

## **HVAC: Refrigerator and Its Malfunctions**

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### **Abstract**

HVAC systems have become one of the main things in every household. The HVAC systems control the thermal energy in houses and refrigerators and ensure gas flow regulation for better performance. The gas in this process will be exposed to many conditions, especially in refrigerators. Therefore, the research will discuss the mechanical gas cycle, factors affecting the cycle to slow the performance, and what the process may be exposed to. The refrigerator cycle consists of copper pipes, a compressor, a condenser, an evaporator, a capillary tube, and, most importantly, the gas. Each part of the cycle has a different function, and this

equipment is mainly consumer equipment. Therefore, they may be damaged or even fail, so understanding the process can create familiarization with the system functioning.

**Keywords:** Refrigerator, Condenser, Evaporator, Compressor, Filter, Gas cycle.

### **\* Introduction**

Refrigeration is the process that entails a cycle of regulating heat from a substance, especially under controlled conditions. In the past, refrigerant cycles were made of basic materials that mainly involved holding the heat so that the temperature of a substance is maintained below the temperature of the surrounding. The basic concept was primarily to use

water as a coolant by continuously adding water to the basin that contained the substance to be refrigerated. A Persian engineer invented a method to store the ice during the summer since there were many losses that people would get due to the hot weather. He made a giant hall made of mud with a depth of 5000m and a space where ventilation could occur. This place was then named Yakhchal, or the ice pit that brought about the idea of the invention of the refrigerator because it was working well for these people. They brought ice in the winter and stored it during the summer, then held food and beverages in the ice pit.

The idea was costly and required continuous maintenance, which led to the invention of the refrigerant cycle that could work independently. Therefore, science had to be improved to make it all work. Most of the scientists were studying how to store food and beverages and decided to look more into modifying the ice box. The study and research led to the development of refrigerators that are highly constituted by the refrigerant cycle, which is like the engine of the refrigerator. The process consists of a compressor, conductor, capillary tube,

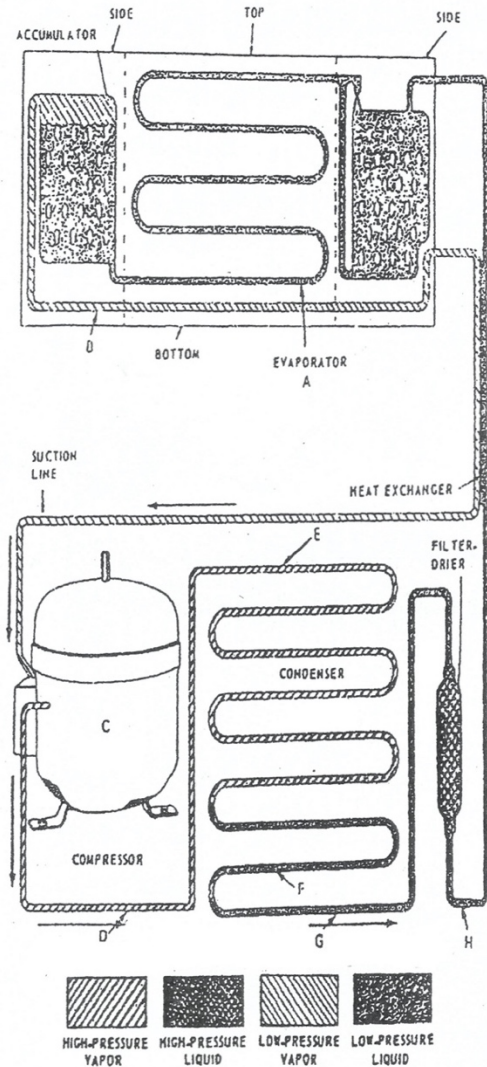
evaporator, copper pipes, and (refrigeration gas). Each component has its specific function that makes the cycle a complete one. For instance, the gas would not flow through the pipes unless compressed and condensed thoroughly. There are possibilities for controlling the compression and condensation of the gas by using different components.

