The Sixth Experiment

THE APPARENT EXPANSION COEFFICIENT OF WATER

The Objective of the experiment:

To calculate the apparent expansion coefficient of water

The Used Equipments:

- Heating water basin.
- Density bottle.
- Thermometer.
- Balance.

The Theoretical Part:

When the density bottle filled with water is heated at a temperature (t1), the excess water will spill out of the bottle as a result of the expansion of the water volume. The (apparent) volumetric expansion coefficient for any liquid is defined by:

$\beta = \Delta V / V_0 \Delta t$ …….(1)

where (ΔV) the change in the volume of the liquid when its temperature changes (Δt) and (V_0) the original volume of the liquid.
So if we assume the mass of the bottle when it is empty, m_0, and its mass when it is filled with water at a temperature of (t_1) = m_1, and if this bottle is heated to a temperature (t_0) and then left to cool to a temperature (t_1), and assume that its mass with the remaining water = m_2 , then the volume of water at temperatures (t_2 and t_1), respectively is as follows:

$V_{t1} = m_1 - m_0 / \rho_1$
$V_{t2} = m_1 - m_0 / \rho_2$

After cooling to a temperature (t_1)
$V_{t1} = m_1 - m_0 / \rho_1$
Substituting into equation (1), we get:

$\beta = m_1 - m_2 / (m_1 - m_0)(t_2 - t_1)$……. (2)

$\Delta V = V_{t1} - V_{t2}$

where, in general, β depends on the temperature.

The Theoretical Part:

1. Find the mass of the density bottle with the lid when it is empty, and let it be m_0 in kg.
2. Fill the bottle with distilled water up to its nozzle so that the water comes out from the stopper nozzle, then make sure that there are no air bubbles inside the bottle and the stopper, then find the mass of the bottle filled with water and let it be m1 in kg.
3. Place the density bottle in a water basin at temperature t_1.
4. Heat the water basin to a temperature of (t_1 + 5) Celsius, then find the mass of the bottle with the remaining water and dry it from the outside and let it be m_2 in kg.
5. Add hot water from the basin to the bottle using a dropper and then place it in the basin again.
6. Raise the temperature of the water basin to (t_1 + 10) Celsius and raise the bottle after making sure that the temperature is stable, then dry it and find its mass with the remaining water in it and let it be m_3 in kg.
7. Repeat the steps (4 and 5) at temperatures (t_1 + 15), (t_1 + 20) and (t_1 + 25) respectively.
8. Calculate the apparent expansion coefficient (β) according to equation (2).
9. Draw a graph between (β) and temperatures (t) and then discuss it.

Example:

Find the apparent expansion coefficient of water if you know that if the mass of the density bottle before heating it is 568.5 grams and the temperature is 26 degrees Celsius and the mass of the bottle after heating is 68.32 grams and its temperature is 45 degrees Celsius, knowing that the mass of the bottle while it is empty is 43 grams?

Solution:

$\beta 1 = m_1 - m_2 \,/\, (m_1 - m_0)(t_2 - t_1)$

$\beta 1 = 68.55 - 68.32 \,/\, (68.5 - 43)(45 - 26)$

$= 0.22 / 485.45$

$= 0.00047378 \ c^{-1}$

Assignment:

Find the following:

1. Compare the apparent coefficient of expansion for three cases
2. Find β2 and β3 if you know the following :

m_1	t_1`	m_2	t_2
68.32	**45**	**68.08**	**65**
68.08	**65**	**67.54**	**85**