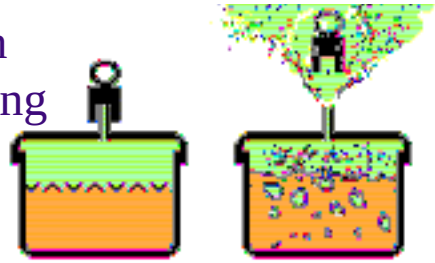
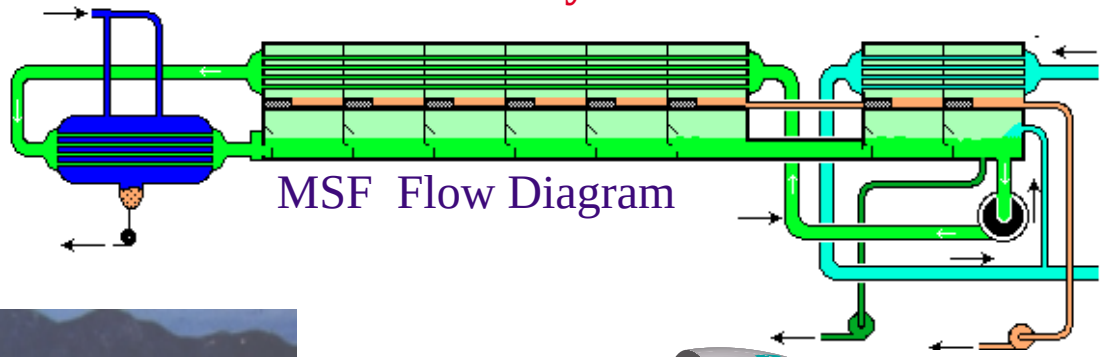
Trends in Desalination Technology: The processes

Multistage Flash Distillation (MSF)

