Tutorial-5

Evaporators

Apr 2020

Exercise 1. 60,000 kg/h of 44% NaOH at 40 °C is to be concentrated to 65%. Saturated steam at 3 atm absolute pressure is available. An evaporator supplier can provide an evaporator which has an overall heat transfer coefficient of 2000 W/m^{2}K and operates at 8 kPa absolute pressure. Obtain the required heat transfer area. Calculate the steam requirement, heat transfer rate and area.

Exercise 2. It is desired to concentrate 50000 lb of a solution at 100 °F and 10% solid to a product containing 50% solid. Steam is available at 26.7 psia and the vapor space of the evaporator is operated at 2 psia. Assume negligible BPE, specific heat=1.0, condensate leaves at saturation. The overall heat transfer coefficients is 125 Btu/hr ft^2 °F. Calculate the steam required and heating surface required.

Exercise 3. It is desired to concentrate 50000 lb of a solution at 100 °F and 10% solid to a product containing 50% solid. Steam is available at 26 psia and the last effect of a triple effect evaporator is operated at 2 psia. Assume negligible BPE, specific heat=1.0 in all effects, condensate leaves at saturation. The overall heat transfer coefficients for the three effects are U_1 = 600, U_2 = 250 and U_3 =125 Btu/hr ft^2 °F. The evaporator is operated at forward feed. Calculate the heating surface required and steam economy.

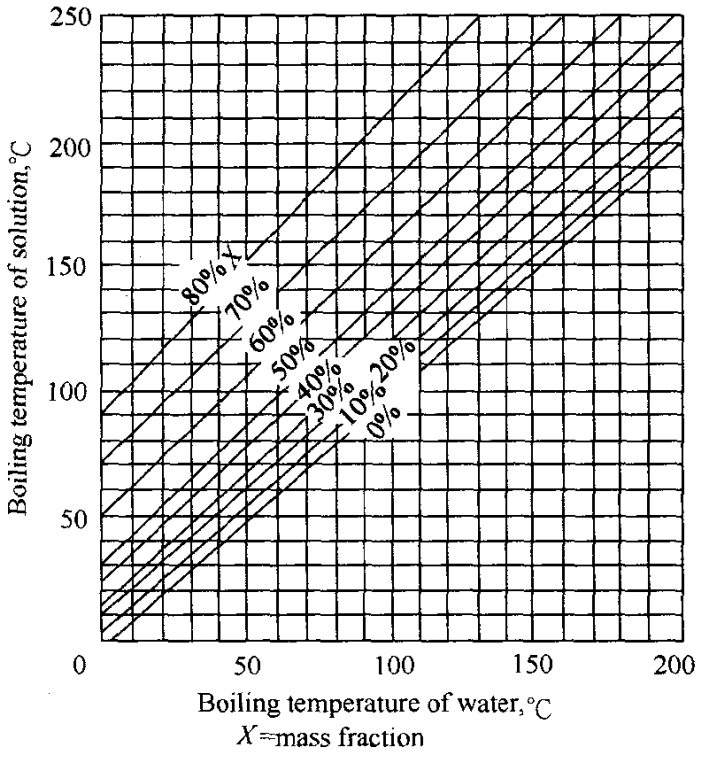

Fig. 5.10 Dühring lines, system sodium hydroxide–water.

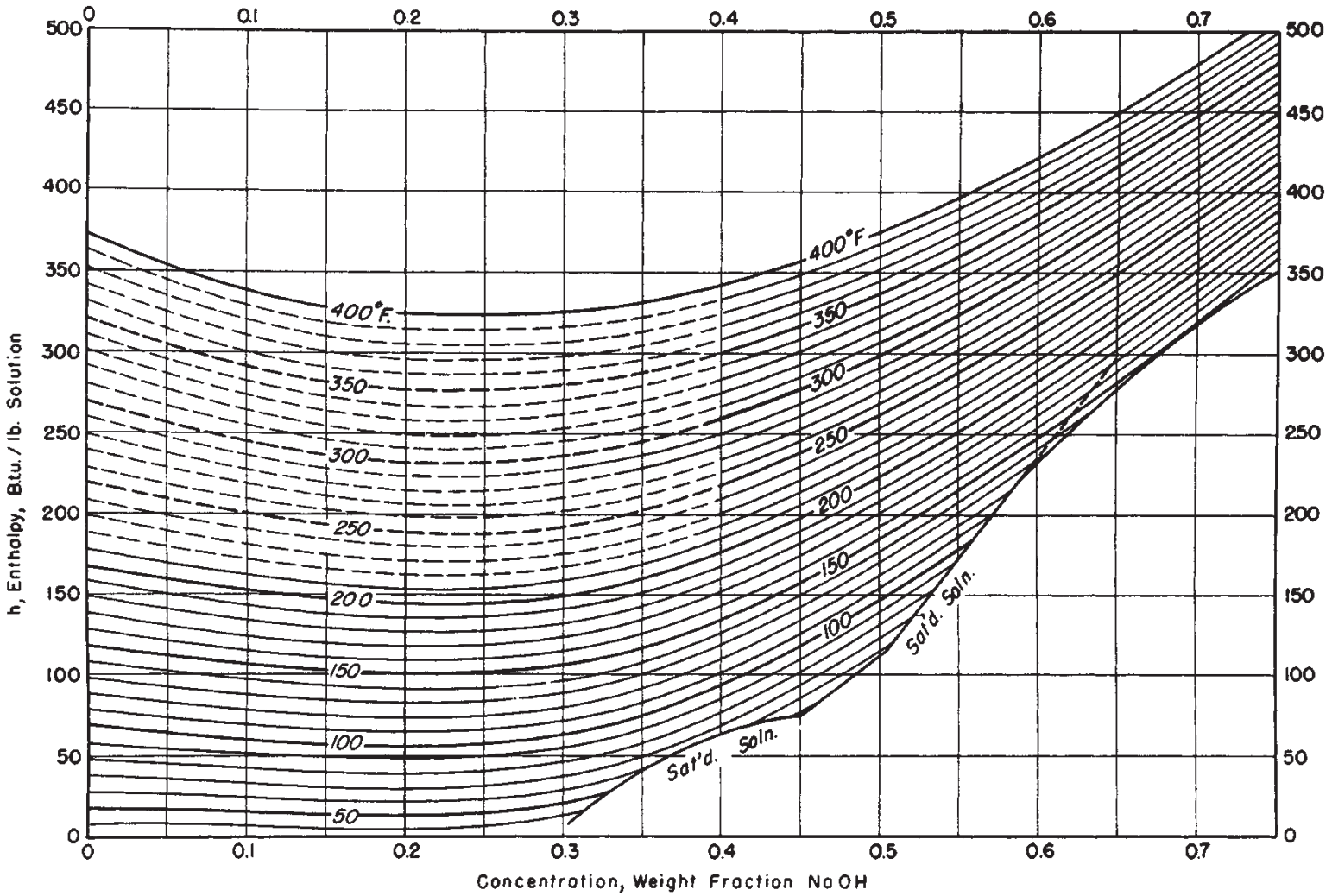

FIG. 2-29 Enthalpy-concentration diagram for aqueous sodium hydroxide at 1 atm. Reference states: enthalpy of liquid water at 32°F and vapor pressure is zero; partial molal enthalpy of infinitely dilute NaOH solution at 64°F and 1 atm is zero. [*McCabe,* Trans. Am. Inst. Chem. Eng., ***31,*** *129 (1935).*]