Marwari college Darbhanga

Subject---physics (Hons)

Class--- B. Sc. Part 1

Paper---02 ; group----A

Topic--- Degradation of Energy and Clausius principle

(Thermal physics)

Lecture series—35

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Degradation of Energy

The available energy of a system decreases as its temperature or pressure decreases and approaches equilibrium to the surroundings. When the heat is transferred from a system, its temperature decreases and

hence the quality of its energy deteriorates. The degradation is more for energy loss may be the same, but quality wise the losses are different. While the first law states that energy is always conserved quantity wise, the second law emphasizes that energy always degrades quality wise. When a gas is throttled adiabatically from a high pressure region to low pressure region, the enthalpy (or energy per unit mass) remains constant, but there is a degradation of energy or available work. The same holds good for pressure drop due to friction of a fluid flowing through an insulated pipe. If the first law of thermodynamics is the law of conservation of energy, the second law of thermodynamics is also know as the *law of degradation of energy*.

The Second law of thermodynamics have many statements. It is also called as the Law of the degradation of the Energy.

It states that no Heat Engine in this whole Universe can have the efficiency equal to 100%, under Ideal Conditions. (when there will be no friction or any dissipating force).

This law states if energy is transferred to the system then whole energy cannot be converted to the work, some will move in the sink, which must be there for the flow of the heat.

Hence, there must be the loss of the energy to the sink without which the system cannot work. Thus, the energy is said to be degraded and Second law of the Thermodynamics also called as the Degradation of the energy.

Clausius principle

Rudolf Julius Emanuel Clausius, a German mathematician and physicist, is one of the central founders of thermodynamics science. There are a few important concepts introduced by Rudolf Clausius which are the theory of heat which is a restatement of the Carnot cycle. In the year 1850, he published a paper on “The Moving Force of Heat”. In 1865 he introduced entropy and virial theorem in the year 1870.

Clausius Statement from the second law of thermodynamics states that:

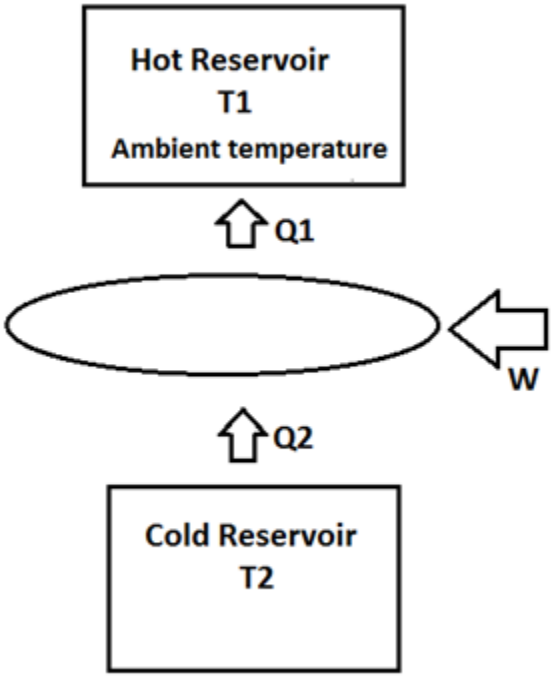
> “It is impossible to design a device which works on a cycle and produce no other effect other than heat transfer from a cold body to a hot body.”

That is, heat transfer can only occur spontaneously in the direction of temperature decrease. For example, we cannot construct a refrigerator that operates without any work input.

The heat engines that convert heat energy into work and its application in various fields of thermodynamics.

But refrigerator and heat pump that works on the opposite principle of a heat engine

Refrigerator



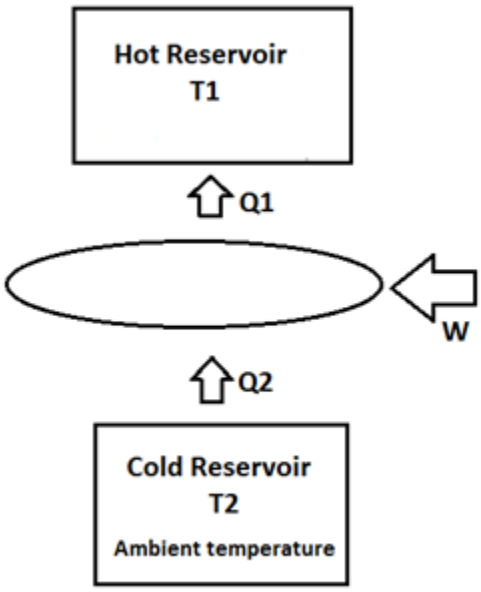
Working

In the refrigeration cycle, there are five basic components: a fluid refrigerant; a compressor, a condenser coil, an evaporator coil and an expansion device. The compressor constricts the refrigerant vapour, raising its pressure, and pushes it into the coils on the outside of the refrigerator. When the hot gas in the coils meets the cooler air temperature of the kitchen, it becomes a liquid. Now, in the liquid form at high pressure, the refrigerant cools down as it flows into the coils inside the freezer and the fridge. The refrigerant absorbs the heat inside the fridge, cooling down the air. Lastly, the refrigerant evaporates and then flows back to the compressor, where the cycle repeats itself.

Applications

- Separation of gases :- Separation of air into its constituents by fractional distillation as different components of air liquefies at different temperatures.
- Condensation of gases :-- In industries, gases such as ammonia are condensed before storage and shipment.
- Dehumidification of air :- Air is dehumidified by liquefying and separating the moisture present in it.
- Cooling for preservation :- Vegetables, organic-chemical and explosives are kept in cold storages for preservation.

Heat Pump



A heat pump is a mechanical compression cycle that can be reversed to either heat or cool a controlled space.

Working

A typical heat pump consists of two parts: an indoor unit called an air handler and an outdoor unit similar to an air output unit. A compressor circulates a refrigerant that absorbs and releases heat as it travels between these two units. Here, the working fluid or the refrigerant (in its gaseous state) is pressurized by a compressor and circulated through the system. The process of compression makes the fluid hotter. The hot and pressurized vapour, on the discharge side of the compressor, is cooled in a heat exchanger called a

condenser, until it condenses into a high pressure, moderate temperature liquid. The pressure of the condensed fluid is reduced using a pressure lowering devices such as a capillary tube or an expansion valve. The temperature of the low-pressure liquid is increased in a heat exchanger after which the refrigerant is made to return to the compressor and the cycle is repeated.

Applications

- Space heating: -Heat pump is used to heat an enclosed area such as a workspace, greenhouses and houses.
- Water heating:-- Water in industries and household is heated using heat recovered from other reactions using the heat pump.
- Process heating:- In industries, the heat pump is used to heat the process fluid before the reactions.
- Heat recovery :-Heat pump is used to recover process heat from other reactions.