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Study of Physics Principles in Various Home Appliances

[1]Author: Goparaju Savitri, Assistant Professor of Physics, Telangana.

[2]Co-Author: Varahagiri V S J Bhaskar,Sr. Manager Design-Santres Engineering, Hyderabad

Abstract:

We come across various home appliances in day-to-day life. It is fascinating to understand the basic Physics principles applied in a few of those home appliances, making our life easy. This paper is a study of basic Physics principles used in various home appliances like Rice cooker, Mixer Grinder, Iron Box, Refrigerator, Washing machine, Vacuum Cleaner, Water HeaterFan.

Keywords: Physics Principles, Home Appliances,Rice cooker, Mixer Grinder, Iron Box, Refrigerator, Washing machine, Vacuum Cleaner, Water Heater, Fan.

Introduction:

Physics is part of education from primary classes. However, it is exciting to relate Physics Principles to various home appliances we use daily.Understanding physics principles may sound overwhelming, but everyone is more than likely already familiar with many physics concepts. Physics can be more enjoyable with examples and ideas to help everyonefeel interested and excited to learn about "how" and "why" and the principlebehind them.

1.Rice Cooker:

There are two types of Cookers

a. Pressure Cooker
b. b. Electric Rice Cooker

a.Pressure Cooker

The basic principle involved in a pressure cooker is that the "Boiling point of water increases with pressure."A pressure cooker is a vessel with a tight-fitting lid and few valves for safety. When anyone locks the cooker with a lid, theyseal the vessel shut and create a closed pressure system.

It is known that the Ideal Gas Law and the equation arePV=nRT, where P = pressure, V= volume, and T = temperature (n= the number of moles and R = is the gas constant, but they are notgoing to change in this case so that we can ignore them, and since the volume of your vessel will not change, we will ignore this also). This equation applies to a closed system.

So basically, we have an equation of P=T. So, if we increase the pressure, the temperature will also increase, and vice versa.

In an uncovered vessel at sea level, water boils at 100ºC. The steam that evaporates from this pot is also at 100ºC. No matter how much heat is supplied to the water, it will remain at 100ºC. If a tightlysealing cover is put on the pot to trap the steam, the pressure inside the pot goes up. As the pressure rises, the temperature of the water and steam inside the now pressurized pot also rises above the normal 100ºC boiling point temperature.

So, when you begin heating the cooker, the internal pressure will increase, and as the pressure increases, the internal temperature also rises. This will continue to increase until it reaches the trigger pressure of the safety valves/Whistle, about double the psi at sea level.

Since temperature increases in pressure cooker ~121ºC (~15 psi pressure), the cooking time reduces ~ one-third of the original time.

b. Electric Rice Cooker

The mechanism of a rice cooker could be easily understood with simple physics knowledge. When the rice is done, the water inside the rice cooker will evaporate from a liquid state to a gaseous state. When a substance changes from a liquid state to a gaseous state, a certain amount of energy called 'latent heat' is required. At this moment, the temperature would remain at the boiling point. After the water is evaporated, the temperature inside the cooker rises again. When the thermometer and the electronic devices inside detect the rise, the cooker stops cooking. Some electric cookers also come with a "Keep warm" setting, which keeps the food warm at 65Deg.C.

