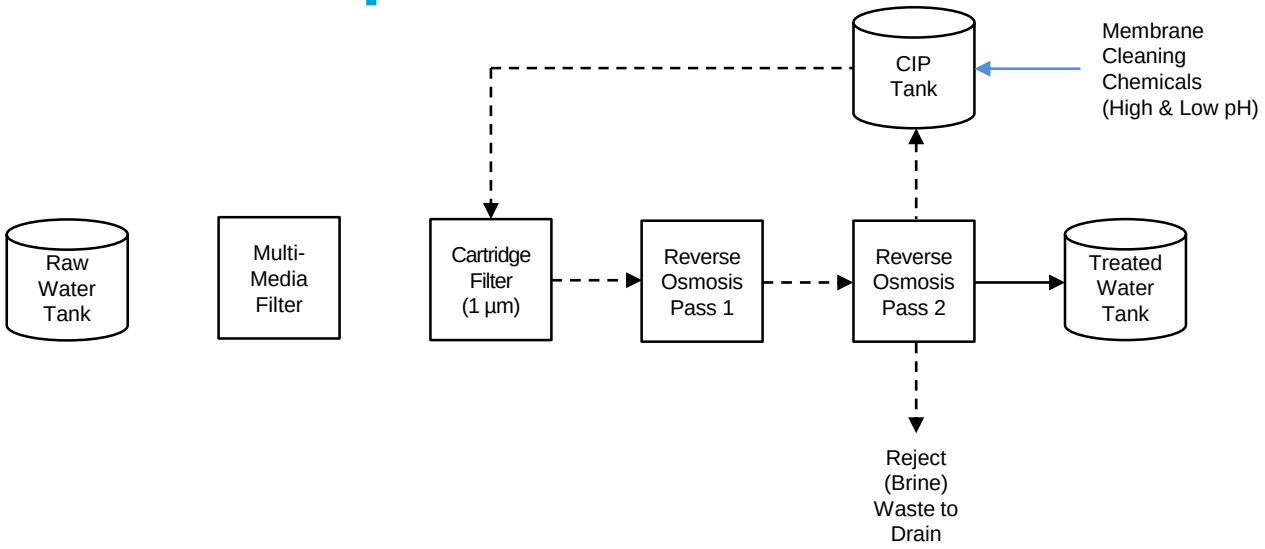
Desalination – Reverse Osmosis – Pass 2

The overall ratio of permeate to reject varies according to feedwater quality and system configuration.

On any given feedwater, factors affecting recovery rate include membrane and anti-scalant selection, system operating pressure, concentrate recirculation, membrane configuration (single stage, two stage, three stage etc) and path length.

MAK Water's process engineers can customise each RO design to suit the client's objectives and priorities.

Process Steps



Desalination – Membrane Chemical Cleaning

A Clean in Place (CIP) system is provided for routine membrane chemical cleaning; the chemical clean is a semi-automated function requiring an operator, whereby acid/alkaline chemicals (in solid form) are manually added to the CIP tank; the low pressure pump takes suction form the CIP tank and circulates the CIP solution throughout the membranes.

The CIP solution is circulated though the cartridge filters to trap any particles or contaminants removed from the membranes by the cleaning process.

A CIP membrane clean is typically performed on a monthly basis as part of routine planned maintenance procedure.

Options – ClearAccess™

Optional ClearAccess™ Remote Monitoring enables personnel to view and operate the plant remotely. This saves time in response to emergencies and assists local operators to diagnose problems. It prevents unnecessary service call-outs and improves reliability and plant uptime.

Process Support via ClearAccess™

Key Functionality:

- Remotely view and operate the plant on your PC, smart phone or tablet
- Automatic alerts (email or SMS) on alarm conditions
- Automatic report generated daily and emailed to your inbox
- Real time monitoring of process data, such as flow rates, pressure and alarm conditions/status messages
- Password protected system with two login security levels

ClearAccess™ from your Smart Phone or Tablet

Inclusions:

- Additional electrical instrumentation (premium package)
- Additional PLC hardware and programming
- Programming of email alert system

NOTE: Remote monitoring requires an internet connection or mobile network coverage (client to provide SIM card).