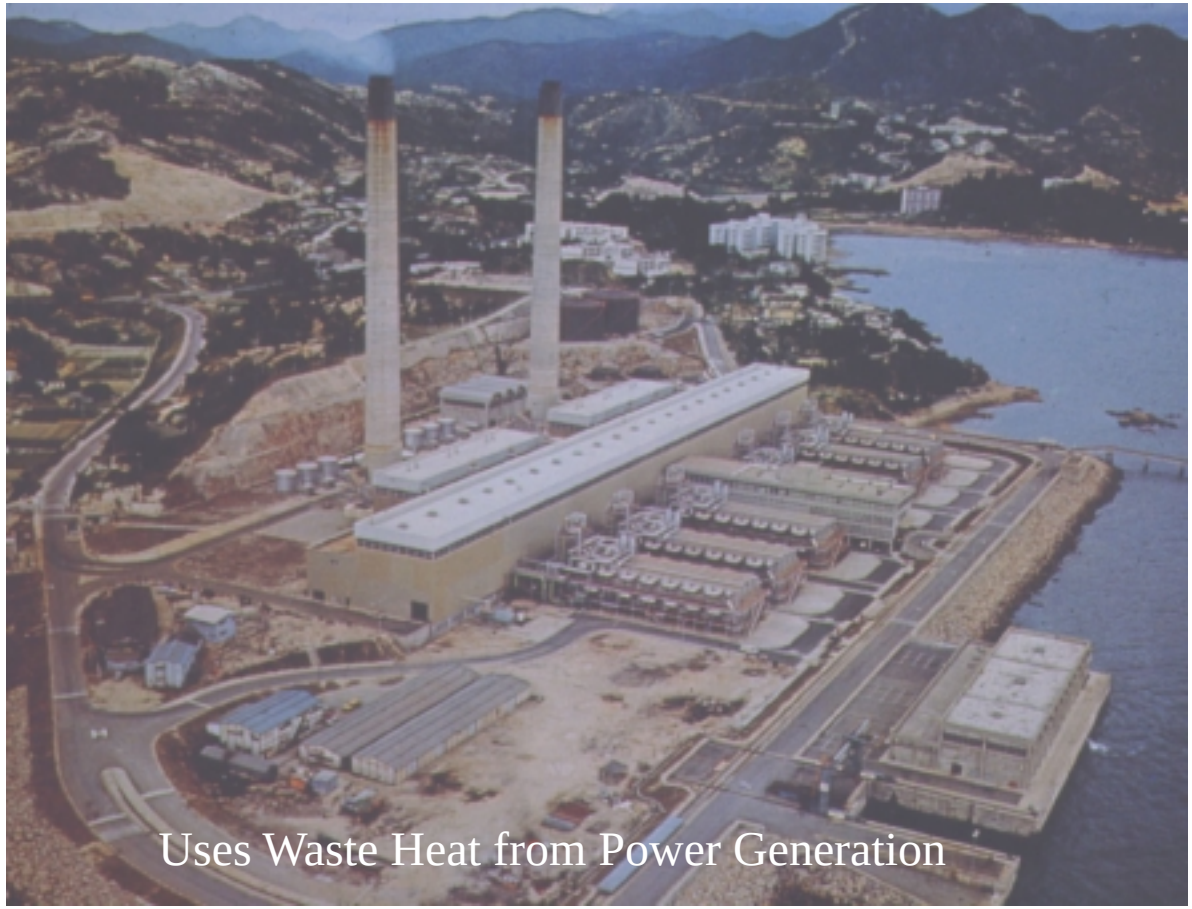
Produces Very Pure Product

Flash Boiling

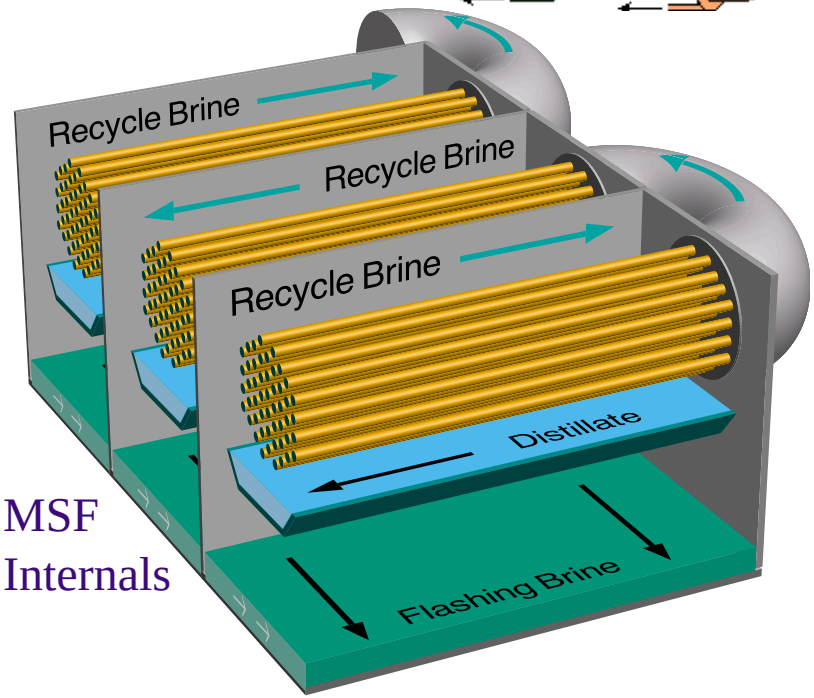




MSF Flow Diagram



Uses Waste Heat from Power Generation



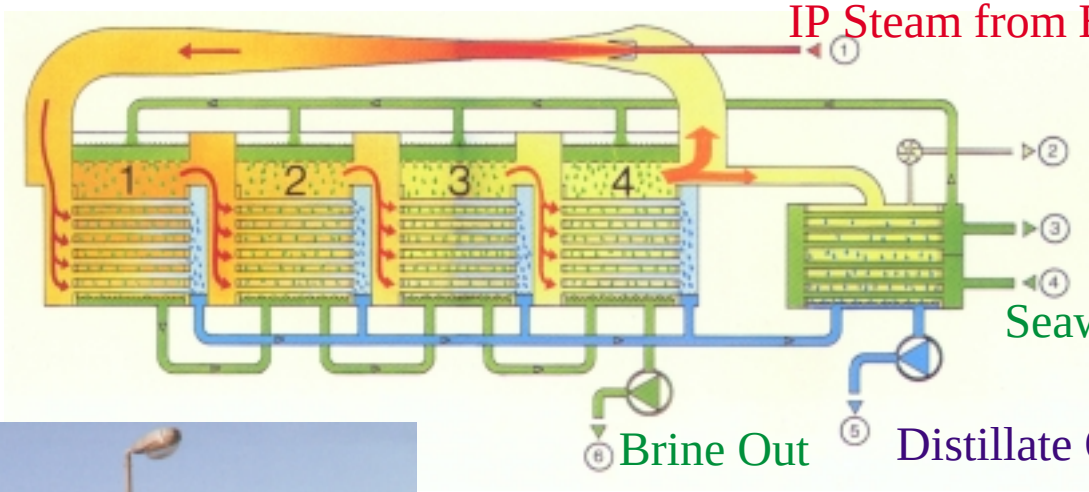
MSF Internals

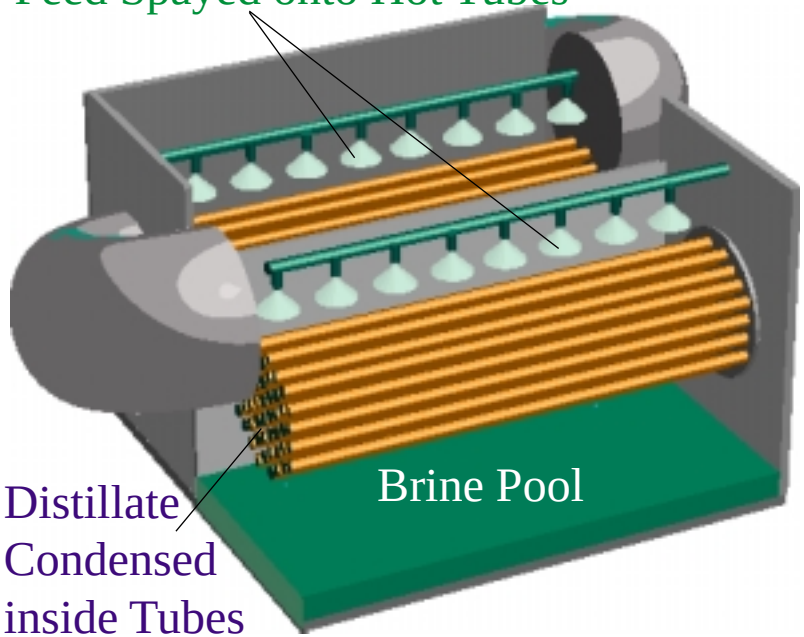
Power to Water ratios: 3 to 20 MW/Migd
Capacities up to 13 Migd/unit
Only Competitive for Seawater

Trends in Desalination Technology: The processes

Thermocompression Multiple Effect Distillation (TCMED)

Very Pure Product
Stand Alone Plants
Capacities up to 2 Migd
Copes with High TDS Seawaters
Package Boiler Driven
Only Competitive for Seawater

