Chapter 1
Introduction

1.1 Mechanics and thermodynamics:

One of the oldest attempts to describe the motion of particles is done by Newtons three laws which , describesthe motion of any particle which can be seen by nacked eye.

The discovery of atom later on makes it difficult to use Newtons laws to describe the behavior of aggregated of atom. One of the earliest applications, which need understanding the behavior of a large number of atoms, is the behavior of gases in composition engines.

The behavior of the gases was described by the so called kinetic theory of gases. This theory is based on Newtonian mechanics and the relation between temperature and kinetic energy of atoms.

Later on the kinetic theory is promoted to the so called thermodynamics. The laws of thermodynamics define new physical quantities that can describe the behavior of thermal dynamical system.

The most widely used and popular ones are the internal energy and the entropy. The concept of internal energy relates the kinetic energy of atoms and modules to the temperature. While the entropy measures the degree of temperature disorder in any system.

1.2 Research problem:

The laws of thermodynamic are concerned with ideal systems in which friction and potential energy does not exist.

Practicaly in many systems friction and fields’ plays an important role, thus one needs new thermodynamical laws to account for these effects.

1.4 Aim of the work:

The aim of this work is to modify the first law of thermodynamics to incorporate the effect of friction and potential with in the system.

1.5 Presentation of the thesis:

The thesis consists of three chapters. Chapter one is the introduction. The title of chapter two is the first law of thermodynamics. Chapter three is concerned with the contribution of the study.

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Chapter 2

Energy and the first law of thermodynamics

2.2 Energy concept:

The first law deals with macroscopic properties, work, energy and entropy. One of the most fundamental laws of nature is the conservation of energy principle. Its simply states that; during interaction, energy can change from one form to another but the total amount of energy remains constant or alternatively during an interaction between a system and its surrounding, the amount of energy gained by a system must be exactly equal to the amount of energy lost by the surroundings.

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

Energy can cross the boundary of a closed system in two distinct forms, heat (electromagnetic radiation) and work. It's important to distinguish between these two forms of energy.

We can use the principle of conservation of energy to define a function (U)called the informal energy. When closed system undergoes a process by which it passes from state(A) to state (B), if the only interaction with its surroundings is in the form of transfer of heat (Q) to the system, or performance of work (W) on the system, the change in (U) will be :

Equation (2.2.1) define (W) as the work done on the system and(Q) is added to the system. if (W) work done by the system, equation (2.2.1) would become.

For an isolated system there is no heat or work transferred from the surroundings, thus: W=Q

The first law of thermodynamics states that this energy difference (ΔU) depends only on the initial and final states, and not on the path followed between them. Both (Q) and (W) have many possible values depending on exactly how the system passes from(A) to (B), but $Q+W = \Delta U$ in invariable and independent of the path. If this were not true, it would be possible, by passing from A to B along one path and then returning from B to A along another, to obtain a net change in the energy of the closed system in contradiction to the principle of conservation energy.

For differential change, equation (2.2.1) becomes:

$$dU = dQ + dW \qquad (2.2.4)$$

for reversable process, A —— —— B A, when the system returns to state A, it has same U, thus:

2.3 Heat transfer:

Heat is define as the form of energy that is transferred between two systems (or a system and its surroundings) by virtue of a temperature difference. That is an energy interaction is heat only if it takes place because of a temperature difference.

Heat is energy in transition. It is recognized only as it crosses the boundary of a system.

One in the surrounding, the transformed heat becomes part of the internal energy of the surroundings. Thus in thermodynamics, the term heat simply means heat transformer. A process during which there in no heat transfer is called adiabatic process. There are two ways a process can be adiabatic:

Either a system is well insulated so that only a negligible amount of heat can pass through the boundary, or both the system and the surrounding are at the same temperature and therefore there is no driving force for heat transfer.

2.4 Work:

Work, like heat, is an energy interaction between a system and its surroundings. As mentioned earlier, energy can cross the boundary of a closed system in the form of heat or work. Therefore, if the energy crossing the boundary of a closed system is not heat, it must be work.