Options – Containerised Plant

MAK DWRO plants can be installed in ISO sea container(s) for safe, fast deployment by sea, road and rail. Installing the plant inside sea container(s) is an ideal way to protect the plant and equipment from harsh operating conditions in remote sites. The durable construction assures the plant is able to be transported through rough terrain and perform to the design requirements on arrival at remote sites (plug and play operation).

Standard 20' Container

Premium Fit Out (insulation, floor coating and access door)

Standard Inclusions:

- As new, freshly painted inside and out (high gloss enamel)
- Distribution board with separate circuits for lights & aircon
- Overhead internal lighting & reverse cycle air conditioning
- GPO's for maintenance work

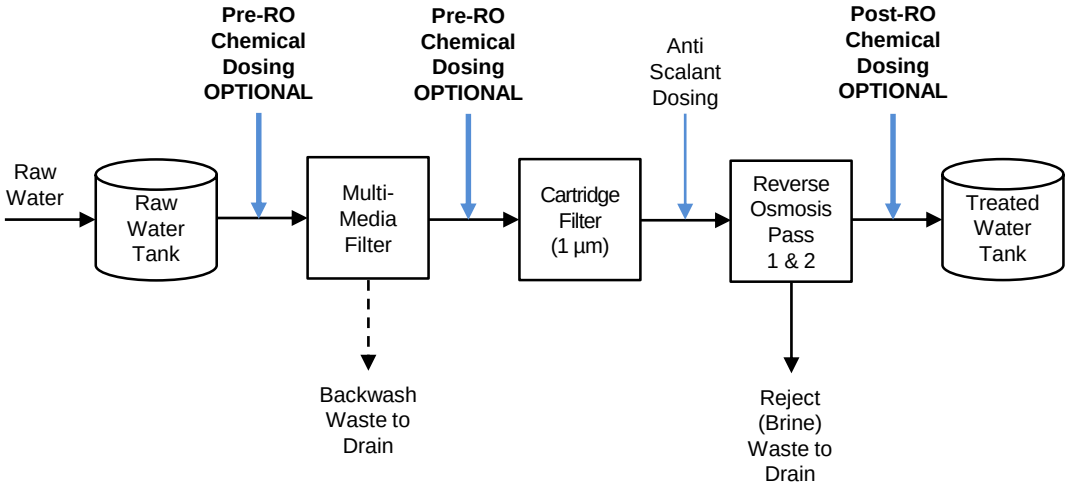
Premium Container Fit Out Options:

- Chemically resistant, non-slip floor coverings
- Wall and ceiling insulation
- Personal access doors & windows
- Smoke detectors and alarming
- Safety shower & eyewash station with flow switch & lighting
- Winterisation for extreme climates (-40ºC/-40ºF)
- High spec/high build two-pack epoxy container painting

Containerised WTP with access door, window, safety shower & eyewash station

Clearmake
a mak water company

Options – Chemical Dosing



Acid, caustic and sodium hypochlorite dosing systems

Pre/Post-RO Chemical Dosing

Pre and post RO chemical dosing systems may be added as required to suit feed water conditions and/or treated water quality requirements. Typical chemicals include acid and/or caustic for pH correction, sodium hypochlorite for iron/manganese oxidation and oxygen scavenging chemicals for chlorine neutralisation and/or de-oxygenation of the permeate.

Depending on the application, chemical dosing rates are pre-set based on flow rate (flow paced), or automatically controlled by the PLC, based on online instrumentation (such as pH, ORP or DO analysers) downstream of the dose point.

All chemical storage tanks are fitted with a low level switch for auto-shutdown & to alert the operator of a low level condition; the tank levels should be checked regularly and topped up as required.

Options – Iron & Manganese Removal

Iron and/or manganese has the potential to cause fouling of RO membranes; depending on feedwater chemistry, it may need to be oxidised and removed prior to desalination.

