

## THERMODYNAMICS AND HIS APPLICATION AREAS

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**ABSTRACT :** Thermodynamics is a subject that deals with energy, which is essential for sustenance of life, and has long been an essential part of engineering curricula all over the world. It has a broad application area ranging from microscopic organisms to common household appliances, transportation vehicles, power generation systems and even philosophy.

**KEY WORDS :** thermodynamics, principle, application.

### 1. INTRODUCTION

Thermodynamics can be defined as the science of energy. Although everybody has a feeling of what energy is, it is difficult to give a precise definition for it. Energy can be viewed as the ability to cause changes.

The name thermodynamics stems from the Greek words therme (heat) and dynamis (power), which is most descriptive of the early efforts to convert heat into power. Today the same name is broadly interpreted to include all aspects of energy and energy transformations, including power generation,

refrigeration, and relationships among the properties of matter.

One of the most fundamental laws of nature is the **conservation of energy principle**. It simply states that during an interaction, energy can change from one form to another but the total amount of energy remains constant. That is, energy cannot be created or destroyed. For example, a rock falling off a cliff, picks up speed as a result of its potential energy being converted to kinetic energy (figure 1).

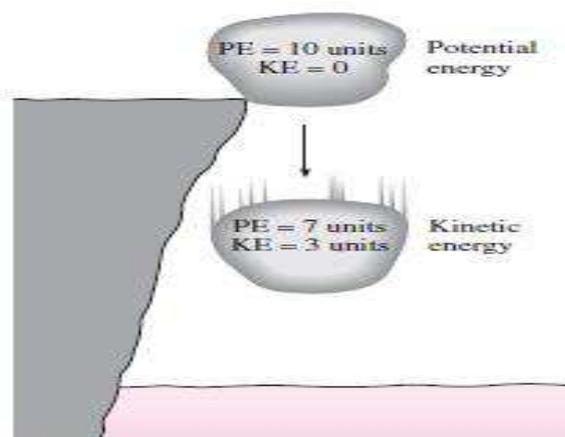


Figure 1 The first law of thermodynamics

The conservation of energy principle also forms the backbone of the diet industry: A person who has a greater energy input (food) than energy output (exercise) will gain weight

(store energy in the form of fat), and a person who has a smaller energy input than output will lose weight (figure 2).

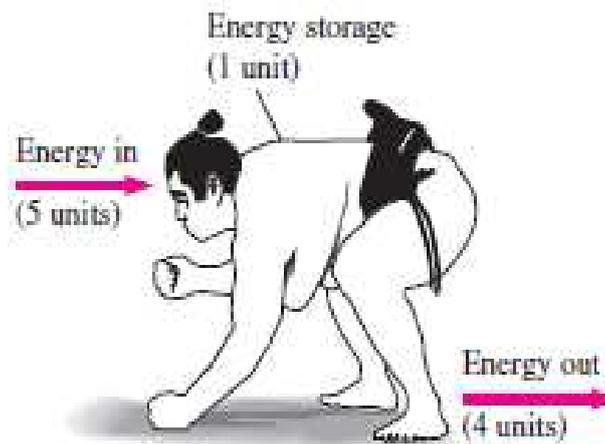


Figure 2 Conservation of energy principle for the human body

The change in the energy content of a body or any other system is equal to the difference between the energy input and the energy output, and the energy balance is expressed as  $E_{in} - E_{out} = \Delta E$ .

The **first law of thermodynamics** is simply an expression of the conservation of energy principle, and it asserts that energy is a thermodynamic property.

The **second law of thermodynamics** asserts that energy has quality as well as quantity, and actual processes occur in the direction of decreasing quality of energy.

For example, a cup of hot coffee left on a table eventually cools, but a cup of cool coffee in the same room never gets hot by itself ( figure 3).



Figure 3 Heat flows in the direction of decreasing temperature

The high-temperature energy of the coffee is degraded (transformed into a less useful form at a lower temperature) once it is transferred to the surrounding air.

Although the principles of thermodynamics have been in existence since the creation of the universe, thermodynamics did not emerge as a science until the construction of the first successful atmospheric steam engines. These engines were very slow and inefficient, but they opened the way for the development of a new science.

The first and second laws of thermodynamics emerged simultaneously in the 1850s, primarily out of the works of William Rankine, Rudolph Clausius, and Lord Kelvin. The term thermodynamics was first used in a publication by Lord Kelvin in 1849. The first thermodynamic textbook was written in 1859 by William Rankine, a professor at the University of Glasgow.

