

Charging

Theoretically, it takes about 6 to 9 hours to reach 80 % of the battery capacity level if the battery capacity is approx. 0 % SoC. It is recommended that the batteries are discharged as little as possible to optimise battery life.

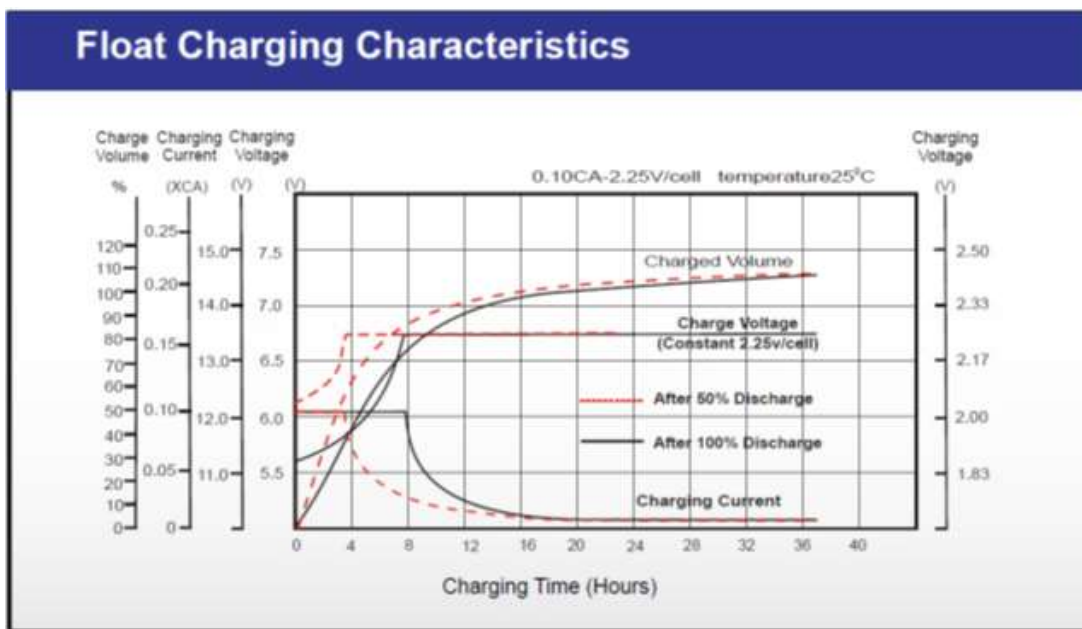
The battery discharging time and capacity level depend on the load characteristics of the application and the way in which the battery is used.

LINAK recommends a charging time up to approx. 14 hours which gives 100 % capacity.

At full charging capacity, the battery will not discharge as fast as at 80 %.

The internal and external battery charging characteristics are identical.

The battery alarm on a LINAK control box will be activated at approx. 17 to 18 V. The battery charging must be started before it reaches this level to maintain as long a battery life as possible.



80 % capacity ~ up to 6 to 9 hours charging time depending on the discharge level.

100 % capacity ~ up to 14 to 17 hours charging time depending on the discharge level.



It is not advisable to use larger batteries than the LINAK product range as this will result in overloading the LINAK battery charger.

Internal Resistance

The resistance within the battery is generally different for charging and discharging and also depends on the battery SoC. As internal resistance increases, battery efficiency decreases.

Consequently, a battery may be modelled as a voltage source in series with a resistance. In practice, the internal battery resistance depends on its size, chemical properties, age, temperature, and the discharge current. It has an electronic component due to component material resistance and an ionic component due to electrochemical factors such as electrolyte conductivity, ion mobility, and electrode surface area. An internal resistance measurement is a guide to the battery condition. Internal resistance depends on the temperature.

LINAK is applying the following acceptance criteria:

- SoC \geq 50 %
- OCV \geq 12.5 V DC single batteries
- OCV \geq 25.0 V DC on battery set
- Test Conditions: 25 °C \geq temperature \geq 22 °C stabilisation time before measurement > 3 hours
- Change of responsibility: EXW LINAK A/S

A new battery may not initially provide 100 % capacity. The capacity typically improves over the first few recharges, reaches a peak, and declines until the battery reaches the End Of Life (EOL). A reduction to 80 % of the rated capacity is usually defined as EOL for a lead-acid battery. Below 80 %, the battery deterioration rate accelerates, and it is more liable to sudden failure resulting from a mechanical shock or a high discharge rate. Note that even under ideal conditions, a battery is expected to eventually wear out.

Self-discharge and storage

LINAK has an optimised battery supply chain. In the ideal situation with valid forecasts and a steady flow through the pipeline, the lead-time from the battery manufacturer to the customer can be short (approx. 3 to 4 months).

Due to the self-discharge, it cannot be expected that the batteries are fully charged when they leave the factory. LINAK advises the customer to charge the batteries immediately upon receipt and no later than 3 months after the LINAK production date. The earlier the batteries are charged, the longer the battery life. The initial charging should last at least 24 hours and longer if possible.

All lead acid batteries are affected by self-discharge. If the capacity loss due to self-discharge is not compensated for by recharging, the battery capacity may become unrecoverable. The temperature also plays a role in determining the battery shelf life.