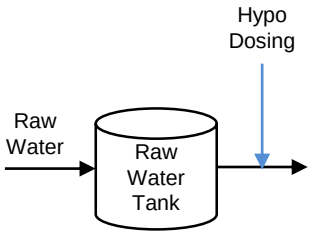
There are a number of ways to achieve this, each method has its own advantages and disadvantages:

	Chemical Oxidation + DMI-65 Media Filtration	Chemical Oxidation + Multimedia Filtration	Venturi (Air) Oxidation + Multimedia Filtration
Feed Water pH	5.8 to 8.6	5.8 to 8.6	7.2 to 8.0 for $Fe2^+$ ≥ 9.5 for $Mn2^+$
Feed Water $Fe2^+$	> 5 mg/L is tolerated	Maximum 5 mg/L	Maximum 3 mg/L
Feed Water $Mn2^+$	> 5 mg/L is tolerated	Maximum 5 mg/L	Maximum 3 mg/L
Reaction Time (Feed Tank Size)	Nil	15 to 30 minutes	45 to 60 minutes
Advantages	• Broadest application • Instantaneous reaction • Also removes arsenic, aluminium, some other metals and hydrogen sulphide	• Broad application • Lower capital cost than DMI-65 media	• Lowest capital cost • No chemical consumption
Disadvantages	• Chemical consumption • Higher capital cost • Does not tolerate clays, large organic molecules and very high hardness	• Slow reaction • Chemical consumption	• Slowest reaction • Narrow pH range • Limited application

Clearmake
a mak water company

Options – Iron & Manganese Removal

Chemical Oxidation + DMI-65 Media Filtration



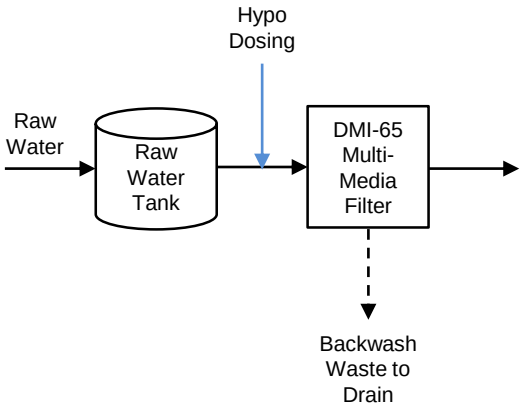
Chlorine Dosing (Oxidation)

Firstly, the raw water is dosed with chorine to promote oxidation of dissolved iron & manganese, aiding in removal via a DMI-65 media filter. The dose rate is automatically controlled via ORP sensor installed downstream of the DMI-65 media filter. Alarms are generated by any abnormal readings.

The chlorine storage tank is fitted with a low level switch for auto-shutdown and to alert the operator of a low level condition; the level should be checked regularly and topped up as required.

Options – Iron & Manganese Removal

Chemical Oxidation + DMI-65 Media Filtration



DMI-65 Granular Catalytic Media Filtration

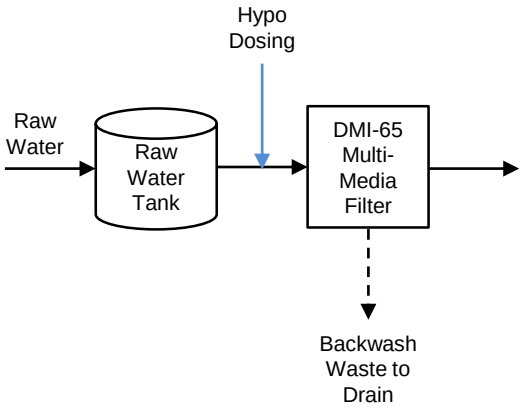
DMI-65 is an extremely powerful catalytic water filtration media that is designed for the removal of iron and manganese in aqueous solutions (water) without the need for potassium permanganate or chemical regeneration. The unique microporous structure of DMI-65 efficiently removes dissolved iron to almost undetectable levels as low as 0.001 ppm and manganese to 0.001 ppm.

The media is designed to operate in the presence of chlorine or other oxidant; it acts as an oxidation catalyst with immediate oxidation and filtration of the insoluble precipitates derived from this oxidation reaction.

