THERMODYNAMICS

Thermodynamics is the branch of physics that deals with the relationships between heat and other forms of energy. In particular, it describes how thermal energy is converted to and from other forms of energy and how it affects matter.

In examining engineering processes, we are concerned mostly with a macroscopic view. The branch of thermodynamics that deals with this macroscopic approach is called *classical thermodynamics*. Another branch of thermodynamics, called *statistical thermodynamics*, is concerned with what happens at a molecular level, and the average behavior of a group of molecules is considered.

Thermodynamics also helps us in determining the potential that defines and determines the equilibrium. By knowing potential, we can determine the direction a process will undertake. Although thermodynamics may not tell us how long a process will take to arrive at its final state, it does help in determining what the final state will be. Thus, time is not a thermodynamic variable,

LAWS OF THERMODYNAMICS

1.16.1 First Law of Thermodynamics

The first law of thermodynamics is a statement of the conservation of energy. The law states:

The energy of an isolated system remains constant.

Stated in other words,

Energy can be neither created nor destroyed but can be transformed from one form to another.

Energy can be either stored within an object or transferred to another one, such as in the form of thermal or mechanical energy. If we increase the elevation of an object, its potential energy will increase.

The increased potential energy will remain stored in the object until we move it again. Similarly, we can increase the thermal energy of an object by transferring heat into it and observing an increase in temperature.

Energy can also be transformed from one form to another. For example, in a hydroelectric plant, as water falls from a high elevation onto the blades of a turbine, the potential energy of water is converted into mechanical energy in the turbine, and the generator then converts the mechanical energy into electrical energy. The electrical energy is transmitted to homes or factories where it is further converted to other useful forms such as thermal energy in electric heaters.

During the energy conversion or transmission processes, there is also generation of heat, often misstated as “loss” of energy, when it is actually conversion of energy to other forms that may not be directly useful for the intended purpose. For example, when electrical energy is converted into mechanical energy in an electric motor, the energy “loss” may be 10 to 15%. The “loss” in this case is the conversion of part of the electrical energy into heat due to friction. Although we can convert all mechanical energy into heat because all processes are assumed reversible, we cannot convert all heat into work, as will be evident when we consider the second law of thermodynamics.