The gas cycle will start in the compressor, which will be compressed through small pipes. Afterward, the temperature of the gas will be increased, and where it will be moved through the condenser. Therefore, the condenser will move through the pipes until it hits the filter. The filter then removes humidity from the gas and transfers it into a tiny line between the filter and the larger tubes. After the small pipe, the gas will be moved freely into larger pipes where the temperatures decrease dramatically through the evaporator and hit the cooling temperature of less than 10C. Therefore, the cooled gas will move through the tube and enter the compressor again, where the cycle is once again repeated as long as there is an electric power supply.

Through this process, many accidents may occur along the way

because of the failure and power technicalities. These probabilities should be considered because the cycle needs to be complete for the foods and the beverages to be stored longer without going rancid. In the research on the mechanical and electrical benefits of the components, the causes of the technical errors will be discussed, and how to properly know when to involve an electrician.

Also, how this process appears through the science equations will provide a better understanding of the whole cycle. Furthermore, how the maintenance processes are regarded will also be considered.



**\* Methods**

Components of the mechanical refrigerant cycle.

## 1- Compressor



A compressor consists of an electrical engine. Its main work converts electrical energy into mechanical energy used to drive the machines. First, the compressor is powered by electrical power whenever a switch is on, and the connections have been made. Then, electricity will rotate the piston slowly while increasing the speed for the adequacy of the working process. The piston and connecting rod will spin up and down; this movement will pull and push the gas into the pipe system. The compressor will continuously rotate and move since there is an electric power supply. The compressed air will have high pressure and high temperatures, which are then

discharged into the condenser through the delivery pipe connecting them.

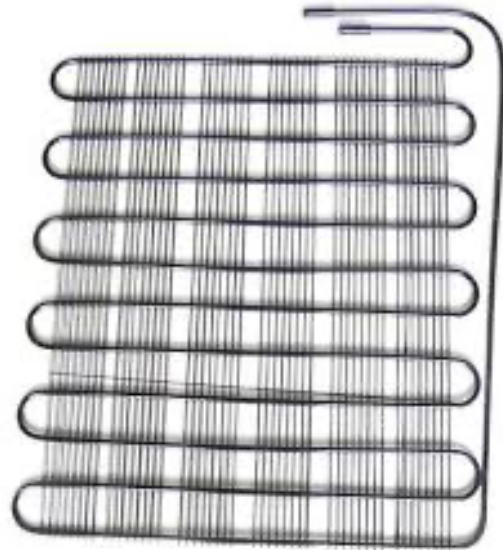


In the image above, there are three pipes out of the compressor. The first one is a high-pressure pipe going to the condenser. The second one is low pressure coming from the evaporator. The last one is for filling the compressor with Freon gas. The picture shows us the compressor from the inside and the features so that there is a better understanding of how the cycle works in keeping the refrigerator moving. There are two windings, one for a start and the other for running the electricity all the time for proper regulation. When electricity runs through the windings, the piston starts to rotate, which will then continue towards the next activity into the condenser. The rotational motion of the compressor will convert to reciprocating motion, the motion that will create a rhythmic power working system for the whole operation process. This kind of compressor is

known as a Reciprocating Compressor, and it is the most widespread and most preferred because of its high efficiency. The compressor must always be filled with Freon gas with a pressure of 10 Psi for the work to be fully effective.

## 2- Condenser

The condenser consists of a series of spiral pipes where the cooling and the condensation of the high-pressure and temperature gases from the compressor are done. The responsible component received high-pressure gas with high temperature. Its responsibility is to transfer the high-temperature gas through the small diameter pipe to the capillary tube. The condenser is often located at the back of the refrigerator. The main goal of the condenser is to transfer gas and condense it to become a high-temperature liquid. It is known as the hot part of the refrigerator. The process involves the refrigerant being forced to lose the latent heat to the surrounding condensing medium, which can either be water or gas. Losing this heat cools the compression point.



