Evaporator Design Guidelines

(Reference: W.L.Badger, and J.T. Banchero, Introduction to Chemical Engineering, McGraw-Hill, 1957)

Heat Transfer rate:

$$Q = UA\Delta T_m$$

where Q = heat transferred per unit time, W,
U = the overall heat transfer coefficient, $W/m^2\,°C$,
A = heat-transfer area, m^2,
ΔT_m = the mean temperature difference, the temperature driving force, °C.

Temperature Difference:

ΔT_m = Temperature of condensing steam – temperature of boiling liquid

Boiling Temperature of Liquid
It is calculated based on the saturation temperature of water corresponding to the pressure prevailing inside the evaporator plus the boiling point elevation (due to the solid content, and hydrostatic head, if any)

Calandria Evaporator

This is the "Standard Evaporator", also called as calandria evaporator, or vertical short tube evaporator. This is used mainly for batch concentration of liquids.

Design Procedure:

- With the approximate values of heat transfer coefficients, an estimate can be made of a possible configuration for a given duty (diameter, length, number of tubes)
- Heat transfer correlations can be applied to these geometrical data, and area can be recalculated

Heat Transfer Coefficient Estimations

Tube side heat transfer coefficient:

Tube side fluid is generally the condensing steam, and the heat transfer coefficient for the same can be taken to be constant as 8000 $W/m^2.K$.

Shell side Heat Transfer coefficient:

This estimation is based on boiling heat transfer coefficient estimation.

Standard Dimensions

- Cross sectional area of central down-take: 75 – 150% of the total cross sectional flow area of tubes.

- Tubes: 1 to 4 inch dia; 3 to 5 ft long
    - Std: 2 inch dia, 5 ft long

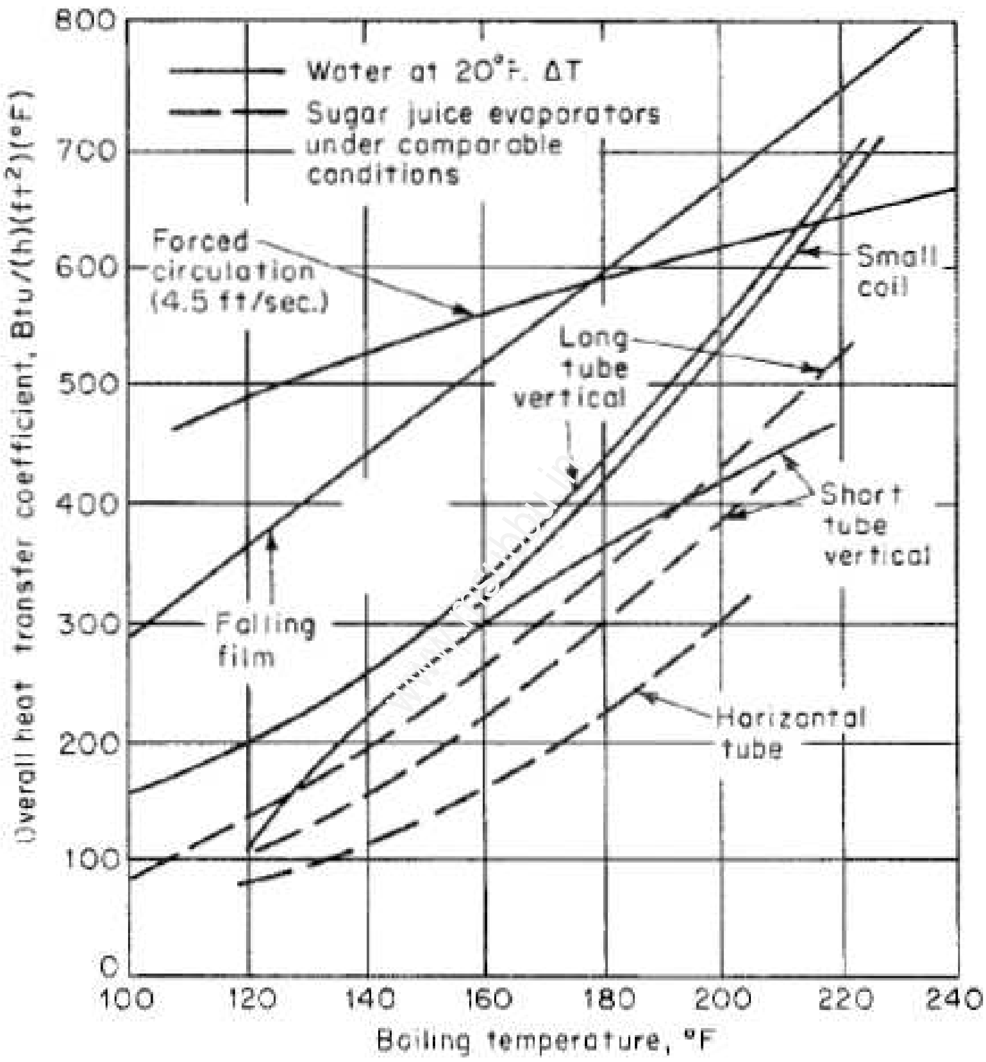

Fig. Overall heat transfer coefficients in some types of evaporations
(Walas, S.M., Chemical Process Equipment, Butterworth-Heinemann, 1990)