Further reading on DMI-65 Media Filtration: http://www.dmi65.com/

Options – Iron & Manganese Removal

Chemical Oxidation + DMI-65 Media Filtration



DMI-65 Granular Catalytic Media Filtration

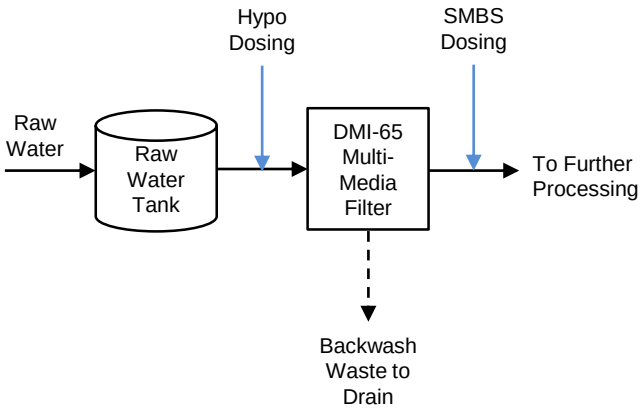
The low pressure pump takes flooded suction from the raw water tank and supplies the chlorinated raw water to the media filter containing DMI-65 media, which removes oxidised iron & manganese, as well as suspended solids (20 micron or greater) from the water.

The filter is periodically backwashed with raw water, based on operator adjustable time clock setting, via an electrically actuated multi-port control head.

Where ClearAccess™ remote monitoring is installed, pressure transmitters continuously monitor the differential pressure across the media filter; the filter is automatically backwashed when the differential pressure set point is triggered.

Options – Iron & Manganese Removal

Chemical Oxidation + DMI-65 Media Filtration



SMBS Dosing (Chlorine Neutralisation)

The filtered water is dosed with SMBS to neutralise residual free chlorine, thus protecting the RO membranes from damage via oxidation. The dose rate is pre-set and need not be varied.

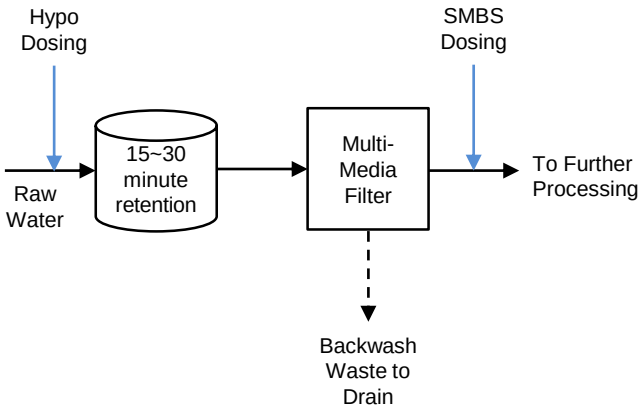
An ORP sensor continuously monitors the de-chlorinated water for the presence of chlorine; a shutdown alarm is generated on detection of chlorine to prevent damage to the RO membranes.

The SMBS storage tank is fitted with a low level switch to alert the operator of a low level condition; the level should be checked regularly and topped up as required.

The pre-treated water is now available for further processing downstream.

Options – Iron & Manganese Removal

Chemical Oxidation + Conventional Multimedia Filtration

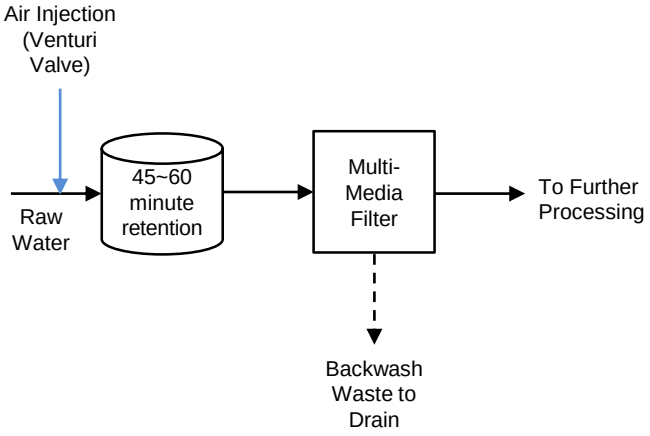


This process is the same as the DMI-65 process, except that the hypochlorite is dosed into the raw water tank upstream of the conventional multimedia filter, with a minimum 15 minutes of reaction time before filtration.

Steps should be taken to prevent “short circuiting” of the feedwater, though the use of appropriate baffles in the raw water tank, ensuring the minimum required contact time is maintained.