Heat transfer and work are interactions between system and its surroundings, and there are many similarities between the two. First of all both are recognized at the boundaries of the system as they cross them. That is both heat and work are boundary phenomena. Secondary the system passes energy, but not heat or work. That is, heat and work are transfer phenomena. Thirdly both are associated with a process, not state. Unlike properties, heat or work has no meaning at state.

2.5 Energy forms of working substance:

Working substance is heat engines producing power involve a working substance. A fluid in which energy can be stored or transmit is called a working substance as a liquid, gas, or vapor they offer little resistance to deformation energy.

Energy means a certain something that appear in many different forms that are related to each other by the fact that conservation can made from one to another.

2.6 Internal Energy:

Consider a gas in a follow cylinder closed on its upper end by a movable piston, is heated by supplying heat to it by heat source. If the piston is kept fixed and firmed, the heat gained by the gas does not move the piston, thus does not change the gas volume. This means that no work is done, i.e.:

$$dW = Pdv = 0 \qquad (2.6.1)$$

where $dv = 0$

The heat gained by the gas increases kinetic energy of the gas molecules. This gy random motion increases the friction of the molecules with hands, when touch the gas. This strong friction and collision of particles with our skin gives a feeling of hotness. One can immediately decide that heat gives by the heat source increases the temperature (T), i.e.

$$dQ = dU = CdT \qquad (2.6.2)$$

where :

$dQ \equiv$ heat given to the gas

$dU \equiv$ increase of the internal energy of the gas

$C \equiv$ gas specific heat

$dT \equiv$ increase of the temperature of the gas

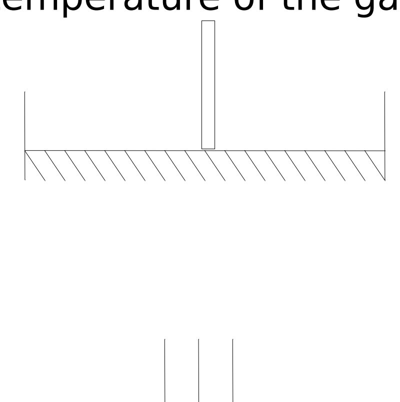

Fig (2.1) gas in a cylinder

The relation between the kinetic energy of the molecule (Ke) and temperature T, is straight forward from the kinetic theory of gases, where

M,v,k are the molecular mass and velocity, where k is the Boltezman constant respectively .

Chapter 3
The first law of thermodynamics on the basis
of plasma and fluid equations

3.1 Introduction:

The conventional first law of thermodynamics suffer from not recognizing many energy forms. A wide variety of applications, like the thermodynamic properties of supper conductors, shows the need to modify this law. This chapter is devoted to use fluid plasma equations to promote the first law of thermodynamics.

3.2 Plasma Equation and new energy relation:

Consider a fluid of mass density (), which is given by:

(3.2.1)

Where (m) stands for particle mass,(n) is the particles density, the equation of motion for a fluid subjected to pressure frictional force (F), and potential is given by:

(3.2.2)

Changing the speed differential form time to spatial it, yields:

(3.2.3)

Restricting to one dimension, and defining the frictional force in terms of work, in the form:

(3.2.4)

Equation (3.2.3) in the x – direction, with the aid of equation (3.2.4) in the form

(3.2.5)

Since the total number of particles (N) in a volume (V) can be stand for the number

Thus equation (3.2.5) can be rewritten in the form:

Thus

The pressure (p) can be assumed to be thermal ($P_{t)}$ and mechanical pressure ($P_{m)}$, where

$P_tV = NkT$ $P_t = nkT$

M = Nm

$P = P_t + P_m$

(3.2.8)

The kinetic energy (Ke), internal energy (U), resistive sheer energy ($W_{r)}$, and potential energy (V) are given by:

Thus using equations (3.2.8)& (3.2.9) one gets.

$$W_m + Ke + U + W_r + V_p = C_1 \qquad (3.2.10)$$

This constant of motion can be defined to respect the total energy (E) of the system.

$$E = Ke + V_p + U + W_r + W_m \qquad (3.2.11)$$

3.3 The first law of thermodynamics:

The first law of thermodynamics relates the heat delivered to the system to the mechanical work done .i.e.

$$dQ = dE \qquad (3.3.1)$$

This means that the heat added increases the energy of the system, while the heat librated from the system decreases the energy.