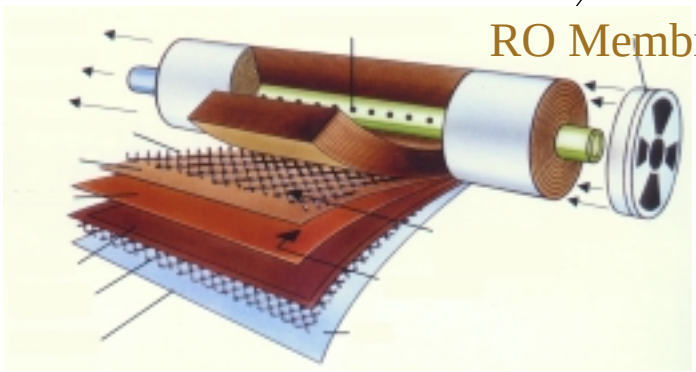


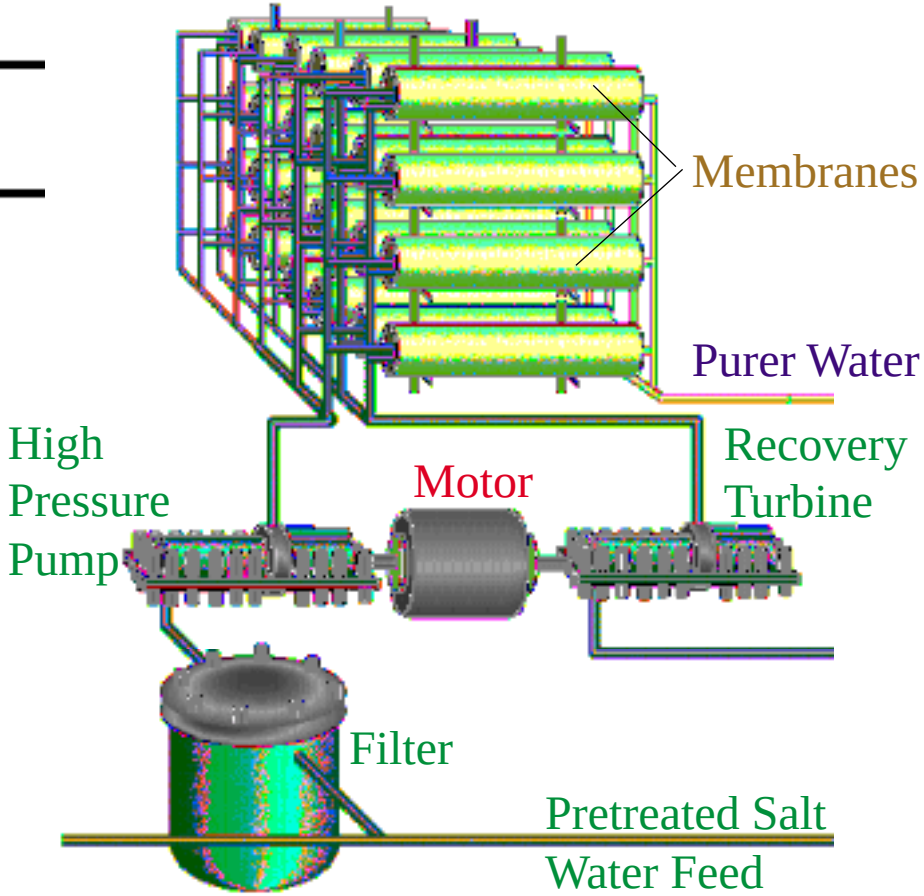


Trends in Desalination Technology: The processes

Reverse Osmosis (RO)

