

Solution

1. Select basis = 1 kg wet food product
2. Mass of water in inlet stream = 0.7 kg
3. Water removed in drying = $0.8(0.7) = 0.56$ kg/kg of wet food material
4. Write material balance on water,

$$\text{Water in dried food} = 0.7(1) - 0.56 = 0.14 \text{ kg}$$

5. Write balance on solids,

$$0.3(1) = \text{solids in exit stream}$$

$$\text{Solids} = 0.3 \text{ kg}$$

6. Thus, the dried food contains 0.14 kg water and 0.3 kg solids.

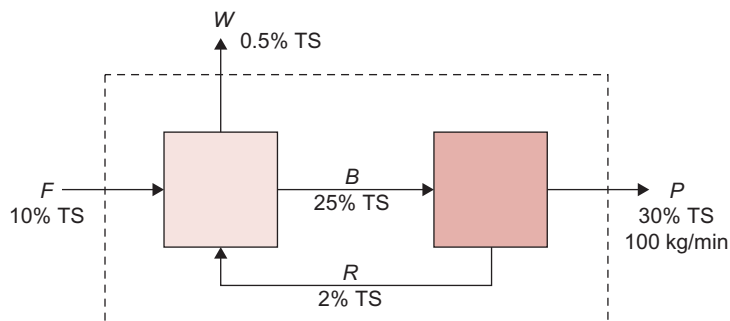
A membrane separation system is used to concentrate total solids (TS) in a liquid food from 10% to 30%. The concentration is accomplished in two stages with the first stage resulting in release of a low-total-solids liquid stream. The second stage separates the final concentration product from a low-total-solids stream, which is returned to the first stage. Determine the magnitude of the recycle stream when the recycle contains 2% TS, the waste stream contains 0.5% TS, and the stream between stages 1 and 2 contains 25% TS. The process should produce 100 kg/min of 30% TS.

Example 1.8**Given**

(Fig. E1.6)

Concentration of inlet stream = 10%

Concentration of exit stream = 30%



■ **Figure E1.6** A schematic arrangement of equipment described in Example 1.8.

Concentration of recycle stream = 2%
 Concentration of waste stream = 0.5%
 Concentration of stream between two stages = 25%
 Mass flow rate of exit stream = 100 kg/min

Solution

1. Select 1 min as a basis.
2. For the total system

$$F = P + W$$

$$Fx_F = Px_P + Wx_w$$

$$F = 100 + W$$

$$F(0.1) = 100(0.3) + W(0.005)$$

where x is the solids fraction.

3. For the first stage

$$F + R = W + B$$

$$Fx_F + Rx_R = Wx_W + Bx_B$$

$$F(0.1) + R(0.02) = W(0.005) + B(0.25)$$

4. From Step (2)

$$(100 + W)(0.1) = 30 + 0.005W$$

$$0.1W - 0.005W = 30 - 10$$

$$0.095W = 20$$

$$W = 210.5 \text{ kg/min}$$

$$F = 310.5 \text{ kg/min}$$

5. From Step (3)

$$310.5 + R = 210.5 + B$$

$$B = 100 + R$$

$$310.5(0.1) + 0.02R = 210.5(0.005) + 0.25B$$

$$31.05 + 0.02R = 1.0525 + 25 + 0.25R$$

$$4.9975 = 0.23R$$

$$R = 21.73 \text{ kg/min}$$

6. The results indicate that the recycle stream will be flowing at a rate of 21.73 kg/min.
-