HORIZONTAL TUBE MULTIPLE EFFECT - STACKED DESIGN

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The stacked design - though possible in principle for MSF is particularly interesting for ME systems since high gain ratios can be achieved with a lesser number of stages.

The effects are placed on top of each other - the gravity and pressure difference are utilized for the brine transport from effect to effect.

In this contribution all important design parameters such as heat exchanger (tube bundle) geometry, brine distribution, critical wetting rates, and the influence of non-condensables on overall heat transfer are discussed in detail for the most common type - the HT evaporator. Seeding, a special technique of interest in cases where concentrates of RO brackish water desalination units or waste water are to be concentrated by HT ME units, is also discussed.

Details of two plants, the HT MES solar powered plant in Abu Dhabi (VAE) and the Al-ain (VAE) MES pilot unit based on thin sheet welded plate heat exchangers, are presented.

1. Introduction

In "stacked" plants, which were first introduced by Bongard and Muylle (1970) and Takada (1976), the effects are placed vertically on top of each other. In this case, the
gravity and pressure difference between the effects can be utilized for the transport of 
the brine from effect to effect - only one major pump is necessary for pumping the feed 
through the feed heat exchanger to the top of the stack (see Figure 1) (Takada 1972; 
Rautenbach and Arzt 1985a).

![Diagram of MES process](image)

Figure 1. The MES process (Takada 1972; Rautenbach and Arzt 1985a).

There are two important variations in multiple-effect system (MES) design: LTV (long 
tube vertical) and HT (horizontal tube). In any case, the advantages of MES are as 
follows.

(a) Even for higher concentration factors, the once-through principle can be realized. As 
a consequence, concentrated brine will be in contact only with the effects operating 
at lower temperatures.
(b) A simple mode of operation. Between maximum capacity and zero production, the distillate production is totally controlled by the amount of live steam flowing into the unit.

(c) Almost any combination with vapor compression is possible.

(d) Very high overall heat transfer coefficients can be realized, permitting small temperature differences between the effects at low costs of heat transfer area. This is particularly important for low-temperature waste heat utilization.

Regardless of the choice of MES design, the brine distribution, the brine/vapor phase separation and the venting of the non-condensable gases are of major importance for stacked units consisting of a high number of effects.

It should be mentioned that stacked design is not limited to ME evaporation. There are at least two examples of the stacked multistage flash (MSF) process, a seawater desalination plant at Texel, The Netherlands and a dumpsite leachate treatment plant near Lugano, Switzerland.

Bibliography and Suggestions for further study


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