Title

The First Law of Thermodynamics

I – Open System (Kettle)

Objective

To determine the rate of heat transferred and performance of a kettle

Apparatus

1. Kettle (2 litre without automatic switch)
2. One Thermocouple with Temperature Reader
3. Weighing scale (capacity 2kg with resolution 0.001kg)
4. Timer
5. Clamp meter (watt meter)

Theory

A simple yet convincing example of an open system is a kettle. The first law of thermodynamics can be applied to a kettle to obtain the steady flow energy equation or in short SFEE. It can be written as follows:

$$\square - \square = \square(h_2 - h_1) + 1/2\square(\ V_2^2\ -\ V_1^2\ ) + \square\square(\square_2 - \square_1)$$

Where,

Q = rate of heat transferred

W = rate of work done or power

$\square(h_2 - h_1)$ = rate of enthalpy change

$1/2\square(\ V_2^2\ -\ V_1^2\ )$ = rate of change in kinetic energy

$\square\square(\square_2 - \square_1)$ =rate of change in potential energy

Kinetic energy and Potential energy of boiling water can be simplified as follows if the work is not present, $\square = \square(h_2 - h_1)$.

Whereas, by using water as the fluid medium, equation above can be expressed as: $\square = \square\square\square\square T$

According to the equation above, the temperature rise of the water is because of the heat transfer which is supplied to the water. Using mass flow rate as m/t, the equation now can be expressed as,

$\square = \square\square\square\square/t$

Where; m = mass of water

$\square\square$ = average specific heat of water