Refrigerators: reservoirs and sinks, external forces

Science, Physics

Refrigerators: Reservoirs and Sinks, External Forces

Part 1 – Describe in detail what a heat pump or a refrigerator does, in terms of reservoirs and sinks, external forces. The description should be done in your own words and not just copied from another source. It should include specific terms from the course and be written in prose.

A refrigerator is a household appliance that is artificially kept cold to preserve food and beverages for a reasonably long period. It consists of a thermally insulated compartment accompanied with a heat pump that is used to transfer heat from inside the fridge to the external environment. So that cold temperatures below room temperature are acquired in the internal compartment to facilitate food preservation. There are five essential components of a refrigerator namely the fluid refrigerant which is highly volatile, the condenser, the condenser coils, the evaporator coils and an expansion valve (Serway, Faughn, & Vuille, 2009).

Part 2 – Construct a diagram which allows you to show the functions of its parts. If you use a pre-made diagram you may have to amend it to include detail or make sure that superfluous detail does not obscure your explanation from Part 1 or make your Part 3 unclear. The diagram only needs contain the most basic components of a refrigerator or heat pump.

The above figure shows a simple cross section of the refrigerator.

Part 3 – Relate Part 1 to Part 2: talk about the diagram and explain which part fulfils which function in the machine and where the energy is needed, where it goes and how it changes with regards to the first and second law. Where applicable, include either the Kelvin-Planck or Clausius statements.

The coolant that is in liquid form gets into the expansion valve is shown by 1.

There is a sudden decline in pressure that causes the liquid to expand cool and vaporize into gas as it advances to the inner compartment of the fridge. There is a round pipe buried at the back wall of the fridge through which the liquid passes, and this chiller cabinet serves an important role of absorbing heat from the food inside the compartments. This is true according Kelvin-Planck law that states that heat transfer occurs from a region of high temperature to the region of low temperature. This law accounts for limitations of the first law of thermodynamics for failing to give the direction of heat flow. The part labeled 3 represents the compressor whose purpose is to convert the coolant into a hot high-pressure gas. This compressor squeezes the coolant raising its temperature and pressure (Serway, Faughn, & Vuille, 2009). The coolant passes through thin radiator pipes at the back of the fridge represented by the part labeled 4. In this radiators, most of the heat in the fluid is given out and cools back into a liquid as it advances to the next level. It is equally important to notice that Kelvin-Planck law requires that heat transfer should occur from a warmer to a cooler environment. The liquid then passes through an insulated cabinet to the expansion valve back to the reservoir, and the whole process repeats over and again. Eventually, all the heat in the compartments containing food or beverages is completely extracted resulting to temperatures that are too low for invasion of bacteria that causes decomposition of food (Serway, Faughn, & Vuille, 2009).

Part 4 – Explain how refrigerators and heat pumps are related by the equation

$COP_{HP} = COP_R + 1$

Explain what this means in terms of efficiencies of heat pumps and

refrigerators and explain why heat pumps are always more efficient than refrigerators.

The objective of a refrigerator is to remove heat from a cold medium. On the other hand, the objective of the heat pumps is to take energy from a cold source. Then transfer it to a hot source for purposes of raising the temperature of the part or compensating for heat losses from a region Notably, the efficiency of the refrigerator is given by the coefficient of performance COP. The coefficient of performance COP for a refrigerator is given by the cooling effect divided by Work input. The coefficient of performance of the heat pumps is given by the heating effect divided by the Work input. Mathematically,

where w is the compressor work input

But,

therefore, relationship between COP for heat pump and refrigerator respectively (Serway, Faughn, & Vuille, 2009).

References

Serway, R. A., Faughn, J. S., & Vuille, C. (2009). College physics. Belmont, CA, Brooks/Cole, Cengage Learning