Thermodynamics 2nd Summary

First law of thermodynamics

The first law of thermodynamics is the application of the law of conservation of energy.

The principle of conservation of energy proves that energy can only be transformed or the net energy transferred is equal to the change in internal energy.

Closed system

Consider an adiabatic closed system (where heat does not cross the boundary) .when provided with an external work the system eventually heats up due to rise in temperature brought about by transformation of work done into heats

$$\Delta U = Q - W$$

$$\Delta U = (Q_{in} - Q_{out}) - (W_{in} - W_{out}) \ldots \ldots \ldots \ldots \ldots (1)$$

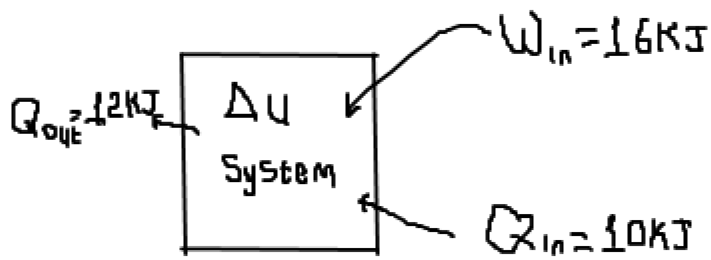
$$If\ \Delta \mathrm{U} = 0 \qquad 0 = \mathrm{Q} - \mathrm{W} \qquad \mathrm{Q} = \mathrm{W}$$

$$It\ can\ be\ deduced\ that\ when\ \Delta U = 0 \qquad Q_{in} = W_{out} \qquad and\ \ Q_{out} = W_{in}$$

Energy Transferred

1. Determine the change in internal energy of a closed system that receive a staff work of 16 kJ, a heat of 10 kJ and loses 12kJ of heat.

   <u>Solution</u>



For this case we can see that $W_{out} = 0$

From eqn 1 $\Delta U = (Q_{in} - Q_{out}) - (W_{in} - W_{out})$

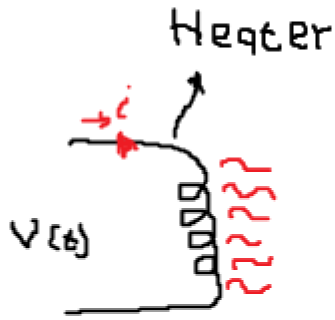
$$\Delta U = (10 - 12) - (0 - 16)$$

$$\Delta U = -2 + 16 = 14KJ$$

2. State the energy interactions occurring at the boundaries of the following systems.
   i. electric heater and its surrounding
   ii. a well-insulated room containing a room heater
   iii. a cooking pot

<u>Solution</u>

i. taking the metallic walls of the heater as the system boundary the energy interaction can be seen to be



- electric energy from a source (work)
- heat loss to the surrounding (Heat)

ii. when an insulated room is consider as the system instead we have Work input in the form of electric current only since the room is an adiabatic system the work input will only increase the internal energy of the room (no heat transfer since it is an insulated room (adiabatic)).

iii. a cooking pot
   - receives heat input from stove or cooker
   - loses heat to the surrounding by virtue of its metallic boundaries
   - No work interaction.

3. using the first law of thermodynamics determine if the following process is possible

a water pump that consume 2 kw of electric power when operating is claimed to take in water from a lake and pump it to a pool whose free surface is 30 m above the free surface of the lake at the rate of 50 L/s.

<u>Solution</u>

We have the work input

$$\dot{win} = 2kw \quad note\ that\ work\ in\ as\ a\ rate\ of\ work\ (\dot{win})$$

First law requires that the power taken by the pump should be equal to the output work. In this case is the work done in pushing 50L/s of water to a height of 30m is given by:

$$w_{in} = \dot{m}gh$$

$$\rho = \frac{\dot{m}}{\dot{v}} \qquad \dot{m} = \rho\dot{v} \qquad \rho = 1000kg/m^3 \quad for\ water\ \text{(Constant)}$$

$$\dot{m}gh = \rho\dot{v}\,gh = 1000 \times 50 \times 10^{-3} \times 9.81 \times 30 = 14.7kw$$

$$2kw \neq 14.7kw$$

Hence the process is impossible.

Solution to 2years Pastquestion Paper Will Be Solved and Uploaded On Smartbukites. Latest 11th Week of the Semester

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