It is well-known that a substance consists of a large number of particles called molecules. The properties of the substance naturally depend on the behavior of these particles. For example, the pressure of a gas in a container is the result of momentum transfer between the molecules and the walls of the container. However, one does not need to know the behavior of the gas particles to determine the pressure in the container. It would be sufficient to attach a pressure gage to the container. This macroscopic approach to the

study of thermodynamics that does not require a knowledge of the behavior of individual particles is called **classical thermodynamics**. It provides a direct and easy way to the solution of engineering problems. A more elaborate approach, based on the average behavior of large groups of individual particles, is called **statistical thermodynamics**. This microscopic approach is rather involved and is used in this text only in the supporting role.

## APPLICATION AREAS OF THERMODYNAMICS

Thermodynamics is commonly encountered in many engineering systems and other aspects of life. The heart is constantly pumping blood to all parts of the human body, various energy conversions occur in trillions of body cells, and the body heat generated is constantly rejected to the environment. The human comfort is closely tied to the rate of this metabolic heat rejection. We try to control this heat transfer rate by adjusting our clothing to the environmental conditions.

Other applications of thermodynamics are right where one lives. An ordinary house is, in some respects, an exhibition hall filled with wonders of thermodynamics ( figure 4).



Figure 4 Solar hot water system, involves thermodynamics

Many ordinary household utensils and appliances are designed, in whole or in part, by using the principles of thermodynamics. Some examples include the electric or gas range, the heating and air-conditioning systems, the refrigerator, the humidifier, the pressure cooker, the water heater, the shower,

the iron, and even the computer and the TV. Thermodynamics plays a major part in the design and analysis of automotive engines, rockets, jet engines, and conventional or nuclear power plants, solar collectors, and the design of vehicles from ordinary cars to airplanes ( figure 5).

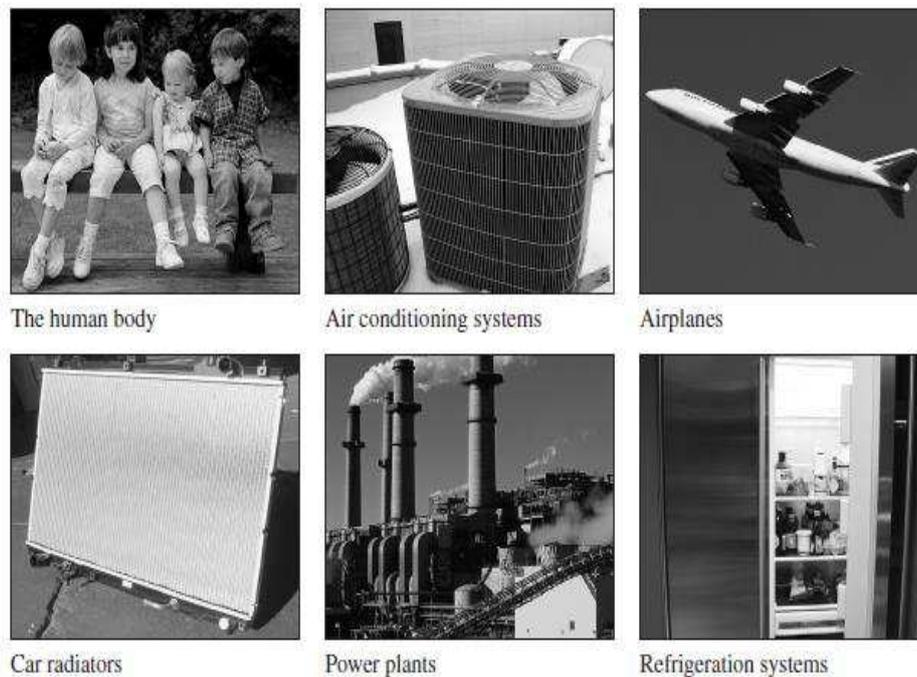


Figure 5 Application areas of thermodynamics

## CONCLUSIONS

The energy-efficient home that you may be living in, is designed on the basis of minimizing heat loss in winter and heat gain in summer. The size, location, and the power input of the fan of your computer is also selected after an analysis that involves thermodynamics.

All activities in nature involve some interaction between energy and matter; thus, it is hard to imagine an area that does not relate to thermodynamics in some manner. Therefore, developing a good understanding of basic principles of thermodynamics has long been an essential part of engineering education.

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