High Efficiency Evaporator

MEP: Multi-Effect Plate evaporator

The Alfa Laval Multi-Effect Plate (MEP) evaporator is used, among other places, on cruise vessels and at diesel power plants to produce the highest quality fresh water at the lowest possible overall production costs. The MEP system shown here has three effects and an integrated shell & tube condenser.

Application

Supplying high quality fresh water to meet the demands onboard the fleets of the world and at diesel power plants is a challenge that must be addressed in order to support sustainable development. To meet the growing demand for potable and technical water, it is important to be able to provide economical and efficient desalination technologies.

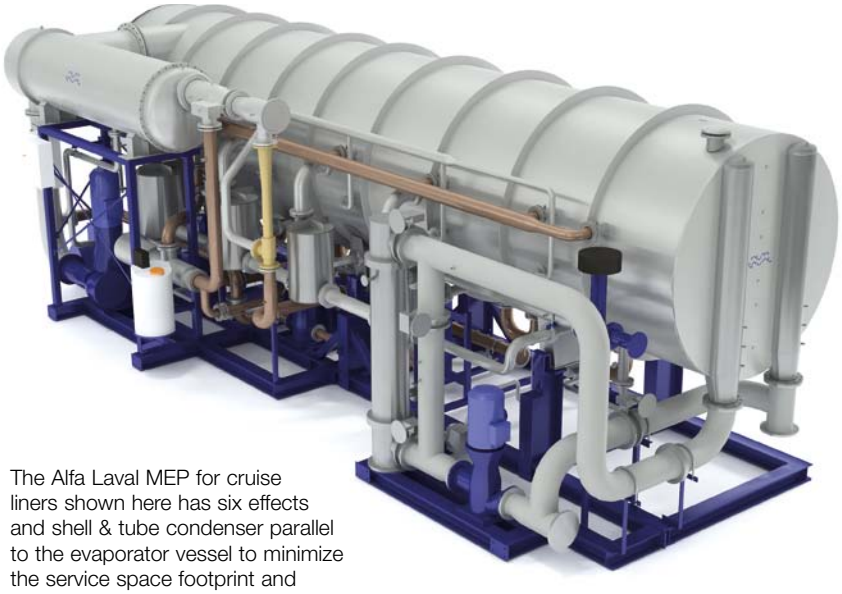
MEP system from Alfa Laval

The Alfa Laval MEP system is an easy-to-use fresh water distiller that uses seawater to produce the highest quality distillate with a conductivity of less than 20 µS/cm at the lowest possible overall production cost.

Economical and highly efficient, the MEP employs combined plate-type evaporator/condenser effects to produce fresh water using the available waste heat from hot water or low-pressure steam, or a combination of both. The self-contained automated MEP evaporator is designed with very high thermal efficiency for high production rates using very little waste heat. Furthermore, the electric energy consumption is kept to a minimum through the use of an optimized pump configuration and the application of frequency controlled motor on the sea water pump.

With its modular design, this highly reliable MEP evaporator is easy to configure to the requirements of any vessel, diesel power plant. Straightforward operation and automated control provides maximum uptime at less cost compared to technologies such as reverse osmosis (RO) and multi-stage flash (MSF). Its lightweight, space-saving design takes up less floor space while offering much higher thermal efficiency in relation to its volume and weight compared to other evaporators. This enables the production of much higher volumes of fresh water than other desalination technologies.

The MEP system offers the lowest possible consumption of both electric energy and chemicals. The electric energy consumption of the four-effect MEP-4-750 desalination unit, for example, is less than 2.5 kWh/m^3. Moreover, the MEP does not require brine circulation or any anti-foam injection, and its total anti-scale chemical consumption is less than traditional multi-stage flash units.



The Alfa Laval MEP for cruise liners shown here has six effects and shell & tube condenser parallel to the evaporator vessel to minimize the service space footprint and avoid a cross-tube design.

Alfa Laval MEP in brief

- Low water production cost
- State-of-the-art and user-friendly control technology
- Fast start-up and quick response to load changes
- Corrosion-resistant titanium plates
- Patented plate design and thin film process for high thermal efficiency
- Unique construction that allows direct access to heating surfaces
- Evaporator vessel of AISI 316L steel
- High distillate purity and salinity of 5–10 ppm (10–20 µS/cm)
- Capacity range: 180–1000 m^3/24 h per unit

Features and benefits

Lowest overall water production costs
The MEP is the most economical and cost-effective technology available today to produce fresh water from seawater when waste heat is available. A simple, straightforward design and PLC-based control system make the MEP easy-to-use without requiring extensive operator training.

Energy efficiency
The MEP uses between 30% and 70% less electric power than comparable reverse osmosis systems, and between 50% and 80% less compared to multi-stage flash desalination systems. Actual cost savings will vary according to the unit type, operating conditions and electricity prices. In addition, unlike reverse osmosis systems, the MEP does not require pre-heating of the seawater when seawater temperature drops below 25°C.

