Section 13: The Refrigeration Plant

Learning Outcome 13

On completion of this section you should be able to start up and shut down a small refrigeration plant, explain the basic principles of operation and recognise simple operating faults.

The areas you will cover in this section are:

13.1 Basic mechanical refrigeration plant

13.2 Components of a refrigeration plant

13.3 Cut out and re-setting

13.4 Required temperatures

13.5 Refrigerants

13.1 Basic mechanical refrigeration plant

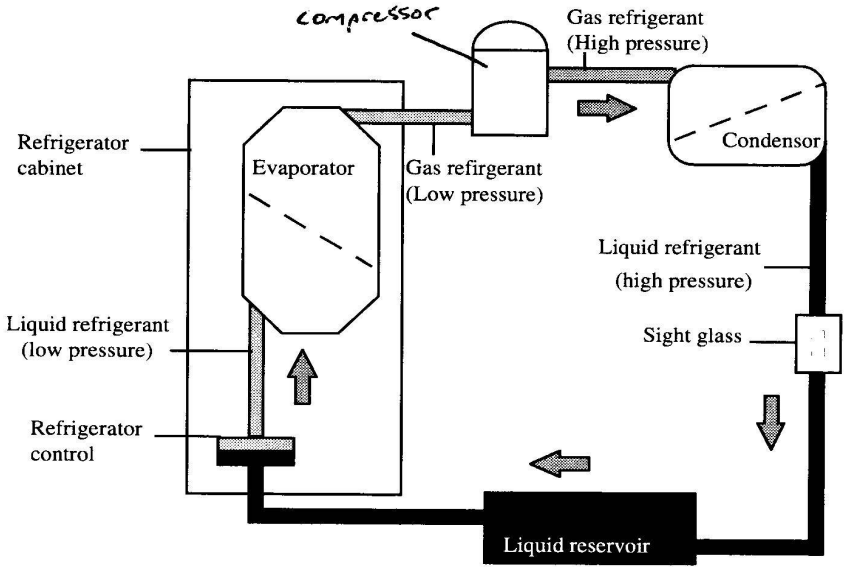
The basic operating principle of refrigeration plant is to use a liquid refrigerant to absorb heat from inside the plant and transfer that heat to surrounding fresh air.

The process follows a cycle as the liquid refrigerant is drawn by a compressor through a cooling unit (an "evaporator") where the heat from the plant is used to evaporate the refrigerant, turning it into gas.

The gas is then pumped under high pressure and high temperature into a condensing unit (a "condensor"). The gas is cooled while in the condensor, giving up its heat to the surrounding fresh air. As the gas cools it returns to a liquid. This cycle continues until the refrigeration plant reaches the required temperature.

13.2 Components of a refrigeration plant

The following is a list of components in a basic refrigeration plant and their function.



Basic refrigeration system

Refrigerator cabinet	This cabinet provides cold storage space and houses the cool tubing from the refrigeration plant.
Refrigerant	The liquid which flows through the plant absorbing heat and releasing it into the surrounding air.
Refrigerant reservoir	A container which holds the liquid refrigerant.
Refrigerant control	This control reduces the pressure of the refrigerant as it flows from the reservoir to the evaporator.
Evaporator	This is a cooling unit where heat from the plant is absorbed by the refrigerant, evaporating the liquid and turning it into gas.

Tubing	The refrigerant flows through the tubing either as liquid or gas.
Compressor	The compressor draws the gas refrigerant from the evaporator and forces the gas into the tubing and through to the condenser.
Condenser	As the refrigerant gas enters the condenser it cools with the heat transferring to the outside air. As it cools the gas returns to liquid.
Sight glass	Shows the level of refrigerant in the system and if there is any moisture present.

13.3 Cut out and resetting

All refrigeration plant have controls for setting the desired temperature within the refrigerator cabinet. These controls generally work within a set range of temperatures which can be changed if required. This control will be linked to the refrigerator motor.

The refrigerator motor has two primary controls, apart from the direct power supply:

a) temperature control
b) pressure control

Some refrigeration plant, particularly smaller types, may have only a temperature control as this is the most common.

Temperature controls

These controls can be set to allow a range of temperatures in which the plant will operate. This temperature should not be confused with the internal temperature within the refrigerator cabinet itself.

If the temperature of the plant exceeds the maximum setting, the temperature control closes off the electrical circuit control and shuts down the system. There may also be an overload protector which will reopen the system if there is any danger of a build up in electrical current.

Most systems also have a manual shut-off switch.

Pressure control

Commercial refrigeration plant also use pressure controls on the motor.

