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وزارة التعليم العالي والبحث العلمي

جامعة الانبار

كلية الهندسة

قسم الهندسة الميكانيكية

الكـــراس التـــعريفي لتجــــــــــــارب

مختبــــــــــــر التثليج

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تجربة رقم (٠٣)

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(Experiment 03)

Name of the experiment:

Demonstrating faults in a compression refrigeration system.

The goal of the experiment:

Identify the symptoms of some faults that occur in a compression refrigeration system.

- **Introduction**

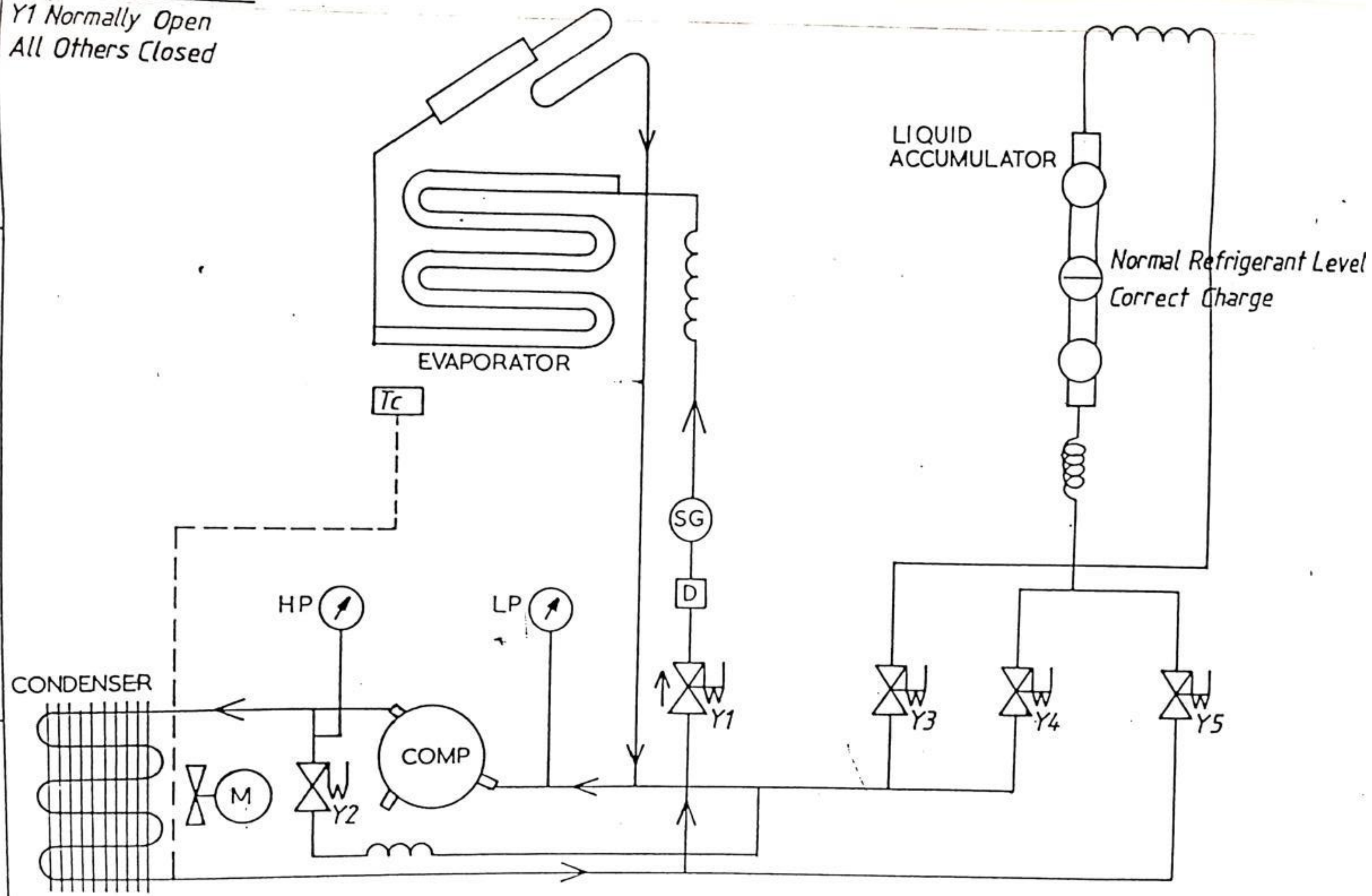
The compression refrigeration system, as is known, consists of four main parts: the compressor, the condenser, the evaporator, and the expansion device, in addition to other accessories. This type of refrigeration system is the most common in air conditioning and other refrigeration applications, from home refrigerators to freezers and other diverse applications. Refrigeration units of all types are susceptible to numerous malfunctions, and accurately identifying the malfunction is the first important step in repairing it. To diagnose most compression refrigeration system malfunctions, we typically monitor the condenser and evaporator pressures, the condenser and evaporator temperatures, and the connection pipes, comparing them to normal conditions.

- **The used device**

The apparatus used for this experiment is a compression refrigeration system specifically designed to simulate some of the malfunctions that occur in this type of system. The system consists of a closed-type compressor, a forced-air-cooled condenser, a capillary tube expansion device, and an evaporator positioned on the front of the device, where it naturally absorbs heat from the surrounding environment. The figure shows a schematic diagram of the components of this system, **Focus 804** model. It features a high starting torque compressor motor, allowing the system to be restarted if it stops before the pressures equalize. In addition to the other main parts, there is a liquid accumulator and a set of solenoid valves that can be seen when lifting the back cover of the device. There is also a set of buttons and vision glasses on the left side.

