Water is Life

SERCK COMO GmbH

# CONDENSATION

## KONDENSATION

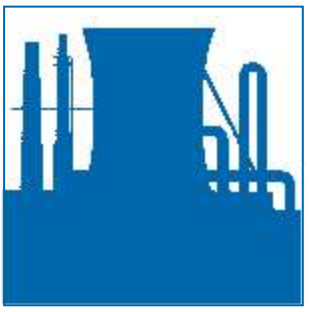
# TUBES OR PLATES ???

## for Fresh Water Generators

# EVAPORATION

## VERDAMPFUNG






# TUBES OR PLATES ???

## for Fresh Water Generators

It is the aim of this article to disperse some confusion which might have been created by publications about so-called advantages of plates above tubes in single or multiple effect distillers.

### Single Effect Evaporators

There is no doubt that the plate type single-effect evaporation has developed to a well-proven technology for cargo ships, replacing – except in some remaining special applications – the conventional tube-type single-effect rising-film or submerged-tube evaporators. These plate evaporators work according to the rising film evaporation principle. The new multi-effect plate-type distillers for cruise ships operate according to the falling film principle. This makes a remarkable difference.

### Multi-Stage / Multi-Effect Distillers

The technology of multiple-effect and multistage flash evaporators on board of large cruise ships (up to 900 $m^3$/d per unit) has its origin in the land-based seawater desalination. The mostly applied technologies are the **M**ulti-**S**tage **F**lash evaporation (**MSF**, for large capacities up to approx. 50000 $m^3$/d per unit) or the **M**ulti-**E**ffect **D**istillation (**MED**, up to approx. 10000 $m^3$/d per unit). The latter process operates in most cases with falling film evaporation on horizontal tubes. To a smaller extent vertically arranged plates of special design are used.

The discussion whether tubes or plates are better for MED falling film evaporators is somewhat academic with respect to cruise ships. Except very few cases – falling film evaporators with tubes do not exist on cruise ships.

There is only one supplier applying the falling film principle in evaporators for cruise ships, but he uses plates instead of tubes as evaporation surface, for this reason called **MEP** instead of **MED** (please refer to fig. 1).

Most of the evaporators on board of cruise ships work according to the **MSF** principle with tubes as condenser surfaces, only a minor portion applies the rising film principle with vertical tubes.

A realistic comparison of plates and tubes for evaporators on cruise ships must consider the principle differences between the **MED** and the **MSF** process. This is the main aim of this article.

### Scale Formation

MED-evaporators are principally more often subject to scaling than MSF evaporators. Possible reasons are:

- The falling film principle requires a uniform distribution of low feedwater flows on comparably large evaporation surfaces.
- The flow of the feed water flow along the evaporation surfaces is driven **by gravity** mainly, creating only **a low turbulence** in the liquid films.
- The seawater concentration is raised by factor **1.4 – 1.5**, and the evaporation takes place **during heat transfer**. The heat transfer surfaces have to be kept coverd with liquid, in spite of comparably high vapour volumes develop.
- An over-concentration of the seawater during evaporation is physically possible and will occur in case of not enough feed water is injected.
- Cloggings in the feed water distribution system create local dry areas on the evaporation surfaces and are hardly recognisable for the operator. Access to the distribution holes in evaporation plates requires dismantelling of plates !
- MED-plants are principally more sensitive to under-dosing of anti-scale chemicals than MSF plants.
- It is probably a risky procedure to dismantel and re-arrange hundreds of evaporation plates with all the rubber seals (claimed as a practicable method for the removal of hard scales).

