

INDUSTRIAL LEAD ACID BATTERIES: TYPES AND THEIR SELECTION

1. Basic theory of lead acid batteries

Refer figure 1 below:

The lead acid battery comprises of two chemically dissimilar lead based plates in a dilute sulphuric acid solution. The positive plate contains lead dioxide PbO_2 , and the negative plate pure lead in a spongy form. When immersed in dilute sulphuric acid, the nominal electric potential between the two plates is 2 volt. This voltage is universal for all lead acid batteries.

During discharge, the sulphite ions in the electrolyte interact with the negative and positive plates, forming lead sulphate on both. The loss of sulphite ions in the electrolyte reduces its specific gravity in proportion to the charge delivered.

During recharge, the electric current converts the plates back to their charged state, and the sulphate back to sulphuric acid. The specific gravity of the electrolyte likewise rises again as a result.

The chemical formula for these processes is shown in figure 1. From this the following is evident:

- The process is reversible, i.e. a lead acid battery can be discharged and recharged many times.
- The capacity of the battery (in ampere hours) depends on the amounts of lead dioxide (on the positive plate), spongy lead (on the negative plate) and sulphuric acid (in the electrolyte) present in the battery. These are applied in a specific ratio, and a loss of any one will result in a drop in capacity of the battery.

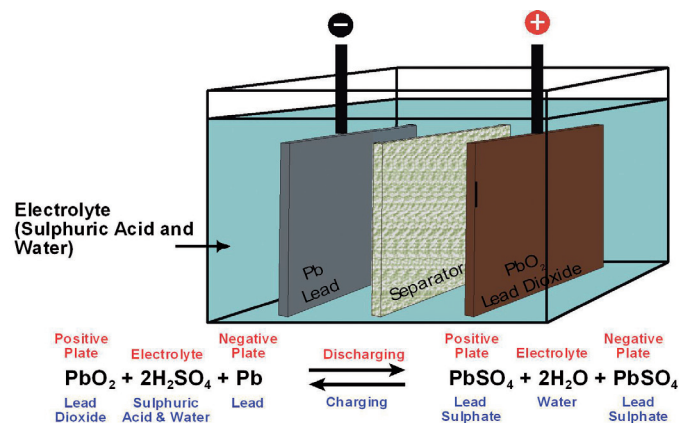


Figure 1. Basic operating principle of a lead acid battery

2. Types of lead acid batteries

Table 1 below contains the range of lead acid batteries commonly available in the market. There are other purpose specific lead acid designs not covered in this article and information on these can be obtained from manufacturers.

The two basic battery groups discussed herein are briefly explained as follows:

> **Vented lead acid (VLA)** group batteries are all “open”, allowing gas to escape without any positive pressure building up in the cells. They can be topped up when required and are therefore more tolerant to high temperature operation and over charging. The free electrolyte also facilitates cooling of the battery.

Group		Vented lead acid (VLA)			Sealed lead acid (SLA or VRLA)	
Type		Planté	Pasted plate	Tubular	Pasted plate	Tubular
Positive plate	Construction	Pure lead Lamellae	Lead antimony /calcium alloy grid	Lead antimony /calcium alloy spines	Lead calcium alloy grid	Lead calcium alloy spines
	Active material	PbO_2 grown from pure lead plate	PbO_2	PbO_2	PbO_2	PbO_2
Negative plate	Construction	Lead antimony alloy grid	Lead antimony alloy grid	Lead antimony alloy grid	Lead calcium alloy grid	Lead calcium alloy grid
	Active material	Spongy lead	Spongy lead	Spongy lead	Spongy lead	Spongy lead
Electrolyte	Chemical	Sulphuric acid solution in pure water			Sulphuric acid solution in pure water	
	Containment	Free liquid			Immobilised liquid, using:	
	Venting	Free to air			Absorbent glass mat (AGM)	Silica based gel (Gel)

Table 1. Simple classification of lead acid batteries by type

> **Sealed lead acid (SLA or VRLA)** group batteries, also known as maintenance free batteries, are sealed with a pressure release valve, which limits the escape of gas to above the release pressure. Hence the term “Valve Regulated Lead Acid”, or VRLA for short. The electrolyte is immobilised to prevent spillage and facilitate gas recombination within the battery. These batteries are usually more compact in size than vented lead acid batteries and typically used in areas where ventilation is insufficient to accommodate vented batteries. They cannot be topped up and are more susceptible to failure due to high temperature than vented lead acid batteries.