This control monitors the pressure of the refrigerant. If the pressure becomes too high the control will shut down the motor. Similarly, if the pressure drops the control will start the motor.

The pressure of the gas refrigerant on the low side of the compressor is also indicative of the temperature within the refrigerator cabinet. By monitoring this low pressure, the motor can be switched on and off to control the temperature with the cabinet.

So, apart from the direct power supply, the refrigeration plant may cut-out as a result of the temperature or pressure within the plant exceeding the pre-set maximum level or by using the manual switch.

Refrigeration plant is designed to operate automatically and in all conditions. To be able to do this, the plant is generally manufactured with greater capacity than needed under normal conditions. To ensure that the plant does not over work, temperature and pressure controls are used to run the plant and keep the temperature within the cabinet at the desired setting. Generally the plant will only operate for a proportion of the time the refrigeration system is in use.

If the plant cut-out appears permanent, you need to investigate the reason why. Do not simply adjust the temperature or pressure controls to open the switch and reactivate the motor.

If the manual switch has been has been used, check with all crew members to find out the reason.

If there is no apparent reason for the plant having cut-out, you will need to arrange for a qualified refrigeration mechanic to check the system.

13.4 Required temperatures

As mentioned previously, the temperature of the refrigerator cabinet can be set to a desired level.

While this temperature setting is used to automatically control the motor and the refrigeration plant's operation, there are other factors which will also have an influence on the temperature within the cabinet.

Air temperature and amount of air flow surrounding the refrigerator cabinet	If the surrounding air temperature is warm or the air flow is restricted, the refrigerator plant will have to operate for longer periods and/or more frequently. This may also mean that the temperature within the cabinet will rise quicker than normal when the plant is not operating.
Correct size evaporator for the size and intended use of the refrigerator cabinet	If the evaporator is an incorrect size it will be difficult to maintain normal operating temperatures and the temperature control will need to be adjusted to obtained the required temperature within the cabinet.
Correct refrigerant	There are many different types of refrigerant, each used for a specific purpose and within a specific temperature range. The refrigerant used in a system must be suited to the operating temperature range required of the refrigeration plant.
Leaking refrigerant	Refrigerant leaking from the system will reduce the effectiveness of the system and its ability to maintain the low temperatures required.
Moisture in the system	Moisture in the system may freeze, clogging controls or may effect the efficiency of the refrigerant. Moisture may also cause corrosion, restricting the efficiency of the entire system.

13.5 Refrigerants

Refrigerants are dangerous substances and require special care when being handled or controlled. Mishandling may not only cause personal injury but also possible death and have damaging effects on the environment. Some refrigerants are known to damage the earth's ozone layer.

Some refrigerants are also toxic, restrict breathing, irritate eyes, will burn skin and may be flammable.

If refrigerant is leaking from the system or there is a suspected leak, report the matter to the vessel's master and ensure that the area is well ventilated. Find out what type of refrigerant has been used and any particular safety precautions that are recommended by the manufacturer.

- Always wear protective clothing and goggles. Be aware that a separate breathing apparatus may be needed when dealing with some refrigerants.
- Ensure that machinery is shut down and there are no naked flames near the leak.
- If you suspect a refrigerant leak in a confined space, do not enter the space until the area has been well ventilated and a clear flow of fresh air is available.
- Seek medical attention if your skin comes into contact with refrigerant or you have been breathing fumes from the refrigerant.
- Call for a specialist refrigeration mechanic to repair the leak and replenish the refrigerant.
- If the vessel is at sea and the leak is minor and the refrigerant safe, determine whether running repairs can be made until the vessel reaches port. If not, the refrigeration system will have to be shut down until repairs can be made.

Practical/Written activity

Have your facilitator explain the standard procedure for:

- checking the refrigeration system
- the start up process
- monitoring and
- shut down.

Create a checklist for your future reference.

With your facilitator present, run through the entire process on a basic refrigeration system. Refer to your checklist in need.

If you forget any aspect or your checklist is found to be incorrect, have your facilitator show your the correct method and add this to your checklist.

Place (by stapling or inserting) the checklist in this workbook as part of your assessment evidence.

Assessment Criteria

Can you now:

- ❑ identify the main components of a refrigeration plant
- ❑ explain why a refrigeration plant may cut-out and require re-setting
- ❑ explain why a refrigeration plant may not reach the required low temperature
- ❑ explain the safety precautions necessary with refrigerant gases
- ❑ describe or demonstrate the checking, start up, monitoring and shut down of a refrigeration plant