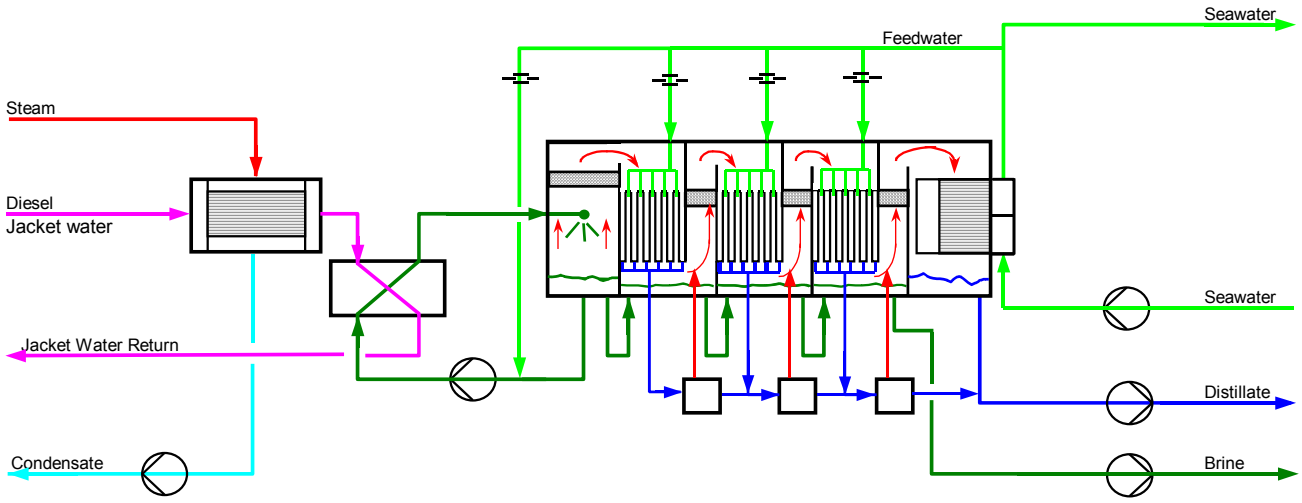



**Fig. 1: Flow Diagram of 4-Effect MED (MEP) Evaporator, Effect 1 operating as Flash Evaporator**

**MSF** evaporators do not know any of these problems and risks (please refer to fig. 2):

- During heat transfer the seawater is flowing **under pressure** with approx. **1.5 – 1.8 m/s** through the tubes and the final heaters (**high turbulence**).
- Evaporation takes place **after heating** by means of stepwise pressure and corresponding temperature reduction in the stages. The seawater concentration is thus rising by factor **1.06** only.
- Hard scales can – as any over-concentration is physically impossible - never occur in MSF evaporators.
- The concentration factor and the feedwater distribution are – due to the once through principle applied - not selectable or adjustable parameters (as the case in MED plants) and can thus not be subject to a wrong design, mal-operation or lack of maintenance.

### Thermal efficiency

**MED:** The thermal efficiency in a MED plant is mainly determined by:

- number of evaporation effects
- feed water / distillate flow ratio
- presence / size of feed water pre-heaters in the effects
- design / surface of final condenser
- temperature difference between hot and cold end of the plant

The size and design (tubes or plates) of the heat transfer surfaces affect the required delta-T between hot and cold end, but not the thermal efficiency of the evaporator.

**MSF:** The thermal efficiency of a MSF evaporator is a matter of the number of stages and the condenser surfaces installed per stage. By "playing" with these 2 design parameters, every requested thermal efficiency can be considered.

For the above reasons no evaporation process - neither MED(MEP) nor MSF - can claim principal advantages concerning the achievable thermal efficiency (nevertheless done for the MEP).

### Utilisation of different Heat Sources

All types of evaporators **- MED, MEP or MSF -** can be coupled to all kinds of heating sources. In this respect again none of these evaporation principles has special advantages (as unjustly claimed for the MEP system).

### Effect of Scaling/Fouling

As soon as the fouling reserves in an **MED** evaporator are "consumed" due to scaling, the production can be maintained by increasing the temperature at the hot end only. This method is not always practicable (for example in case of motor water heating) and also dangerous because thus the scaling process is accelerated. Without such measures a drop of production has to be tolerated.

Whenever a **MSF** evaporator is fouled or scaled (what does not happen very often), the water production can be maintained by increasing the heat input, without having to raise the brine top temperature. A temporary higher heat consumption can – in many cases - be easier tolerated than a lack of fresh water production.

### Resumee

- Plates are not the better choice for evaporators on cruise ships
- Tubes are the safest solution when combined with the MSF principle (turbulent flow of pressurised seawater inside tubes during heat transfer, evaporation in separate flash chambers).
- MSF-Once-Through evaporators are easy to operate. Over-concentration of brine or dry-out of evaporation surfaces are physically impossible.
- SERCK COMO MSF-evaporators on cruise vessels have been in many cases running for years without cleaning even (nevertheless this is not a recommendable method of operation)
- Scaling or fouling of condenser tubes – occurring after extremely long operation periods only – do not automatically lead to a reduction of the water production.
- The majority of all evaporators installed on board of cruise ships up to now is of MSF-type (most of them delivered by SERCK COMO), and this trend is – for the reasons discussed above - going to continue.

(**The author:** Dr. Rainer Greffrath, Managing Director of SERCK COMO GmbH)

