

QUESTION:

How much steam is required to evaporate 627kg of water, when steam is saturated steam and 170C?

SOLUTION:

When steam is cooled down, it releases the heat

$$Q_{\text{steam}} = c_{\text{steam}} m_{\text{steam}} (T_{\text{steam,initial}} - T_0)$$

Here c_{steam} is specific heat of steam, $T_0 = 373.15 \text{ K}$ ($100 \text{ }^{\circ}\text{C}$).

When water absorbs this heat, its temperature decreases, and water boils.

The heat needed to evaporate water is

$$Q_{\text{water}} = c_{\text{water}} m_{\text{water}} (T_0 - T_{\text{water,initial}}) + L_{\text{water}} m_{\text{water}}$$

Here L_{water} is latent heat for evaporation of water. Let's assume, that the initial temperature of water is 293.15 K ($20 \text{ }^{\circ}\text{C}$). Hence

$$Q_{\text{steam}} = Q_{\text{water}}$$

$$c_{\text{steam}} m_{\text{steam}} (T_{\text{steam,initial}} - T_0) = c_{\text{water}} m_{\text{water}} (T_0 - T_{\text{water,initial}}) + L_{\text{water}} m_{\text{water}}$$

$$m_{\text{steam}} = \frac{4180 \cdot 627 \cdot (373.15 - 293.15) + 2260 \cdot 10^3 \cdot 627}{2080 \cdot (443.15 - 373.15)}$$

$$m_{\text{steam}} = 11172 \text{ kg}$$

ANSWER

$$m_{\text{steam}} = 11172 \text{ kg}$$