VRLA batteries can be stored at a temperature between -20 °C and 60 °C but the ideal temperature is 20 to 25 °C. Storing batteries at other temperatures can lead to permanent damage. When batteries are stored in areas with a varied ambient temperature, the self-discharge rate can increase significantly.

The self-discharge rate is typically less than 3 % per month at an average temperature of 20 °C. Batteries may be stored for up to 6 months at 25 °C with an SoC of 40 % or more and before a new charge is required. According to LINAK experience and the LINAK battery supplier, 99 % of all VRLA batteries that have been stored at 20-25 °C can reach normal functionality.

Please be aware that the self-discharge percentage is calculated on the basis of the latest SoC value.

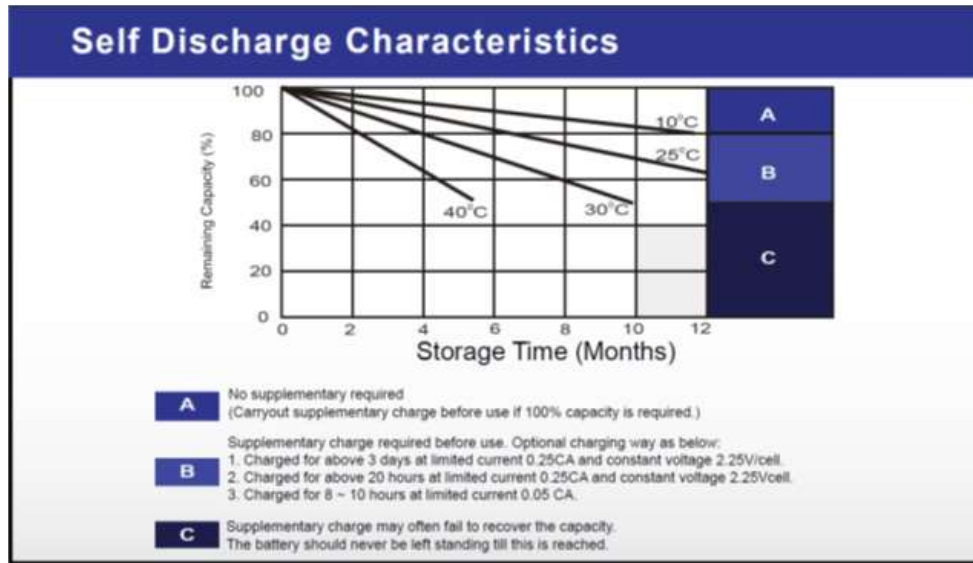
Storage recommendation

When a lead acid battery is fully or partially discharged, lead sulphate is generated at the electrodes. If the battery is allowed to remain in a discharged state or at a very low SoC for a long time, the lead sulphate may be transformed into large crystals which are very difficult to convert into lead and sulphuric acid during the charging process. The generation of these crystals is called sulphation and causes a permanent loss of battery capacity. To avoid this problem, lead acid batteries should therefore only be stored in a fully charged condition and the charge should be topped up from time to time during storage to compensate for the self discharge of the cells.



LINAK recommends to check the battery SoC every 6 months and charge if necessary.

The below figure represents the self-discharge between the storage temperature and the expected battery capacity over a number of months.



Maintenance of batteries

Prior to first use of LINAK batteries, please make sure that they are being charged at least 24 hours and longer if possible in order to reach proper function and prolong the lifetime of the batteries.

**Warning**

Please observe the following maintenance, replacement, and disposal requirements to ensure a safe and reliable operation.

The batteries are to be replaced after 4 years at the latest. Perhaps earlier, dependent on the pattern of use. Frequent and high-powered discharges reduce the battery life. For an optimum lifetime the product must be connected to the mains voltage as often as possible. It is recommended that the batteries are to be charged at least every 6 months - otherwise will the batteries have reduced capacity due to self-discharge. It is recommended to test the battery function at least once every year.

Replacement of batteries

The batteries must only be replaced by the same type of batteries or mechanical and electrical equivalent types. The batteries must be new or maintained by means of charging at least every 6 months. The batteries, which make a set, must be supplied with identical production codes.

Mismatching of production codes may lead to a severely reduced life time expectancy. Before mounting ensure that the battery set is correctly connected, compare with the drawing in the battery room, and check that no connectors are loose.

**Warnings**

From the factory the battery room is hermetically separated from the electronics room. When replacing the batteries this separation must not be damaged or modified as this may allow penetration of battery gas into the electronics room with risk of explosion.

When replacing batteries in waterproof products (IPX5 and IPX6) precautions must be taken that the sealing material (silicone ring or joint filler) is not damaged and that it is correctly placed in the groove. Hereafter the screws in the cover are to be fastened with approx. 1 Nm. If the seal is damaged it must be replaced by a new silicone string (LINAK article no. 0008004 for a roll of 100 meters).

Disposal

The batteries, which are lead-acid batteries, can be returned to LINAK or disposed in the same way as car batteries.

**Warnings**

The battery room is supplied with ventilation that ensures correct and necessary airing of the battery room. This airing must not be blocked or covered as a positive pressure may occur with risk of explosion.

If the product has been exposed to mechanical overload (lost on the floor, collision/ squeezing in the application or a powerful stroke) the product must be sent to an authorized workshop for control of the hermetic separation between the battery and electronics rooms.