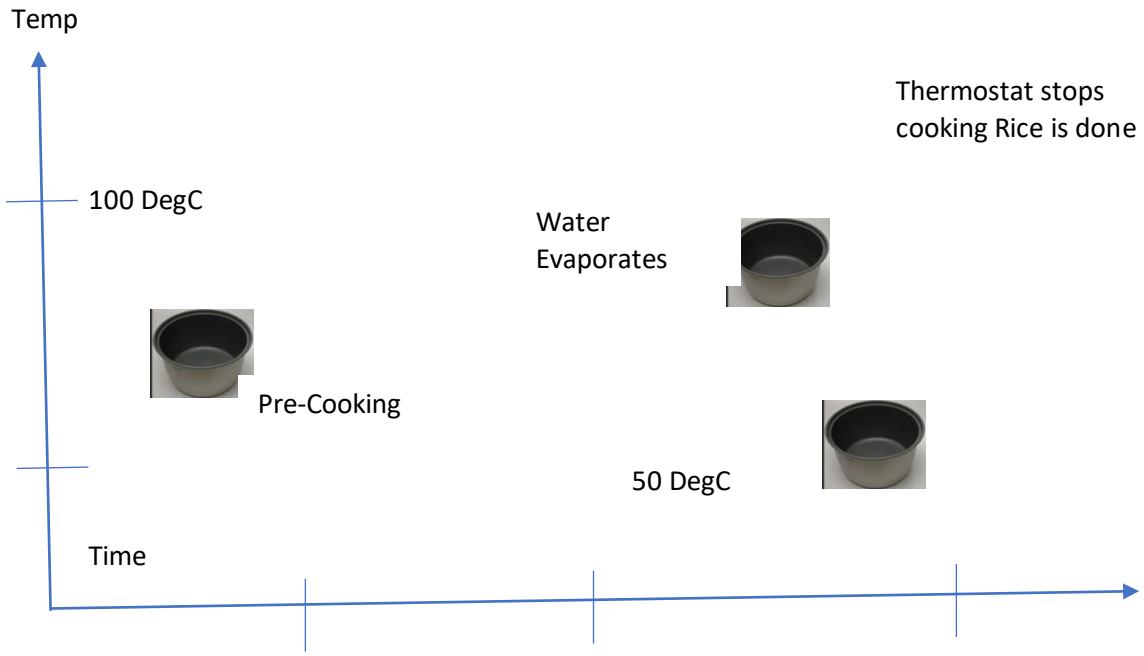

Fig.1: Temp. vs Time Rice Cooker

A basic rice cooker has a main body (pot), an inner cooking container that holds the rice, an electric heating element, and a thermostat.

The bowl is filled with rice and water and heated at full power; the water reaches and stays at boiling point (100 °C) When the water has all been absorbed, the temperature can rise above boiling point, which trips the thermostat.

2.**Mixer Grinder**:

When electricity is provided to a mixer grinder, the blades start rotating. A motor converts electricity to mechanical energy. A coil is placed between the magnetic field. When a current runs in the coil, the coil experiences a magnetic force which causes it to rotate. The blades are attached with this. When the blades rotate, it mixes and grinds the ingredients.

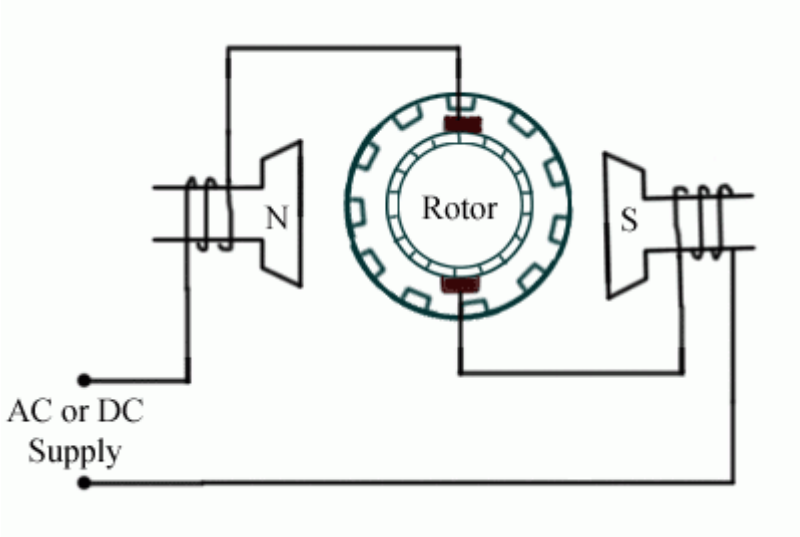

Fig.2 Mixer Grinder Circuit

The working principle of the motor is Since the field winding and the armature winding are connected in series, the same current passes through them when the motor is connected to either AC or DC. The magnetic fluxes of series field and armature produced by this current react with each other and, hence produce rotation.

Because the series field magnetic flux and armature current reverse at the same time, the torque always acts in the same direction.

3.Iron Box:

When an electric current is passed through a coil (or any other heating element present in the iron), it gets very hot. This heat is then transferred to the base plate (the smooth, flat surface that you place against clothes while ironing) through conduction, which elegantly and precisely irons your clothes.