Power Driven; Produces Slightly Saline Product

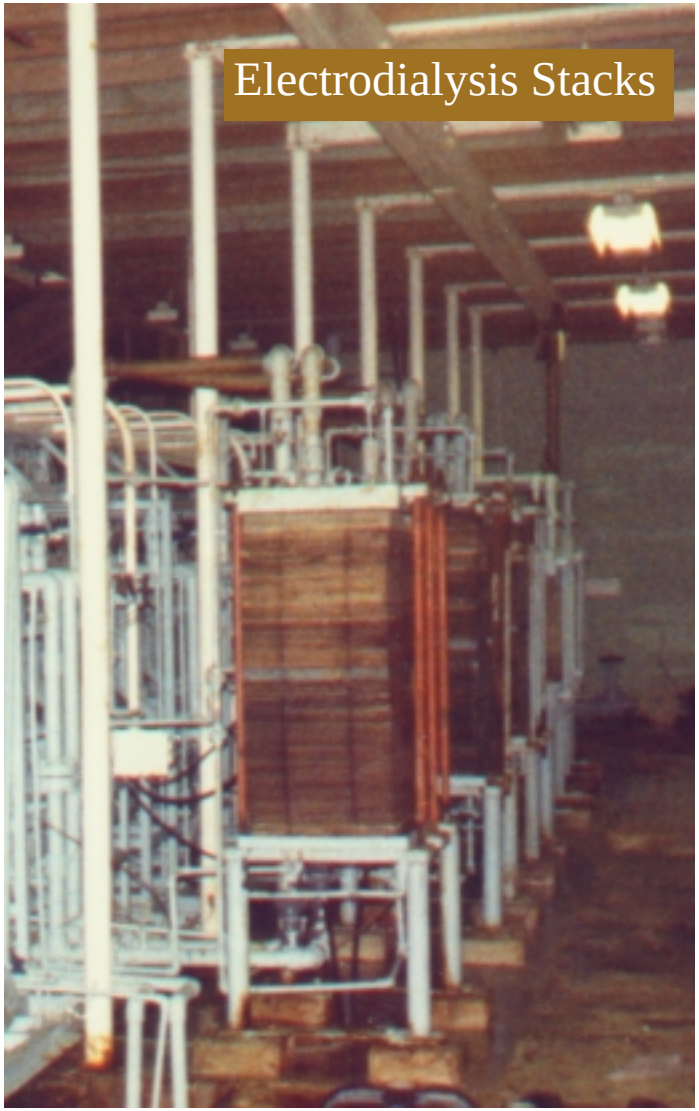


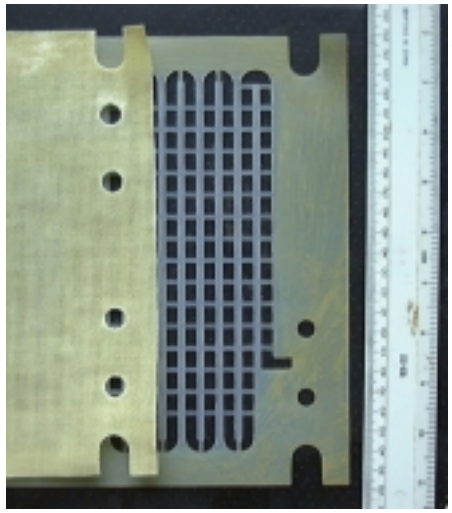


Low Power Consumptions (Feed TDS dependent)
Susceptible to Fouling - Good Pretreatment Vital
Membranes Age - Need Replacing (5 - 10 years)
Competitive for both Seawater & Brackish plant

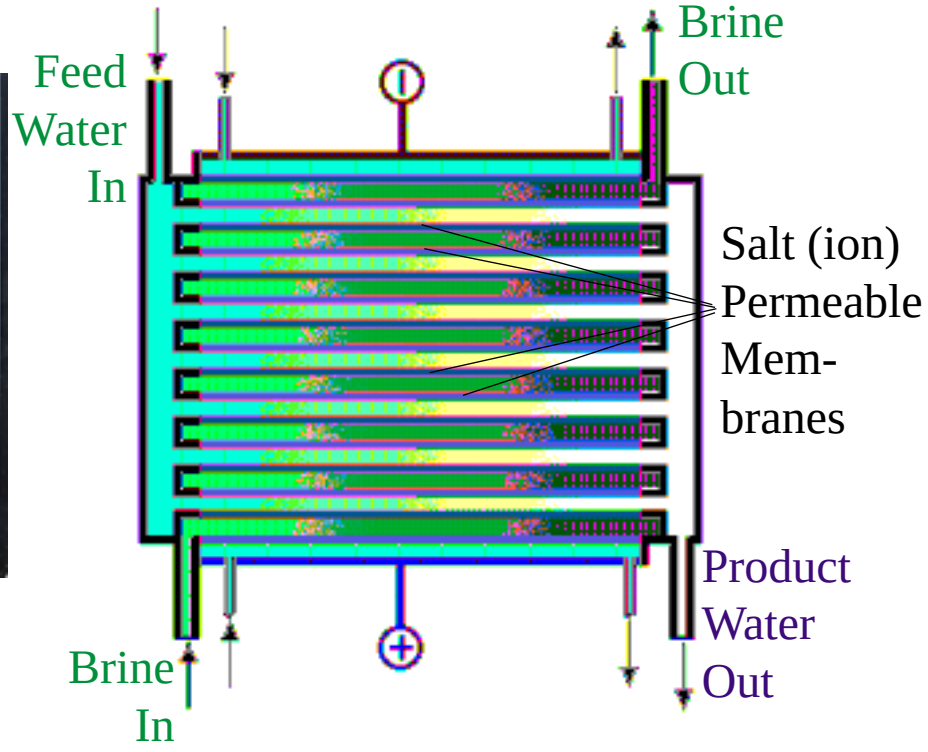
Trends in Desalination Technology: The processes

