(HT1-4) Latent Heat of Fusion of Ice

Aim of experiment

Determination of latent heat of fusion of ice.

Apparatus

Copper calorimeter in water insulating jacket, Ice cubes at 0oC, Scale, Water, Thermocouple attached to the water jacket.

Theory of experiment

A substance often undergoes a change in temperature when energy is transferred between it and its surroundings. There are situations, however, in which the transfer of energy does not result in a change in temperature. This is the case whenever the physical characteristics of the substance change from one form to another; such a change is commonly referred to as a phase change. Two common phase changes are from solid to liquid (melting) and from liquid to gas (boiling).

If a quantity Q of energy transfer is required to change the phase of a mass m of a substance, the ratio L = Q/m characterizes an important thermal property of that substance. Because this added or removed energy does not result in a temperature change, the quantity L is called the latent heat of the substance. The value of L for a substance depends on the nature of the phase change, as well as on the properties of the substance. From the definition of latent heat, and again choosing heat as our energy transfer mechanism, we find that the energy required to change the phase of a given mass m of a pure substance is

$$Q = mL$$

Latent heat of fusion L_f is the term used when the phase change is from solid to liquid (to fuse means "to combine by melting"), and latent heat of vaporization L_v is the term used when the phase change is from liquid to gas (the liquid "vaporizes").

Latent heat of fusion: is defined as the quantity of heat per unit mass that must be supplied to a material at its freezing point to convert it completely to a water at the same temperature.

Ice cubes, of mass m_{ice}, at initial temperature, 0oC are mixed with given mass of water, m_w in a calorimeter of mass, mc at initial temperature, T_i. The temperature of the mix will decrease until an equilibrium temperature is reached, T_f.

In such case, the heat lost by water and calorimeter is gained by ice cubes that are diffused completely to water at the same temperature, due to latent heat of fusion, and to ice diffused water until thermal equilibrium is attained, at T_f.

According to the law of conservation of heat energy:

Heat gained by ice cubes = Heat lost by water and calorimeter

$$m_{ice} L_f + m_{ice} C_w (T_f - 0) = (m_w C_w + m_c C_c)(T_f - T_i)$$

Where Cw ($=4200\ Jkg^{-1} K^{-1}$) is the specific heat capacity of water, Cc is the specific heat capacity of calorimeter and, L_f, is the latent heat of fusion, that can then be calculated if all other quantities are known.

Procedure

1. Weigh the calorimeter (m_c) and then fill it about one-half with water, and reweigh to find the mass of water (m_w).
2. Note the temperature of the water and calorimeter T_i.
3. Weigh the ice cubes (m_{ice}) .
4. Drop gently the ice cubes in the calorimeter and cover by its lid, and wait until equilibrium is reached, and note the final temperature T_f.
5. Repeat the above steps 3 times and find T_i and T_f in each case.
6. Calculate the average latent heat of fusion of ice.

Results

Mass of calorimeter m_c = ……... . Kg
Mass of water m_w = ……... . kg
Mass of ice m_{ice} = ……... . kg
Sp. Heat of calorimeter C_c= …… $Jkg^{-1} K^{-1}$
Sp. Heat of water C_w =…….. $Jkg^{-1} K^{-1}$

Trial	m_w	T (°c)	T (°c)	m_{ice}	Lf ($J.kg^{-1}$)
1					
2					
3					

Average latent heat of fusion L_f = ………… $J.kg^{-1}$

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