The temperature needed for this is usually around 180-220oC, depending on the type of cloth. Ironing the cloths works by loosening the bonds between the long-chain polymer molecules in the fibers of the cloth. The fibersin the cloth are straightened by the weight of the iron while the molecules are hot, and they hold their new shape as they cool. Some fabrics, like cotton, require the addition of water to loosen the intermolecular bonds. A thermostat is used to control the temperature of the Iron box depending upon the type of clothes option you selected in the Iron box.

4.Refrigerator:

A refrigerator works on the principle of the second law of thermodynamics. This law is related to the extraction of heat from a body,i.e., to lower the temperature of the body. The temperature of the body can be lowered by extracting or removing the heat from the material or the body.

The refrigeration cycle is based on the long-known physical principle that a liquid expanding into a gas extracts heat from the surrounding substance or area.

Refrigerants used in Refrigerator evaporate or "boil" at much lower temperatures than water, which permits them to extract heat at a more rapid rate.

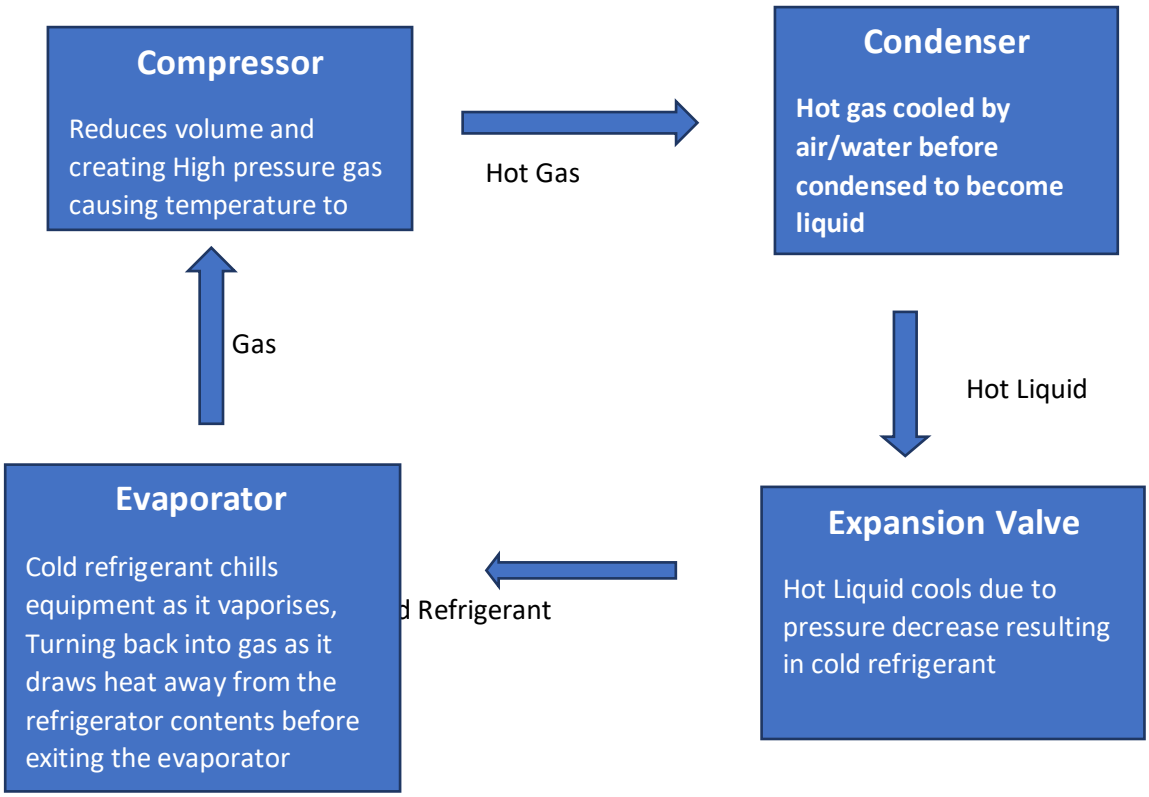

Fig.3 Refrigeration cycle

5.Washing Machine

The washing machine works on the principle of both laws of physics, namely centripetal and centrifugal force. The machine works on two cycles wash cycle and rinses cycle.