Options – Iron & Manganese Removal

Venturi (Air) Oxidation + Conventional Multimedia Filtration



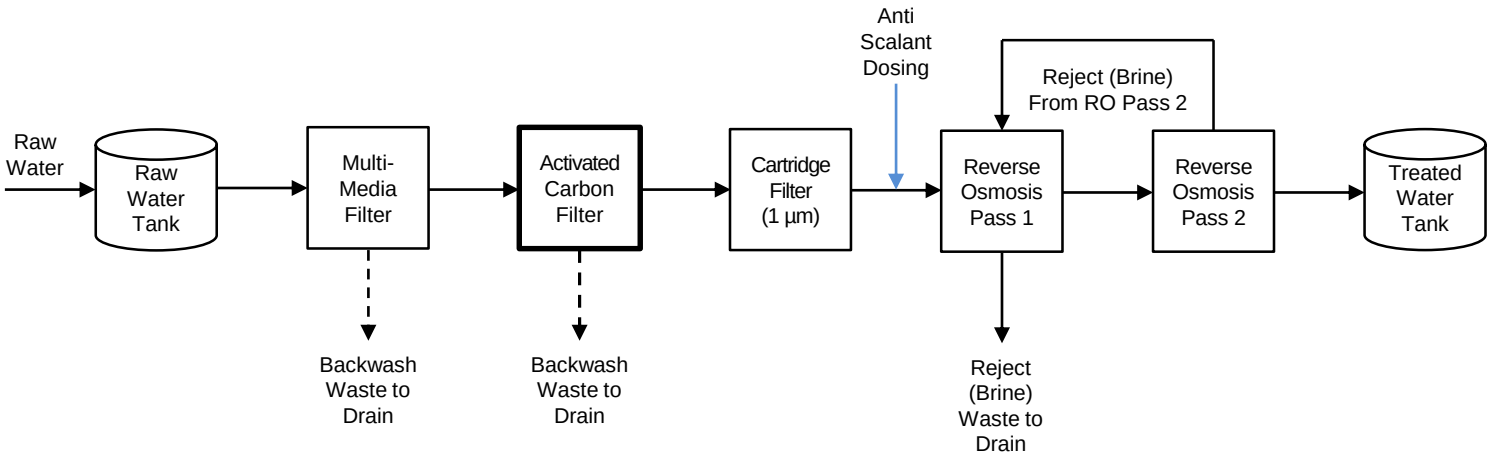
In this process, rather than dosing hypochlorite into the feedwater, a venturi valve is used to inject air into the water pipe supplying the raw water tank.

As no chlorine is used, the de-chlorination (SMBS dosing) step is not required.

A minimum of 45 minutes of retention time is required.

Steps should be taken to prevent “short circuiting” of the feedwater, though the use of appropriate baffles in the raw water tank, ensuring the minimum required contact time is maintained.

