Question # 74827

2 kg of water is heated from 0°C to 100°C and converted into steam at the same temperature. Calculate the increase in entropy, given that specific heat of water is 4.18 × 10^3 J/kg/K and Latent heat of vaporisation is 2.27 × 10^7 J/kg .

Answer:

The increase in entropy for a process of heating up of a fluid is given by:

$$\Delta S_H = M c_p \ln \frac{T}{T_0},$$

where M = 2 kg – mass of water;

$c_p = 4.18 \cdot 10^3$ J/(kg·K) – specific heat of water;

T_0 = 0°C = 273°K – initial temperature of water;

T = 100°C = 373°K – final temperature of water.

The increase in entropy for a process of evaporation of a fluid is given by:

$$\Delta S_V = \frac{Mr}{T},$$

where M = 2 kg – mass of water;

r = $2.27 \cdot 10^7$ J/kg – latent heat of vaporisation;

T = 100°C = 373°K – temperature of vaporisation.

Thus, the increase in entropy of the whole given process equals to:

$$\Delta S = M \left(c_p \ln \frac{T}{T_0} + \frac{r}{T} \right),$$

$$\Delta S = 2 \cdot \left(4.18 \cdot 10^3 \cdot \ln \frac{373}{273} + \frac{2.27 \cdot 10^7}{373} \right) = 1.24 \cdot 10^5 \text{ J/K}.$$