The Wash cycle undergoes centrifugal force wherein the force goes from inside to outside thoroughly, making sure every cloth is soaked in soapy water; here, water with soap will undergo centrifugal force.

The rinse cycle is when the centripetal force comes into action, where the force comes from outside to inside to drain the soapy water and render a water-free zone inside the machine. This occurs by force between clothes and inside drum walls of the washing machine.

The basic idea of a clothes washer is simple: it sloshes your clothes about in soap suds for a while and then spins fast to remove the water afterward.

The two drums are the most important parts of a clothes washer, but there are lots of other interesting bits too. There's a thermostat (thermometer mechanism) to test the temperature of the incoming water and a heating element that warms it up to the required temperature. There's also an electrically operated pump that removes water from the drum when the wash is over. There's a mechanical or electronic control mechanism called a programmer, which makes the various parts of the clothes washer go through a series of steps to wash, rinse, and spin your clothes. There are two pipes that let clean hot and cold water into the machine and a third pipe that lets the dirty water out again.

6.Vacuum Cleaner

Vacuum cleaners work because of Bernoulli's Principle, which states that as the speed of air increases, the pressure decreases. Air will always flow from a high-pressure area to a low-pressure area to try to balance out the pressure. A vacuum cleaner has an intake port where air enters and an exhaust port where air exits. A fan inside the vacuum forces air toward the exhaust port at high speed, which lowers the pressure of the air inside, according to Bernoulli's Principle. This creates suction – the higher-pressure air from outside the vacuum rushes in through the intake port to replace the lower-pressure air. The incoming air carries with it dirt and dust from your carpet. This dirt is trapped in the filter bag, but the air passes right through the bag and out the exhaust. When the bag is full of dirt, the air slows down, increasing in pressure. This lowers the suction power of your vacuum, which is why it won't work as well when the bag is full.

When a centrifugal fan rotates, it makes the airflow by adding external kinetic energy. Air is sucked from behind and pushed forward with pressure and so negative pressure it creates behind the fan. An ideal vacuum cleaner has such a centrifugal fan in it connected to a motor. This unit has suction and discharge connections. On the suction side,the filter bag is fitted before the hose connection. The discharge has another air purifier filter and is opened to the atmosphere. When the electric power is given, the motor rotates, and so the centrifugal fan. Air from the suction side is sucked into the unit; along with the air, all air-born particles, cat allergen, mist, dirt, and small solid particles are carried to the suction filter. They are trapped in the filter, and dirt-free air is pushed out from the discharge opening.

7.Water Heater

An electric heater is an electrical device that converts an electric current into heat. The heating element inside every electric heater is an electrical resistor and works on the principle of Joule heating: an electric current passing through a resistor will convert that electrical energy into heat energy.

8.Ceiling fan

The ceiling fan has a motor that converts electrical energy into mechanical energy. First, the capacitor of the ceiling fan torques up the electric motor, thereby causing it to start and run. As the electrical current reaches the motor, it enters coils of wire that are wrapped around a metal base. When this current passes through the wire, it creates a magnetic field that further exerts force in a clockwise motion. In this way, the electric energy is converted into mechanical energy and causes the motor coils to spin. The blades attached to the motor also start gaining motion with the spinning of the coils.

How The Ceiling Fan Cools

The mechanism behind the ceiling fan is quite simple. It is a known fact that air naturally stratifies – the lighter, warm air rises up while the cool air, which is heavy, sinks down. The rotation mechanism of the ceiling fan is the built-in way so as to attract the warm air upwards. As the hot air rises up, the blades of the fan slice this air and push it down. This being a continuous process causes the air in the room to circulate in the entire room. Thus, a ceiling fan only moves the air around. Contrary to the common belief, fans do not know exactly cool. Rather they speed up the process of evaporation of sweat on our body, which naturally makes us feel 'cool.'

In this way, electrical energy is converted into mechanical energy, which causes the rotor and housing to spin and the blades attached to the housing throws away the air nearby it while creating a cooling effect.