Options – Activated Carbon Filtration



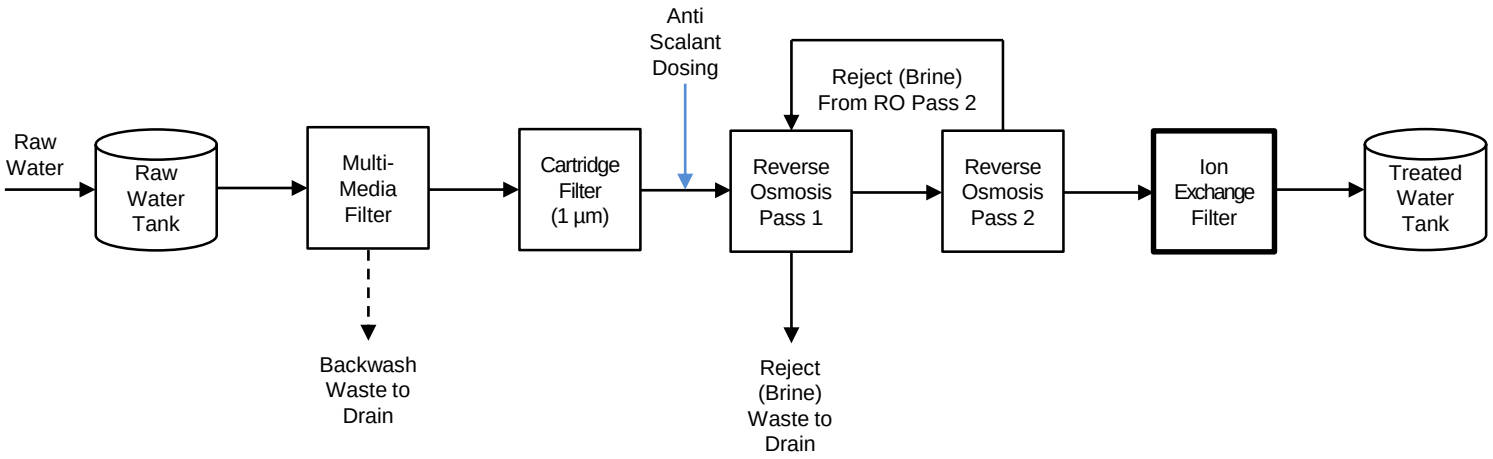
Activated Carbon Filtration

Activated carbon filters can be used to remove free chlorine and/or to remove trace amounts of hydrocarbons prior to desalination.

Where an activated carbon filter is used to remove free chlorine, an OPR sensor is installed downstream of the carbon filter to automatically shut down the RO on detection of free chorine in the feed water. The filter is periodically backwashed with raw water, based on operator adjustable time clock setting, via an electrically actuated multi-port control head.

Where ClearAccess™ remote monitoring is installed, pressure transmitters continuously monitor the differential pressure across the carbon filter; the filter is automatically backwashed when the differential pressure set point is triggered.

Options – Ion Exchange Filtration



Permeate Polishing with Mixed bed Ion Exchange Resin Filter

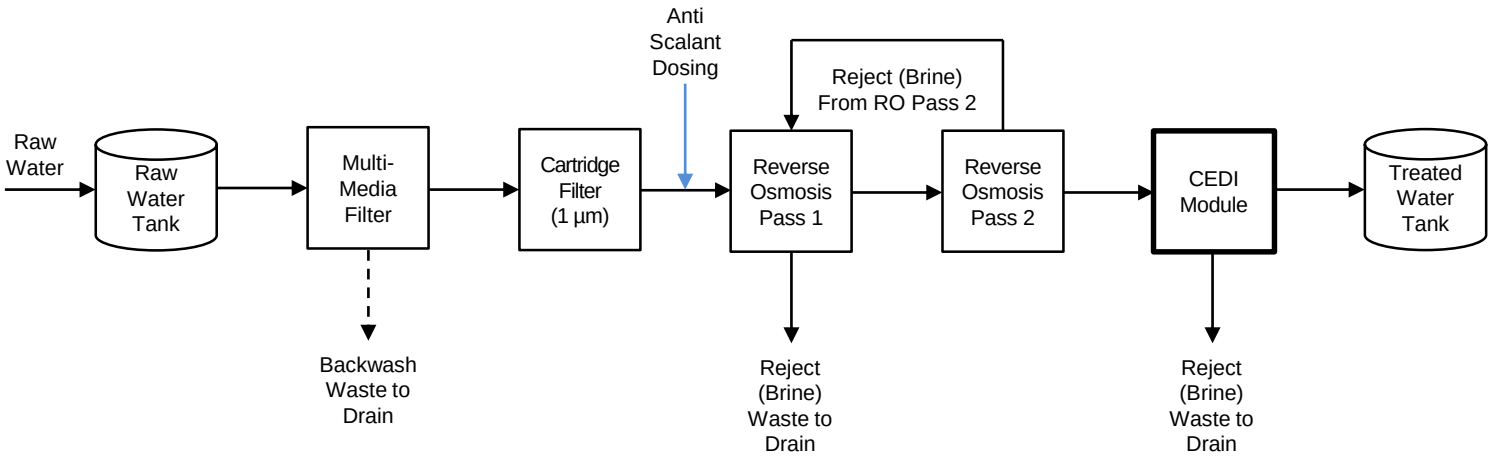
Where further reduction is permeate TDS is desirable, a Mixed Bed Ion Exchange Resin Filter can be provided, to achieve permeate TDS < 0.1 mg/L.

