Section 8: DC Battery Systems

Learning Outcome 8

On completion of this section you should be able to manage a low voltage DC battery system in accordance with safe electrical practice.

The areas you will cover in this section are:

8.1 Testing battery conditions

8.2 Parallel and series connections

8.3 Safety precautions with batteries

8.4 Charging batteries

8.5 Fuses and circuit breakers

8.1 Testing Battery Conditions

You will need to test the condition of a battery using a hydrometer. A hydrometer measures electrolytes in the battery acid. As a battery discharges, the electrolyte becomes less dense, and the indicator in the hydrometer will sink.

Firstly, observe the normal safety precautions:

- Before removing the caps situated over each cell ensure you have sufficient ventilation
- Ensure there are no naked flames in the vicinity.

Using the hydrometer, insert it into each cell squeezing the sembler bulb drawing liquid into the chamber. Reading the scale at eye level will tell you the condition of the battery.

- If the reading is 1.260 then the battery is fully charged.
- At 1.233, the battery is 75% charged.
- At 1.198, the battery is 50% charged.
- At 1.163, the battery is 25% charged.
- If the reading is 1.100 then the battery is fully discharged.

Do not try and test your battery immediately after topping the battery with distilled water or after removing the battery from the charger. Wait for at least 30 minutes. This will allow for cooling and settling to gain a more accurate reading.

Practical Activity

Observe your facilitator assessing the condition of a battery using a hydrometer.

Ask them about procedures and tips. Record them here as your facilitator demonstrates. We have given you an example:

Read at eye level disregarding the curve of the liquid against the glass

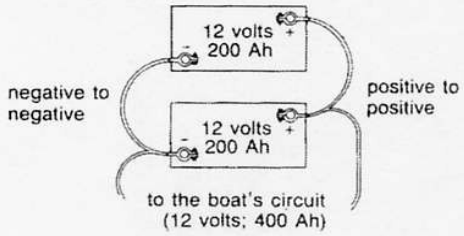
8.2 Parallel and series connections

Series and parallel connections are made when a large storage capacity is needed but a single battery would be too heavy or cumbersome to handle.

A parallel connection is made by linking the positive poles of two or more batteries, and also linking the negative posts.

Paralleling batteries leaves the system voltage unchanged, but doubles its amp-hour capacity.

If you were to connect batteries in **parallel**, for example 2 x 12 volt batteries, the end result would still be 12 volts.

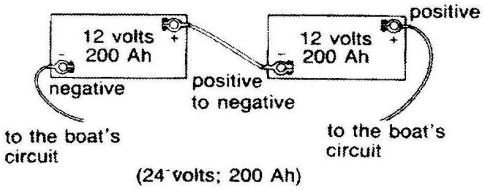


Batteries in Parallel

A series connection is made by linking the positive pole of one battery to the negative post of the other, and then using the remaining positive terminal on one and negative terminal on the other to make the connection to the boat's circuits.

When in series, the total amp-hour capacity of the two batteries together remains the same as the amp-hour rating of either one, but the output voltage is doubled.

If you connect two 12 volt batteries in **series**, the combined output would be 24 volts.



Batteries in series

8.3 Safety precautions with batteries

A battery's electrolyte is a solution of sulphuric acid which can eat through clothing, cause severe burns, melt metal and give off a deadly chlorine gas when mixed with seawater.

Follow these safety tips when handling batteries.

- Ensure you have sufficient ventilation around your batteries.
- Install batteries away from the motor. Heat given off by your motor may weaken or damage the battery housing. Therefore battery acids can leak and cause corrosion to other components. A faulty connection in your starter motor could cause a spark to jump and ignite gases escaping from battery cells.
- Ensure your battery is secure when installed.
- Have an appropriate Amp meter and Volt meter installed for the purposes of monitoring the condition of your battery.
- Fit "kill switches" or circuit breakers to your wiring system.
- Ensure that the correct fuses are used when wiring additional electrical equipment to your vessel.
- Always remove jewellery, especially watches with metal bands.
- Be careful when placing your tools.
- Wear some sort of eye protection.
- If battery fluid spills on your clothing or skin, wash immediately with cold water.
- Install your battery in a well-built acid proof box with a secure vented lid.

8.4 Charging batteries

It is always safer to remove the battery from a confined space before recharging for reasons mentioned in Section 8.3.

When connecting the battery to its charger, firstly remove the caps over each cell and ensure the liquid is above the cell plates to a height recommended by its manufacturer.

When connecting the wire coming from the charger, ensure that the positive wire and the negative wire are connected to the appropriate terminals before switching on the charger.

Ensure that the charger is set on its appropriate 6 volt or 12 volt charge, depending on which battery you are about to charge.

When the meter on the charger indicates that the battery is fully charged (1.260), let the battery sit for at least 30 minutes after disconnecting it and before testing with a hydrometer. This is because the battery temperature has increased whilst on the charger, so you need to allow cooling before getting an accurate reading.

Practical Activity

Ask to observe the procedure for charging a battery.

Write down the steps you observed here. This will help you as a reference later, and also for your assessment.

_____

_____

_____

_____

_____

How did you assess that the battery was fully charged? _____

_____

_____

8.5 Fuses and circuit breakers

Fuses and circuit breakers are fitted for safety reasons. Both are designed to protect electrical wiring and equipment from an electrical overload.

Circuit breakers are load sensitive switches that trip (or open) a circuit if an exceeding current flows through it.

A fuse is a protective device designed to break a circuit by melting if the current goes above a certain level.

For example, if there was a surge in the power supply or a short circuit in the wiring system, the fuse will stop the surge or short circuit continuing down the wiring system. Otherwise, surges may damage electrical equipment or cause electrical fires.

If you do happen to blow a fuse, ensure that it is only replaced with the same Amp fuse. If this is not done correctly, surges may be allowed through the circuit and overload machinery with electricity. This can cause loss of power, blackouts, damage to machinery or even electrical fires.

Circuit breakers are fitted to the power supply system. There are various situations where circuit breakers are useful. For example, if you were to leave your vessel unattended for a period of time, you would turn your circuit breakers off and in doing so, cut off all the power supply from your batteries to whatever electrical equipment you have fitted to your vessel. Circuit breakers are also easily reset simply by reswitching them to the original position.

A **short circuit** occurs when the positive side of the battery is connected directly across to the negative side, bypassing the equipment itself. This causes an excessive current flow, generating heat and causing fire to occur (usually at the smallest wire in the circuit), unless fuses or circuit breakers are fitted.

For instance, a short circuit will occur if you were to drop a metal tool onto your battery and it were to touch both battery poles at the same time.

Check Your Progress

1. What is the voltage of two six volt batteries connected:

a) in series _____

b) in parallel _____

2. Name two safety precautions when handling batteries:

_____

_____

3. What is the purpose of a fuse?

_____

_____

Assessment Criteria

Can you now:

- ❑ assess the condition of a battery using a hydrometer
- ❑ connect batteries in parallel and series and calculate the current and voltage supplied by the resultant battery tank
- ❑ explain the safety precautions associated with the management of batteries
- ❑ carry out the normal charging procedure for a battery and assess whether it is at full charge
- ❑ explain the purpose of fuses and circuit breakers in electrical circuits and the dangers of replacing blown fuses with those of incorrect rating
- ❑ explain the meaning of the term "short circuit" and how this condition could occur

Answers to Check Your Progress

1. a) 12 Volts b) 6 volts

2. Check the text in section 8.3 or ask your facilitator to check your answer.

3. Protects surges of power through circuits by melting if overloaded and therefore breaks the circuit.