CORRECT CHARGE

Y1 Normally Open
All Others Closed



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SERIES 804 TRAINING UNIT
804-1

- **<u>Test method</u>**

  In this experiment, it is possible to represent five possible faults that may occur in refrigeration equipment and compare them with the normal operating condition, as follows:

  1- Normal operation
  2- Exceed discharge pressure
  3- Faulty compressor (lake of capacity)
  4- Blocked capacity
  5- Over charge
  6- Under charge

- **Normal operation**

Connect the system to the power, then set the side switch to 1 and the front switch to 1 1 as well. In this case, all the side buttons are in the off position, and thus all the solenoid valves are off except valve Y1 is on. The level of the refrigerant l in the middle side view bottle must be half full. In this case, the refrigerant flows from the compressor to the condenser, then exits as a subcooling liquid, passing through valve Y1 to the dryer, then to the front view bottle, then to the capillary tube, and then reaches the evaporator, where the refrigerant absorbs heat from the environment and turns into vapor and returns to the compressor as superheated vapor.

Continued operation of the system will lead to ice formation around all evaporator tubes if the refrigerant charge is correct and the low-pressure gauge reading is positive. The high-pressure gauge reading depends on the ambient temperature. The system is left to operate for a period of time until a steady state is achieved, and the readings shown in column 1 of the readings table are recorded.

During normal operation, the following can be observed:

a. The temperature increases slightly or remains constant between point 1, located at the beginning of the evaporator, and point ٢, located at the end of the evaporator.

b. The temperature between point ٢ and point ٣ increases by approximately ٦ degrees Celsius due to additional superheated.

c. The condenser temperature increases by approximately 13 degrees Celsius above the saturation temperature (the difference between the condensing temperature and the end of the condenser temperature can be read directly from the digital gauge.

- **Excess discharge**

When you press side button 1, the condenser fan will stop operating and the pressure on the high-pressure side will gradually begin to rise. In this condition, the system must not operate for extended periods. After recording the readings in column 2, press button 1 to return to normal operation.

- **Faulty compressor (lake of capacity)**

Press button 2, thus opening valves Y1 and Y2, while the other valves (Y3,Y4,Y5) remain closed. Therefore, part of the vapor from the compressor will pass through valve Y2 to return to the compressor again. This condition gives the same result or effect as when there is a problem in the compressor valves or a laceration gasket. Leave the system operating in this condition for a period of time and note the partial increase in the suction pressure as well as the condition of the evaporator, then record the readings recorded in column 3. After that, press button 2 to return to the normal operating condition.

- **Blocked capillary**

Press button 3, which will close valve Y1 and all other valves will be closed. This means that no refrigerant will pass through the capillary tube. After leaving the system running for a short period in this condition, we will notice the ice on the evaporator tubes melting and the evaporator pressure dropping to a negative value. The readings in column 4 are recorded, then press button 3 to return to normal operation.

- **Over charge**

Press button 4 and valves 1 and 4 will be open, while the rest of the valves will be closed. In this case, the refrigeration cycle will operate normally, but an additional amount of liquid will be transferred from the liquid reservoir through valve 4 into the cycle. We leave the system operating under these conditions until the level of the refrigerant liquid in the liquid reservoir drops to the level that can be seen in the lower side view bottle. Then we press button 4 again and leave the system running for a period of time, then record the readings in column 5. After completing the recording, we press button 5 to return the refrigerant liquid to the liquid reservoir. We continue monitoring the side view bottles when the liquid level reaches the middle of the middle view bottle, we press button 5 again to return the system to normal operation.

- **Under charge**

Press button 5, a part of the refrigerant will be transferred from the cycle to the reservoir. Observe the system operating under these conditions until the liquid appears in the upper side view glass. Then press button 5 again and allow the system to operate. In this case, the system operates at a lower charge than normal. After completing the monitoring and recording the readings in column 6, press button 4 to return the liquid in the reservoir. Wait until the liquid level drops to the middle of the central view glass.

- **Notes**

-The amount of increase or decrease in the refrigerant charge within the cycle depends on the length of time that button 4 or 5 is held down.

-After completing the experiment, first disconnect the power to the compressor from the front switch, then disconnect the power to the unit from the side switch.

- **The discussion**

Discuss and explain the following statements:

1. The temperature is constant between the beginning and end of the evaporator, while it increases after it Why?

2. How can you differentiate between a under charge and a partial blockage in the capillary tube?

3. The presence of ice on the evaporator tubes is an insufficient indicator of a correct refrigerant charge.

4. The return refrigerant from the evaporator to the compressor has several disadvantages. Mention two of them.

5. Capillary blockage may be caused by dirt or moisture within the system. How can you differentiate between the two cases?

6. You have the following observations about a compression refrigeration system. What is your comment?

a- High boost pressure

b- High evaporator pressure

c- High refrigerant temperature at the end of the evaporator

7. What are the indicators that the compressor is not pumping refrigerant properly?

- **The readings**

The state	Normal	Hot condenser	Lake of compressor capacity	Blocked capillary	Over charge	Under charge
Environment temp. ^oC						
Evaporator pressure (Bar)						
The temp. at point 1 ^OC						
The temp. at point 2 ^OC						
The temp. at point 3 ^OC						
The temp. at point 4 ^OC						
Superheating amount in evaporator ^OC						
Condenser pressure (Bar)						
Subcooling amount in the condenser ^OC						
The different between the condensation temp. and environment temp. ^OC						
Ice percentage on the evaporator tubes %						