The RO permeate passes through the ion exchange filter which contains resin beads which replace all cations in the water with hydrogen ions (H+) and all anions with hydroxide ions (OH–), thereby demineralising the water via ion exchange.

The treated water conductivity is continuously monitored; an alarm is generated by any abnormal readings.

Note that this mixed bed resin is a consumable requiring periodic replacement.

Options – CEDI



Permeate Polishing with Continuous Electrodeionization (CEDI)

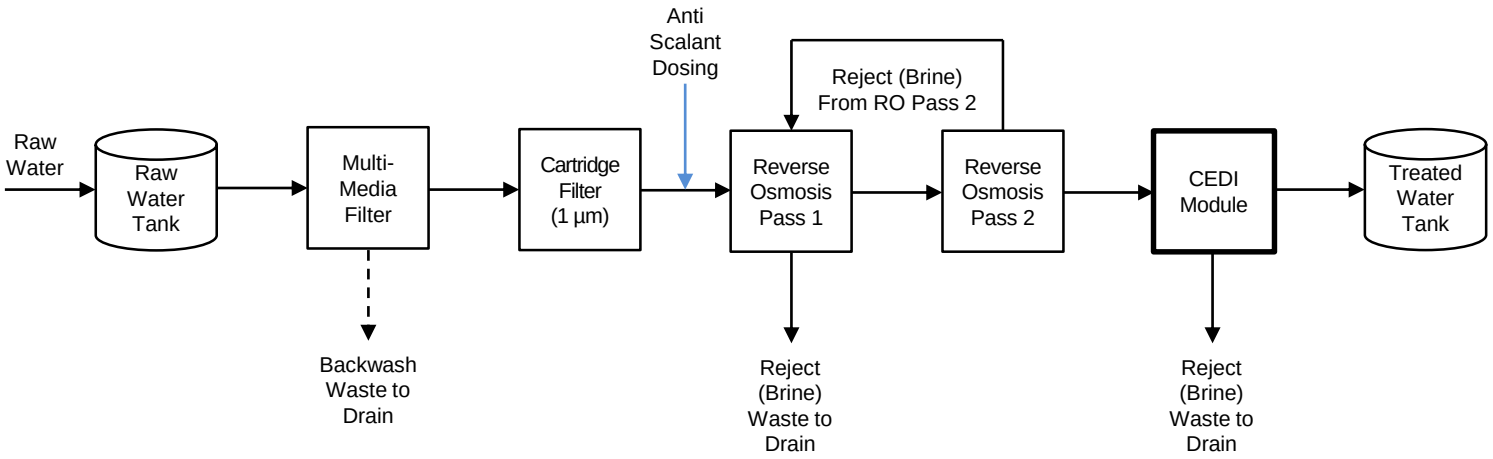
Where further reduction is permeate TDS is desirable, a Continuous Electrodeionization (CEDI) module can be provided, to achieve permeate TDS < 0.1 mg/L.

The CEDI module provides final polishing for removal of TDS and CO_2. The CEDI module is constructed of alternating product and reject compartments with electrode compartments at either end. Each compartment is separated by ion exchange membranes and filled with ion exchange resin.

The feed water (RO permeate) to be deionized is fed through the product compartments with a fraction of the flow being diverted to the reject and electrode compartments. When a transverse DC electrical field is applied, ions in the water are transferred into the reject compartments creating high purity water in the product compartments. The EDI module continually regenerates itself during operation.