Electrodialysis (ED or EDR) — Electrically Driven; Reduces Salinity of Water





Membrane & Spacer



Power Consumptions proportional to Feed TDS & Salt Removed
Not a barrier technology
EDR - good fouling performance
Most Competitive for halving the TDS of a dilute Brackish Water

The Development of Modern Desalination Technology

1960 1970 1980 2000

MSF Trends - Large dual purpose seawater installations

Unit Sizes: 1.0 Migd gradually increasing unit sizes 10 – 13 Migd

Materials: Painted mild steel shells shift to more noble materials Stainless & Cu/Ni cladding

Scale Prevention: Acid & polyhosphate Development of high temperature scale prevention additives

Introduction sponge ball cleaning

MSF State of Art - Mature technology – reliable operation – long plant life – combine with power generation - large unit outputs - high purity product – can treat high TDS seawaters.

1960 1970 1980 2000

Thermocompression MED Trends - Smaller single purpose seawater installations

Unit Sizes: Small units gradually increasing unit sizes 1- 2 Migd

Configuration: Many Types Horizontal falling film configurations have become predominant

TCMED State of Art - Alternative to SWRO for single purpose installations - High purity product – can desalinate high TDS seawaters.

The Development of Modern Desalination Technology

1960 1970 1980 2000

Seawater Reverse Osmosis (SWRO) **Trends** - All sizes of plant

Membrane flux & rejection: improvements allowing single pass seawater desalination

Membrane material development:-

Cellulose acetate Cellulose triacetate

Polyamide HFF

Thin film composite membranes (TFC) - Polyamide (& others)

Membrane configurations: Many - whittled down to - Hollow fine fibres and Spiral wound