According to equations (3.2.11) and (3.3.1)

$$dQ = dU + dW_m + dKe + dV_p + dW_r \qquad (3.3.2)$$

The mechanical work is given by (pdv) thus :

$$dQ = dU + PdV + dKe + dV_p + dW_r \qquad (3.3.3)$$

It is very interesting to note that when one neglects friction, potential and kinetic energy

$$dW_r = 0 \qquad dV_p = 0 \qquad d\,Ke = 0 \qquad (3.3.4)$$

In this case equation (3.3.3) reduces to :

$$dQ = dU + PdV \qquad (3.3.5)$$

Which is the ordinary conventional first law of thermodynamics. The difference between the new and ordinary first law can be checked when a dense water vapour is put in a frictional cylinder with a piston. When the piston move up ward after being supplied by an amount of heat (dQ) the mechanical work done is given according to equation (3.3.3) by

$$dW = PdV = dQ - dU - dV_p - dW_r$$

$$= dQ - CdT - dV_p - dW_r \qquad (3.3.6)$$

This expression is quite natural as far as the frictional term (dW_r), decreases work as far as friction apposes motion, the gravity force also decreases the fact that gravity force pulls particles downwards.

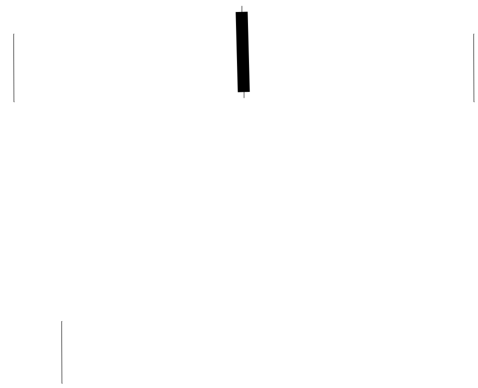

Fig (3.1) : A cylinder consisting of a frictional piston

3.4 Discussion

The plasma equations in section (3.2) are utilized to find the constant of motion by expressing, kinetic term or the left hand side of equation (3.2.2) and the frictional force term as differential functions of coordinate (x).

The constant of motion in equation (3.2.7) consist of kinetic energy beside potential energy. Thus it is quite natural to consider this constant of motion as representing the total energy of the system.

The second term in equation (3.2.7) thus stands for energy resulted from pressure. The pressure is split into two terms. One is the thermal pressure energy which is shown to be related to the internal energy according to equation (3.2.9).

The mechanical pressure energy (W_m) is shown to be related to the work done on or by the system as shown by equations (3.3.2) and (3.3.3).

The third term in (3.2.7) stands for frictional energy which is important to be considered in any physical system.

Thus the new first law of thermodynamics (3.3.2) states that the heat energy given to the thermodynamics system can be converted to internal energy, work, kinetic, potential and frictional energy, This equation reduce to the ordinary first law of thermodynamic. This confirms the reality of this new expression.

This new expression can also be understood by physical intuition. The work done by a gas in cylinder for a moving piston mounted upward is different from that mounted downward. The forward work done is considerable less

Fig (3.2) : upward and down ward piston

than the later one. Since in the first case gas particles are dragged downward against the upward motion by the gravity effect, which decreases the work done.

In the second case gas particles are dragged down, under the effect of gravity, in the direction of motion. This increases the work done.

3.5 Conclusion:

This work shows the possibility of driving a new thermodynamic energy law, which accounts for the effect of friction and potential. This law is useful to describe, real physical systems in which the effect of friction and fields cannot be neglected.

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