

Reversible & Irreversible processes

Q. Explain in brief 'reversible and irreversible processes'. Give two examples of each. What are the conditions for a process to be reversible?

Ans. - Reversible process: We consider a gas enclosed in a cylinder fitted with a frictionless piston, perfectly insulated from its surroundings so that no heat can leave or enter into it. Some removable weights are placed on the top of the piston and P_1, V_1, T_1 are the pressure, volume and temperature of the gas in the cylinder in the initial state.

The weights are now removed by very small amount at a time so that the piston moves outward very very slowly. The gas now expands adiabatically and the pressure and volume of the gas adjust themselves so that the system is always in thermodynamic equilibrium. In other words, the adiabatic expansion of the gas is quasi-static. The process of removing the weights in small steps is continued so that P_2, V_2, T_2 are the pressure, volume and temp. of the gas in ^{the} final state.

The weights are now replaced again in very small amounts at a time so that the piston moves inwards very very slowly. In other words the adiabatic compression of the gas is also quasi-static. The process of replacing the weights in small steps is continued till the gas reaches the initial state with P_1, V_1, T_1 as a pressure, volume & temp. During this process of adiabatic compression the gas would pass through exactly the same intermediate steps are retraced in the opposite directions. Such a process is known as a reversible process.

Hence, a reversible process is that which can be retraced in the opposite direction, so that the working substance passes through exactly the same condition as it does in the direct process.

Conditions : (i) For the process to be reversible, it should be carried out very very slowly so that the system remains in thermodynamic equilibrium at each stage of the process, i.e., the process is quasi-static.

- (ii) There should be no frictional forces present. It is not possible to realise these conditions in actual practice. Thus no process is reversible in the true sense of the word. However, some examples of reversible processes in practice are given below:

Examples: (1) Ice melts when a certain amount of heat is absorbed by it. The water so formed can be converted into ice if the same amount of heat is removed from it.

(2) Electrolysis.

Irreversible Process: If in the experiment described above the weights on the piston are removed quickly the gas will undergo sudden expansion so that the intermediate states will not be equilibrium states i.e. it will not be possible to define the values of pressure, volume and temp. for these states. Similarly, when the weights are replaced quickly the gas will undergo sudden compression and the values of pressure, volume and temp. for the intermediate states will again be not defined. Thus during the process of sudden compression

it will not be possible to reproduce the intermediate states through which the system passed during sudden expansion. Such a process is known as irreversible process.

Hence an irreversible process is that which cannot be retraced in the opposite direction so that the working substance does not pass through the same intermediate states through which it passes during the direct process.

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Examples : (1.) Work done against friction is irreversible. It is because in reversing the direction of motion again work has to be done against friction.

(2.) Heat produced by the passage of a current through a resistance is irreversible. It is because even when the current is reversed the same effect is observed.

(3.) Rusting of iron