Chapter NO.03

Reversible and Irreversible Processes

In the previous chapters the energy equations for non-flow and flow processes are derived, the concepts of reversibility and irreversibility introduced, and the properties of vapours and perfect gases discussed. It is the purpose of this chapter to consider processes in practice, and to combine this with the work of the previous chapters.

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(1) Reversible and Irreversible processes

The reversible process is an ideal process that never occurs in nature while the irreversible process is the natural process which is more commonly found in nature. It is a thermodynamic process which takes place in a closed system and has no fluid flow i.e flow work=0.

(2) Constant Volume Process

An isochoric process, also called a constant-volume process, an isovolumetric process, or an isometric process, is a thermodynamic process during which the volume of the closed system undergoing such a process remains constant.

(3) Constant Pressure Process

An Isobaric process is a thermodynamic process in which the pressure stays constant: $\Delta P = 0$. The heat transferred to the system does work, but also changes the internal energy of the system.

(4) Constant temperature or isothermal process

An isothermal process is a change of a *system*, in which the temperature remains constant: $\Delta T = 0$. This typically occurs when a system is in contact with an outside thermal reservoir (heat bath), In contrast, an adiabatic process is where a system exchanges no heat with its surroundings ($Q = 0$).

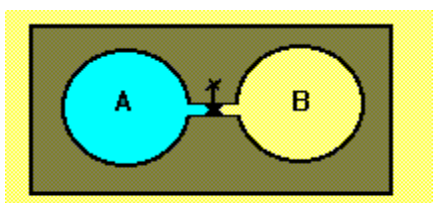
(5) Reversible adiabatic non-flow processes

Reversible adiabatic non-flow processes is also known as *isentropic process* and it is defined as the process which amount of transfer is zero means no heat transfers inside or outside of the system, it is isolated system.

(6) Polytrophic processes

The term "polytrophic" was originally coined to describe any reversible process on any open or closed system of gas or vapor which involves both heat and work transfer, such that a specified combination of properties were maintained constant throughout the process.

(07) Unresisted, or free, expansion



Consider two vessels A and B which are connected to each other by a pipe and a valve. Vessel A is initially filled with a fluid at a certain pressure and B is completely evacuated. By opening the valve, the fluid in the vessel A will expand until it fills both vessels. This process is known as free or unresisted expansion. It is an irreversible process because it needs external work to be done to restore the fluid to its initial condition. Consider a system, consisting of both vessels which is perfectly thermally insulated. Apply the first law of thermodynamics to the system, i.e.

$$Q + W = U2 - U1$$

where indices 1 and 2 represent initial and final states.
Q = 0, because the thermal insulation will not allow any heat transfer between the system and the surroundings. W=0 because the boundaries of the system are not moved. The result will then be:

$$U2=U1$$

The free expansion process is adiabatic but irreversible. If the working fluid is a perfect gas, then U2=U1 is equivalent to T2=T1.

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(08) Throttling

A **throttling process** is a **thermodynamic process**, in which the **enthalpy** of the gas or medium **remains constant (h = const)**. In fact, the **throttling process** is one of **isenthalpic processes**. During the throttling process **no work** is done by or on the system (dW = 0), and usually there is **no heat tranfer** (**adiabatic**) from or into the system (dQ = 0). On the other the throttling process cannot be isentropic, it is a **fundamentally irreversible process**. Characteristics of throttling process:

1. No Work Transfer
2. No Heat Transfer
3. Irreversible Process
4. Isenthalpic Process

(09) Adiabatic mixing

An **adiabatic process** occurs without transfer of heat or mass of substances between a thermodynamic system and its surroundings. In an adiabatic process, energy is transferred to the surroundings only as work

(10) Nonsteady-flow processes

It is a process during which a fluid flows through a control volume steadily. That is, the fluid properties can change from point to point within the control volume, but at any fixed point they remain the same during the entire process.

THE END