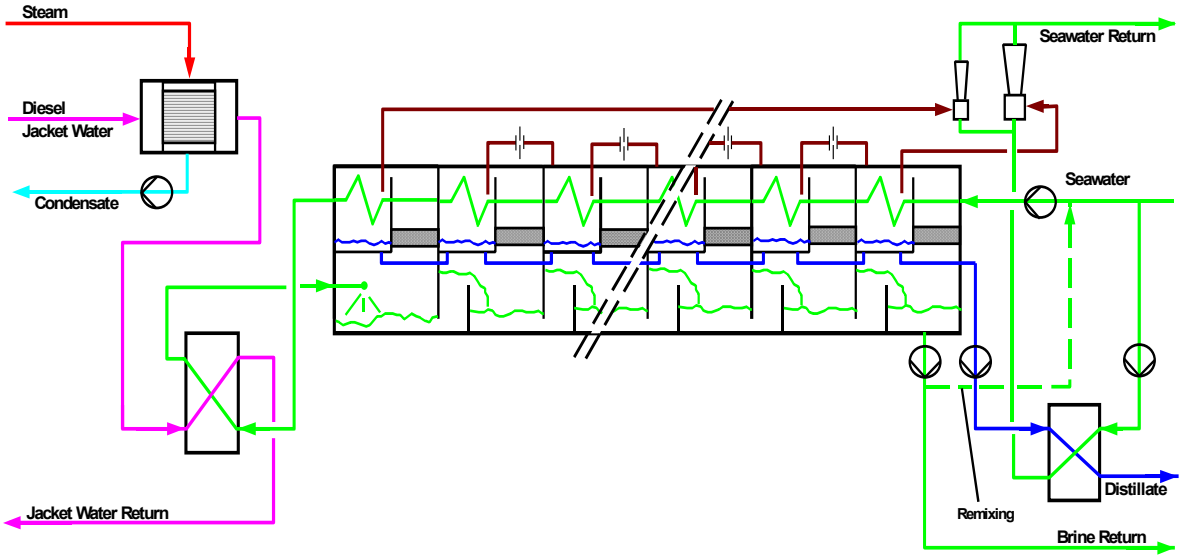



**Fig. 2: Typical Flow Diagram of a SERCK COMO MSF Evaporator for a Cruise Vessel**

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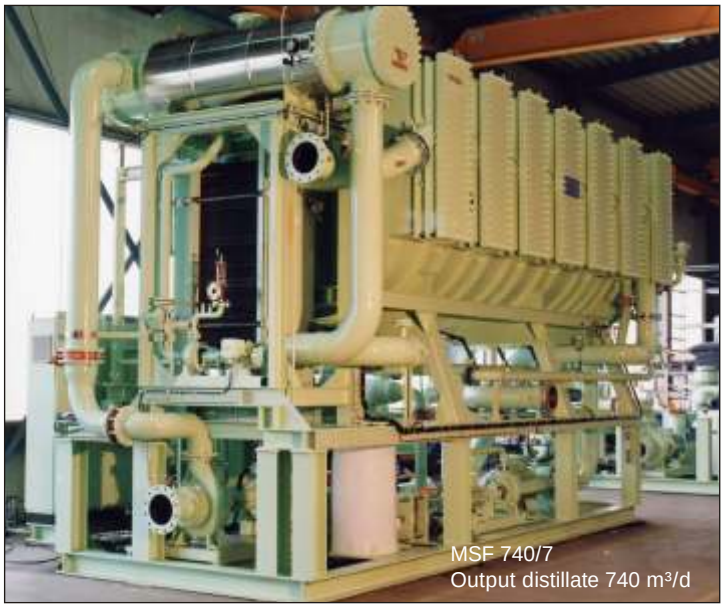
SERCK COMO GmbH

MSF 1400/12
Output distillate 1400 m³/d


MSF 740/7
Output distillate 740 m³/d

## Delivery Program:

**Heat Exchangers for:**

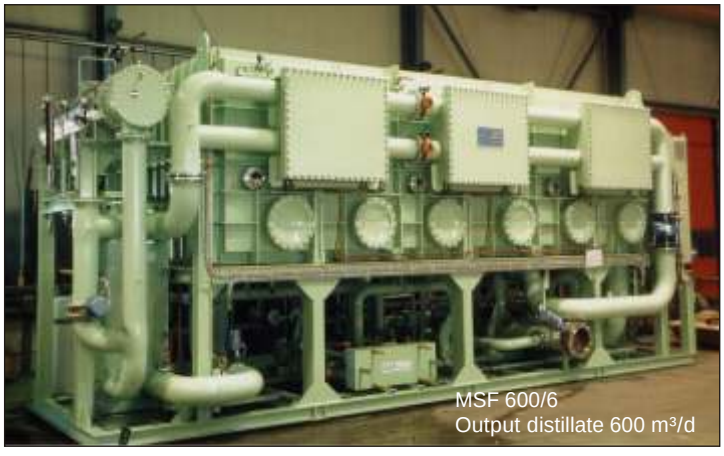
Cooling
Preheating
Condensing
Steam-Steam Generating

**Complete Plants for:**

Condensation
Evaporation
Sea Water Desalination
Waste Water Concentration
Distillate Post-Treatment
Special Application

## Scope of Services:

Consulting
Manufacture
Erection
Commissioning
Training
Maintenance / Service
Spare Parts


MSF 600/6
Output distillate 600 m³/d

Quality is our Objective.

EN ISO 9001 · DIN EN ISO 9001 · ANSI/ASQC Q9001

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