PED laboratory (S-2) Exercise-4 **07-03-2024**

1. A triple effect evaporator concentrates a 5% sucrose solution at the rate of 20000 kg/h to 25 % using steam at 2.5 atm absolute pressure. The feed is at 30^{O}C and a vacuum of 600 mm Hg is maintained in the last effect. The overall heat transfer coefficients corrected for BPEs for 1st, 2nd and 3rd effects are 2500, 2000, and 1800 W/m^{2}K, respectively. Calculate the heat transfer area required (assume equal areas in all three effects), steam economy and rate of steam consumption.
   Given specific heat capacity of feed = 3.9 kJ/kg^{O}C;
   Specific heat of the product = 3.15 kJ/kg^{O}C.

2. A triple effect evaporator concentrates a 5% glucose solution at the rate of 20000 kg/h to 30 % using steam at 2.5 atm absolute pressure. The feed is at 30^{O}C and a vacuum of 650 mm Hg is maintained in the last effect. The overall heat transfer coefficients corrected for BPEs for 1st, 2nd and 3rd effects are 2000, 1800, and 1500 W/m^{2}K, respectively. Calculate the heat transfer area required (assume equal areas in all three effects), steam economy and rate of steam consumption.
   Given specific heat capacity of feed = 3.5 kJ/kg^{O}C;
   Specific heat of the product = 3.1 kJ/kg^{O}C

3. A triple effect evaporator concentrates a 5% NaOH solution at the rate of 20000 kg/h to 25 % using steam at 2.5 atm absolute pressure. The feed is at 30^{O}C and a vacuum of 600 mm Hg is maintained in the last effect evaporator. The overall heat transfer coefficients corrected for BPEs for 1st, 2nd and 3rd effects are 2500, 1800, and 1400 W/m^{2}K, respectively. Calculate the heat transfer area required (assume equal areas in all three effects), steam economy and rate of steam consumption.
   Given specific heat capacity of feed = 3.5 kJ/kg^{O}C;
   Specific heat of the product = 2.9 kJ/kg^{O}C.

4. A triple -effect evaporator concentrates 10% fruit juice at the rate of 25000 kg/h to 40 % using steam at 2.5 atm absolute pressure. The feed is at 30^{O}C and a vacuum of 550 mm Hg is maintained in the last effect evaporator. The overall heat transfer coefficients corrected for BPEs for 1st, 2nd and 3rd effects are 2400, 1800, and 1500 W/m^{2}K, respectively. Calculate the heat transfer area required (assume equal areas in all three effects), steam economy and rate of steam consumption.
   Given specific heat capacity of feed = 4.0 kJ/kg^{O}C;
   Specific heat of the product = 3.5 kJ/kg^{O}C.

5. A triple effect evaporator concentrates a 5% sucrose solution at the rate of 20000 kg/h to 25 % using steam at 2 atm absolute pressure. The feed is at 30^{O}C and a vacuum of 600 mm Hg is maintained in the last effect evaporator. The overall heat transfer coefficients corrected for BPEs for 1st, 2nd and 3rd effects are 2400, 2000, and 1800 W/m^{2}K, respectively. Calculate the heat transfer area required (assume equal areas in all three effects), steam economy and rate of steam consumption.
   Given specific heat capacity of feed = 4.2 kJ/kg^{O}C;
   Specific heat of the product = 3.2 kJ/kg^{O}C.

6. A triple effect evaporator concentrates a 5 % glucose solution at the rate of 25000 kg/h to 35 % using steam at 2 atm absolute pressure. The feed is at 30^{O}C and a vacuum of 650 mm Hg is maintained in the last effect evaporator. The overall heat transfer coefficients corrected for BPEs for 1st, 2nd and 3rd effects are 25 00, 2000, and 1500 W/m^{2}K, respectively
   Given specific heat capacity of feed = 3.7 kJ/kg^{O}C;
   Specific heat of the product = 3.2 kJ/kg^{O}C.

7. A triple effect evaporator concentrates a 10% NaOH solution at the rate of 35000 kg/h to 30 % using steam at 2.5 atm absolute pressure. The feed is at 30^{O}C and a vacuum of 650 mm Hg is maintained in the last effect evaporator. The overall heat transfer coefficients corrected for BPEs for 1st, 2nd and 3rd effects are 2500, 2000, and 1400 W/m^{2}K, respectively. Calculate the heat transfer area required (assume equal areas in all three effects), steam economy and rate of steam consumption.
   Given specific heat capacity of feed = 3.9 kJ/kg^{O}C;
   Specific heat of the product = 3.2 kJ/kg^{O}C.

8. A triple -effect evaporator concentrates 10% fruit juice at the rate of 10000 kg/h to 30 % using steam at 2 atm absolute pressure. The feed is at 30^{O}C and a vacuum of 550 mm Hg is maintained in the last effect evaporator. The overall heat transfer coefficients corrected for BPEs for 1st, 2nd and 3rd effects are 2500, 2000, and 1800 W/m^{2}K, respectively. Calculate the heat transfer area required (assume equal areas in all three effects), steam economy, and rate of steam consumption.
   Given specific heat capacity of feed = 4.0 kJ/kg^{O}C;
   Specific heat of the product = 3.3 kJ/kg^{O}C.