Membrane durabilities: stabilities improve and costs drop

SWRO Energy Consumptions:-

10 to 20 kWh/m^3 reduction of energy consumptions by:- 3 to 4 kWh/m^3

introduction & gradual improvement of energy recovery devices

Pretreatment: Membranes are very fine filters, therefore foul easily

Plugging , Scaling, Biofouling - Mixed

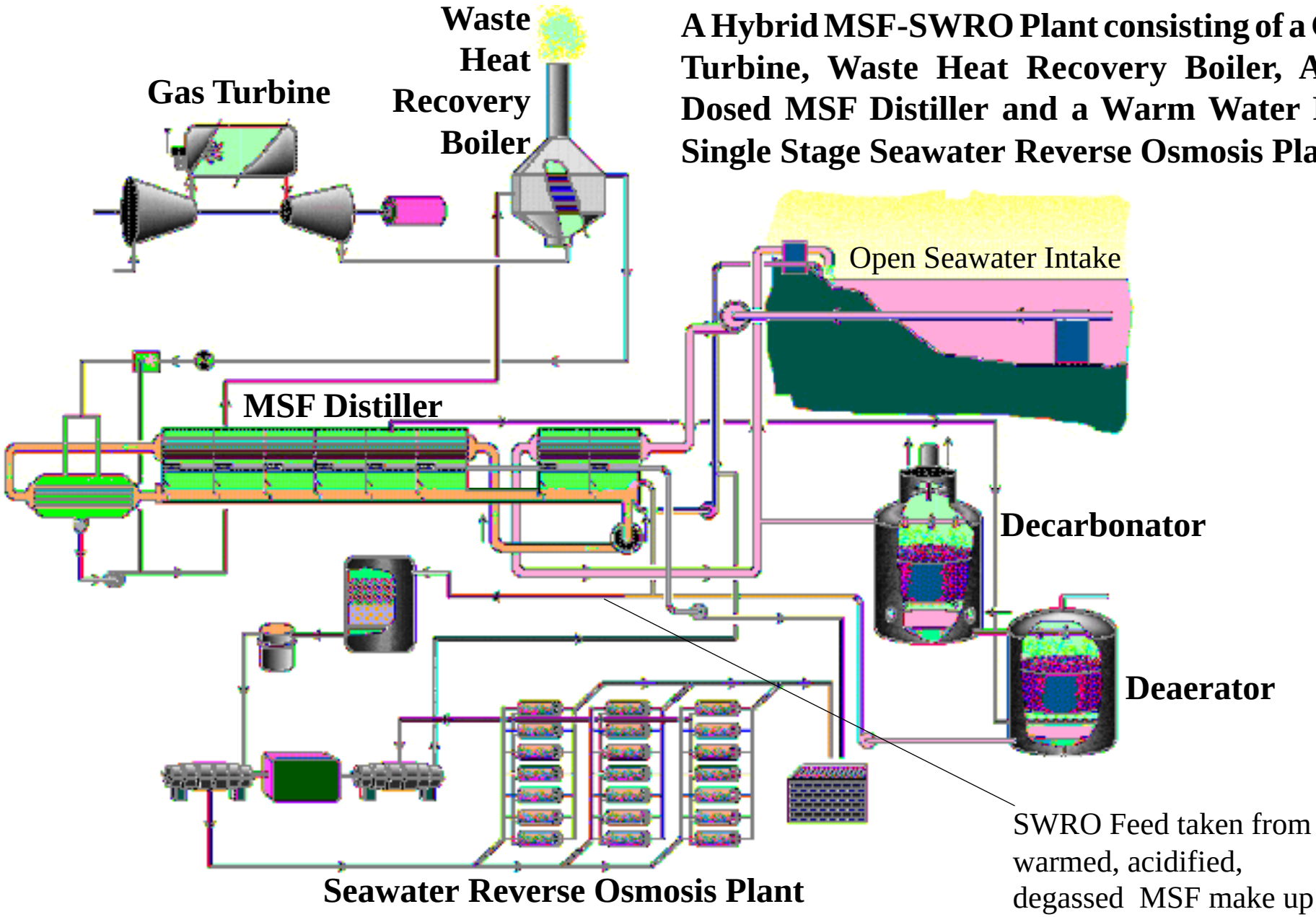
Chlorination - Damages most membranes.

Pretreatment Systems: Conventional, Beach well, Membrane filtration

SWRO State of Art - Often optimum solution where no waste heat available, fuel costs are high and the seawater feed is clean and not too saline. Membranes still vulnerable.

The Development of Modern Desalination Technology

A Hybrid MSF-SWRO Plant consisting of a Gas Turbine, Waste Heat Recovery Boiler, Acid Dosed MSF Distiller and a Warm Water Fed Single Stage Seawater Reverse Osmosis Plant.



The Development of Modern Desalination Technology

Brackish Water Desalination. Feed waters from 500 ppm to ~15,000 ppm TDS

Competing technologies: Brackish water reverse osmosis and Electrodialysis.
Brine disposal problems.

Brackish Water Reverse Osmosis (BWRO)

Membrane development has lead to higher fluxes and better rejections

- Allowing low pressure operation - Hence reducing energy consumptions
- Also allowing higher recoveries - Less waste of feed waters

Development of 'loose' membranes has generated large spin off of the technology into competition with conventional water treatment processes - water softening, non-filtration and microfiltration.

Good pretreatment again vital for preservation & logevtity of the membranes.
Provides a barrier technology for micro-organisms.

Electrodialysis (ED)

The major development in ED has been the introduction of polarity reversal (EDR) which has significantly reduced fouling problems and the degree of pretreatment required.
ED competes only over a relatively narrow range of feedwater TDS's (< 3,000 ppm)

The Development of Modern Desalination Technology

The Future ??

Seawater Desalination

MSF: Mature technology, Scope for progress: Materials, HTA & Demister Fouling.

SWRO: Less mature, will become even more competitive,

Scope for progress:
- Rejections
- Chlorine tolerance
- Energy recovery (capital costs)
- Pretreatment (Membrane filtration)
- Membrane cleaning & restoration

Brackish Water Desalination

BWRO: will dominate Scope for progress:
- Rejections & Water Permeabilities
- Chlorine tolerance
- Pretreatment (Membrane filtration)
- Membrane cleaning & restoration

Electrodialysis: will be squeezed - not a barrier technology