High reliability
The MEP provides more than 95% availability and more uptime than comparable shell & tube evaporators. All available diesel engine waste heat is used independently of the load of the diesel engines. Distillate production can automatically be maintained down to 30% of the design rate.

High efficiency
The MEP evaporator effects consist of corrosion-resistant titanium plates with a patented corrugated design that promotes high turbulence and thereby extremely high thermal efficiency. All plates of an effect are identical but have two different gasket configurations in order to form both condensing and evaporating plate channels on each effect. The effects are fitted into the evaporator vessel, forming a multi-effect plate evaporator.

Minimal environmental impact
Reduced chemicals consumption combined with reduced pumping requirements results in reduced overall CO_2 emissions and compliance with the Kyoto Protocol, which provides subsidies in the EU region.

Reduced chemicals storage and consumption
The MEP only requires cleaning using specially developed non-toxic cleaning agents about once a year, or approximately 10 times less than reverse osmosis systems. This means less floor space is required for storage of full and empty plastic barrels and lower waste disposal costs.

Minimal maintenance and downtime
A continuous thin film of water over the entire plate surface minimizes the risk of deposit build-up (scale) and thereby downtime. Corrosion-resistant titanium heat transfer surfaces and non-coated materials withstand seawater and brines.

The Alfa Laval MEP system for diesel power plants.

Should calcium carbonate scaling occur, it is easily removed by chemical cleaning with a non-toxic solution using Cleaning-in-Place (CIP) equipment.

In the unlikely event of calcium sulphate scaling, which usually results from incorrect operation of the unit, disassembly of the plate pack can be carried out, allowing the scale to fall to the bottom of the desalination vessel. This enables the unit to be brought back online at rated capacity with minimal downtime. This is not possible with a tubular system.

Full access to heating surfaces
Simply open the MEP access doors to inspect and/or clean the MEP vessel's internal compartments, including the entire plate pack as well as individual plates. The plate packs can also be completely removed from the vessel for maintenance, if required.

Easy, automated operation
The MEP is a fully automated PLC-controlled solution that provides reliable operation.

Operating principle
The Alfa Laval MEP desalination process consists of a series of evaporation and condensation chambers known as effects (2). Each effect is fitted with heat transfer surfaces based on patented Alfa Laval plates. In the plate channels of an effect, seawater on one side is heated up and partially evaporated to distillate vapour, which is used in the next effect; on the other side, the distillate vapour from the previous effect is condensed, giving up its latent heat, into pure distillate.

By maintaining a partial pressure difference across the effects, the process is able to yield maximum efficiency from available low-grade thermal energy sources. The performance and the capital cost of the system are proportional to the number of effects contained in a unit.

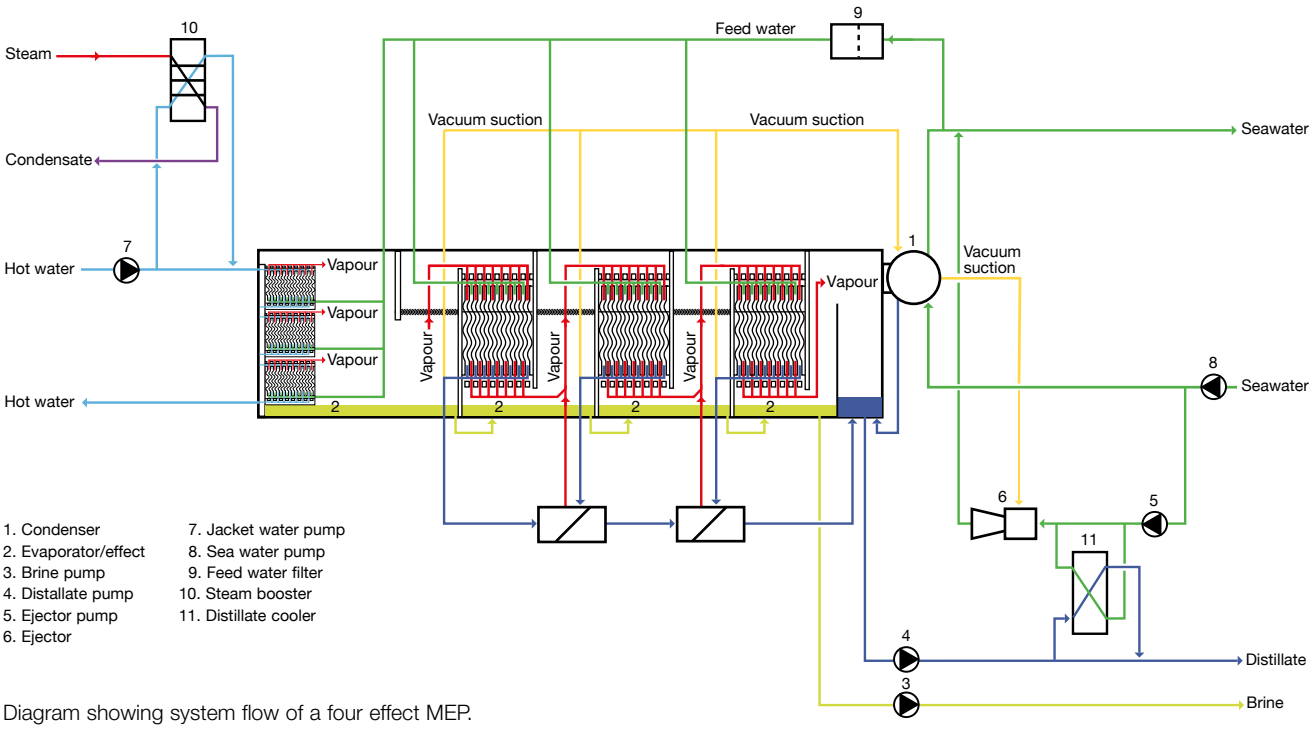
Seawater is pumped into the system via a seawater pump (8) to a condenser (1). Here, the seawater acts as a coolant, removing the heat supplied to the system and thereby maintaining the proper energy balance. In the condenser, the vapour produced in the last effect is condensed into pure distillate.