Clearmake a mak water company

Options – CEDI

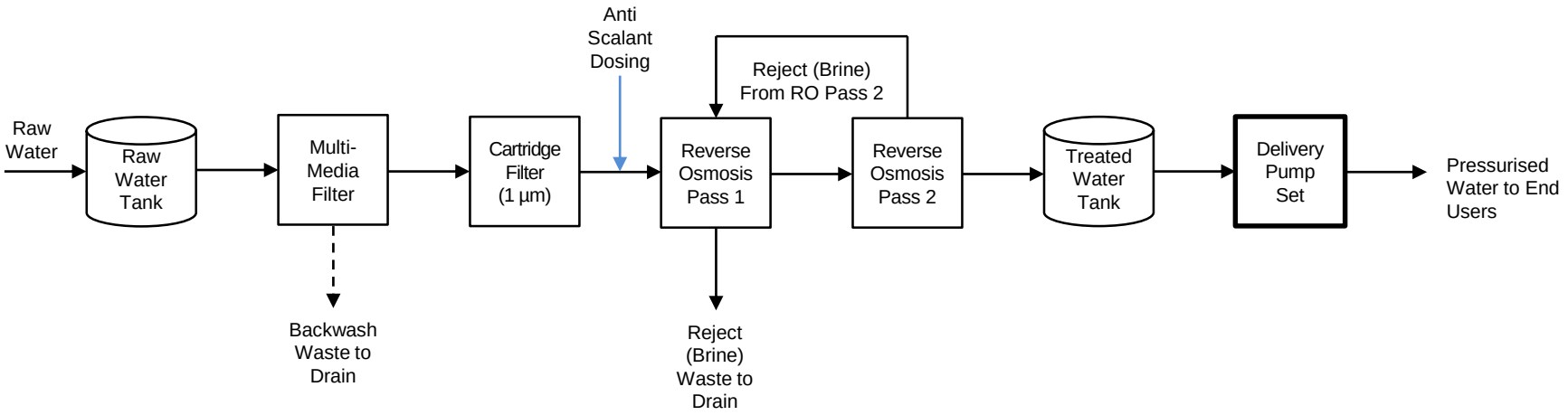


Permeate Polishing with Continuous Electrodeionization (CEDI)

The inlet pressure to the CEDI is continuously monitored; a shutdown alarm is generated on low feed pressure.

The recovery rate varies between 80~90%, depending on feed water quality. The reject flow, treated water flow and treated water resistivity are continuously monitored; alarms are generated by any abnormal readings.

Options – Delivery Pump Set



Demineralised Water Delivery Pump Set

A treated water delivery pump set can be provided to deliver demineralised water to end users.

The system typically is configured as a constant pressure system, with the capability to deliver variable flow rates in response to downstream demand.

A pressure sensor is installed on the discharge manifold to automatically control the operation of the pump.

Various options are available for pumping configurations (jacking pump, standby pumps etc), and electrical controls, to suit the client's requirements.

DWRO Project Experience

Project	Solomon Power Station (TransAlta)
Location	Pilbara reigon, Western Australia
Date	2012
Scope	Design & construct, commissioning & operator training
Capacity	24 m^3/day
Raw Water	Chlorinated tap water, TDS 410 mg/L, pH 6.93
Treated Water	EC < 1 µS/cm @ 25°C, Silica < 0.1 mg/L, pH 6
Features	20’ Containerised plant Pre-RO carbon filter Pre-RO caustic dosing (pH adjustment) Two pass RO process Post-RO mixed bed ion exchange filter MAK Standard (Data Sheet Product)

DWRO Project Experience

Project	Hospital, Surgical Theatres Upgrade
Location	Osborne Park, Western Australia
Date	2014
Scope	Design & construct, commissioning & operator training
Capacity	14 m^3/day
Raw Water	Chlorinated tap water, TDS 700 mg/L, pH 8.0
Treated Water	EC < 1 µS/cm @ 25°C
Features	Skid mounted plant Pre-RO carbon filter Two pass RO process Duty/standby RO pumps (pass 1 & 2) Permeate tank Duty/standby delivery pump set Ethernet interface to Building Management System MAK Standard (Data Sheet Product)

DWRO Project Experience

Project	Neuroscience Research Facility
Location	Nedlands, Western Australia
Date	2015 (installation scheduled for 2016)
Scope	Design & construct, installation, commissioning & operator training
Capacity	2 x 12 m^3/day
Raw Water	Chlorinated tap water, TDS 700 mg/L, pH 8.0
Treated Water	EC < 1 µS/cm @ 25°C
Features	Skid mounted plant Two pass RO process Pre-RO carbon filter Duty/standby RO trains Permeate tank Duty/standby delivery pump set Ethernet interface to Building Management System MAK Standard (Data Sheet Product)