## 3- Filter

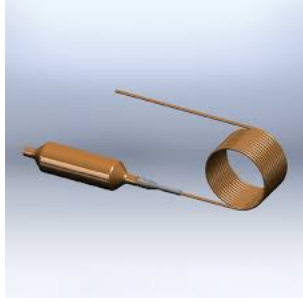
The filter is a small device that is located after the condenser. It aims to remove impurities from the substance so that it will stay free without any impurities. Impurities are removed to avoid damaging the system, which can lead to failure too.



## 4- Capillary tube

The capillary tube is a tiny copper pipe with a small diameter that arranges the passing of the liquid coming from the condenser. It creates

a medium with a pressure difference to the substance between the condenser and evaporator. Afterward, it transfers the air into the evaporator.



### **5- Evaporator**

The evaporator is the cold part of the refrigerator that is found above the compressor. In this part, the evaporator will absorb the heat from the refrigerator, where the cooling liquid will have converted to the gaseous form. The liquid-vapor refrigerant is seen to absorb the latent heat of vaporization from the medium used to cool it. The temperature will always be maintained at a value less than 10C. When this is done, the gas will be transferred to the compressor again but now at a low temperature. There will be a heat exchange inside the compressor between cooling liquid and cooling gas for the proper system regulation. The evaporator enhances the process by creating an environment where the gas is not lost so that it can be well-regulated while being sent back to the compressor.

### **6- Gas**

This is the essential substance in this whole process, and without this, all the systems will not effectively operate because it is passed through the entire system but in different forms. The gas that is used is Freon gas. It is a combination of halogen gases and consists of fluoride, chloride, and hydrogen atoms. It is known as a friend of the environment, which makes it widely used because of its less impact when environmental pollution measures are regarded. If the gas had not been environmentally friendly, and since every household nowadays is loaded with a refrigerator, there would have been a different world altogether.

#### **\* Malfunctions that the Refrigeration Cycle May Encounter**

Like everything else ever made, many obstacles may appear through this process. The problems will cause the stagnation of work and lead to food going rancid, and most people have encountered problems with refrigerators. Looking at these problems might therefore create a better understanding of what is to be anticipated when the issues arise. It might also help in the reasoning with the electricians for effective services. They include;

### **1- The compressor is not working, and there is no cooling**

The reason may be a cut in one of the conductors where the phase is moved to the neutral state. To solve this malfunction, it is necessary to check the conductor and replace it before it creates more extensive damage to the whole cycle system. Also, this might mean that the thermostat is damaged or broken. When the compressor is not working, testing the thermostat will be necessary to know whether to replace it.

### **2- The compressor turns on and off**

This problem is highly associated with the power voltage supply in the circuit. The main reason may be that the electricity is lower than the required one; for example, in Kuwait, there is a single phase for the refrigerator, and the voltage must be 250V. Anything less than this will create complications with the compressor turning on and off. Also, there is the possibility that the compressor might be damaged and must be replaced immediately. The voltage is checked by using an Avometer linked with the cable that then connects it to the voltage scale to be read. Thirdly, the compressor might be working without an induced cooling

effect. The temperature of the compressor might also be too high because of its location near the wall, which can create an adjustment effect on the system. It, therefore, needs to be more than 15 centimeters away from the wall.

### **3- The compressor is working but without cooling**

This problem can be associated with damage to the compressor, but other reasons can be related to it. The first reason may be damage from the capillary tube that supplies the air. In this case, it will need to be tested and checked if there is a need for a replacement or if the damage can be corrected. Secondly, the filters might not be working, so the cycle's humidity has not been absorbed, which will create a malfunctioning problem for the system. Third, the pumping of the Freon gas might have been done at a higher pressure of more than 10 Psi. The Freon gas is often pumped at this pressure so there can be proper regulation of the system and the proper adaptations. Checking the pressure gauge will reveal the issue. Fourth, the refrigerator door might not have been closed. It will affect the cycle's temperature because the required temperature afforded by the cycle will

be exiting the refrigerator. Irregulating the temperature will create an assumed temperature change to the compressor that it might pick up quickly, which will be ineffective to the system.