As distillate vapour is condensed, heat is transferred to the seawater. The seawater pump (8) also transports preheated seawater downstream of the condenser to the various effects (2) of the unit for evaporation. The seawater is led towards the evaporation side of the plate stack, creating a uniform and controlled thin film on the plate. To minimize scaling, the special design of the plate surfaces ensures a uniform flow without any dry areas.

On the evaporation side of the plate stack, the seawater is partially evaporated by the heat from the condensation side of the plate stack. The vapour thus produced is passed through a demister to separate salt from the water droplets before the vapour enters the condensation side of the subsequent heat exchanger plates. Here, the vapour condenses into distilled water while transferring its latent heat through the plates to the evaporation side.

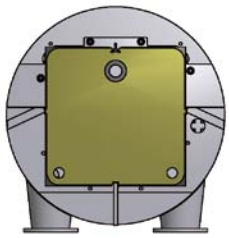
The process is repeated in all effects. Finally, distillate and brine are extracted from the last effect.

The evaporation takes place at sub-atmospheric conditions, and vacuum conditions are created and maintained by a venting system. The venting system is a water-driven ejector (5 and 6), as shown on the flow diagram. The venting system removes air from the plant at start-up and extracts non-condensable gases during operation of the plant.

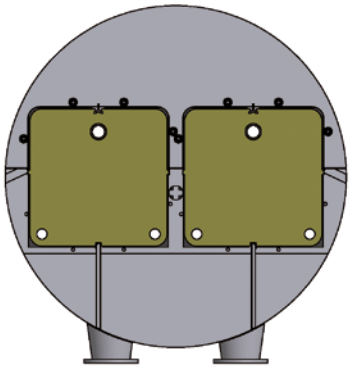


1. Condenser
2. Evaporator/effect
3. Brine pump
4. Distallate pump
5. Ejector pump
6. Ejector
7. Jacket water pump
8. Sea water pump
9. Feed water filter
10. Steam booster
11. Distillate cooler

Diagram showing system flow of a four effect MEP.



MEP 1.6 m vessel.



MEP 2.5 m vessel.

Capacity range

Vessel diameter	Capacity range*
1.6 m	180–500 m^3/24h
2.5 m	500–1000 m^3/24h

* Upon request, Alfa Laval can also supply MEP systems with capacities up to 7000 m^3/24h based on larger plates and vessels.

The MEP system can supply between 180 and 1000 cubic meters of fresh water a day, depending on the unit employed. This means that ship owners and operators need to bunker less fresh water when at port. Based on standard components and a modular concept, each unit is custom-designed.

Ship installations

	Vessel diameter (mm)	Length (mm)	Width (mm)	Height (mm)
MEP-2-180	1600	4500	3000	2700
MEP-3-250	1600	5500	3000	3000
MEP-4-500	1600	9000	3500	3300
MEP-4-750	2500	9000	5000	4100
MEP-5-750	2500	9700	5000	4100
MEP-4-900	2500	9700	5000	4100
MEP-5-900	2500	10400	5000	4100
MEP-6-1000	2500	11800	5000	4100

Service space should be decided depending on machine room layout.

Diesel plant installations, including gangway and stairs

	Vessel diameter (mm)	Length (mm)	Width (mm)	Height (mm)
MEP-2-180	1600	6000	3500	2700
MEP-3-250	1600	7000	3500	3000
MEP-4-500	1600	10500	4000	3300
MEP-4-750	2500	11000	5600	4100
MEP-5-750	2500	11700	5600	4100
MEP-4-900	2500	11700	5600	4100
MEP-5-900	2500	12400	5600	4100
MEP-6-1000	2500	14200	5600	4100

Service space should be designed based on site layout.

Specific energy consumption (in kWh/m^3)

Electrical consumption range*	1.3–3.9
Heat consumption range	128–385

* Note: Electrical consumption will depend on the unit type and actual installation.

Alfa Laval reserves the right to change specifications without prior notification.

How to contact Alfa Laval
Up-to-date Alfa Laval contact details for all countries are always available on our website at www.alfalaval.com

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