### \* Logical Equations

#### 1- Electrical equations

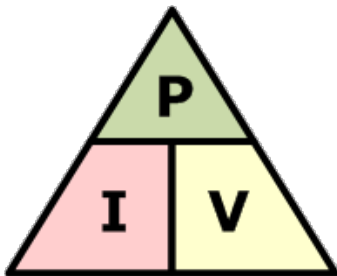
For the compressor, the equation used is:-

( $P = V * C$ ). where;

P is Power

V is Voltage and C is Current.

This formula is used to get the total number of kilowatts required to turn on the cycle and start the process. Kilowatts are the measurements for electricity. Regarding the kilowatt quantity, the consumer will pay his bills to the government to provide them with electricity according to the rates of the working time. Also, the voltage it works with will determine the power rates in Kuwait. The single phase used is 250V. The power quantity is applied for 1 hour of use, which will then be calculated by implying the total hours used.



#### 2- Mechanical equations

An equation was invented to measure the pressure, temperature, and velocity of the substance in pipes and closed cycles all at once. This equation is called the Bernoulli equation. Before using the equation, there is a need to locate a datum as an origin and then get the height required for the operation of the whole system.

#### BERNOULLI'S EQUATION

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho gh_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho gh_2$$

To apply the equation, first, there will be the need to locate two different points where the fluid is flowing and then write down the data. After that, look for the requirements necessary for the sheet so that there can be a determination of how to get these requirements. Then write down the data that has been determined after that, which is the requirement and findings and the result for the equation. For example, the fluid of the refrigerant cycle is the same. The differences are in temperature, pressure, and velocity. Determining these three will create values for the unknown variables that can be used in the equation.



## \* Discussion

While having experience in the mechanical engineering field, there is the agreement that the whole system might vary, but the constituents are the same for the entire operation. Maintenance of the different types of HVAC systems is complex, but it can be done when one properly accesses and understands how the system operates. The understanding of the refrigerators followed by the AC systems creates a high vision board on the management of this system. However, there is so much damage that one can obtain during this process of accessing. In the research, there is the application of knowledge about the damages and how to maintain them.

It is good to have an experience in both mechanical and electrical engineering fields, as they will create a broader version of all that is expected in operations and the connections to understand these damages better. Also, theories that appear in the research are commonly used for electrical and mechanical parts. The refrigerator has become an essential device in every house, and it is used for storing food for a longer time and beverages. People need to have more knowledge of how

refrigerators operate and how to maintain malfunctions.

## \* Conclusion

The knowledge of the working and the operations of the refrigeration system is creating more understanding of how to help create a better environment for everyone. For one, the refrigerant cycle has helped create a straightforward living system. How easy is it to leave food in a box and get to eat it several days later by turning a switch on? The whole concept has brought so much relief to the storage system; therefore, the understanding was to create reliable system guidance. The HVAC systems control the thermal energy in houses and refrigerators and ensure gas flow regulation for better performance. The gas in this process will be exposed to many conditions, especially in refrigerators. Therefore, the research will discuss specifically the mechanical gas cycle, factors affecting the cycle to slow the performance, and what the process may be exposed to. The refrigerator cycle consists of copper pipes, a compressor, a condenser, an evaporator, a capillary tube, and, most importantly, the gas. Each part of the cycle has a different function, mainly consumer equipment.

Understanding this has created an open mindset on maintaining the system and equally regulating the operation. Therefore, the essential part of the refrigerator is the cycle, so keeping it running is necessary by understanding all its features.

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