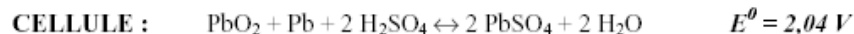
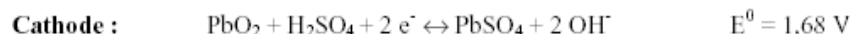
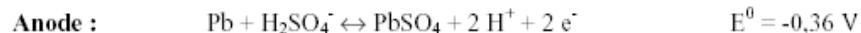
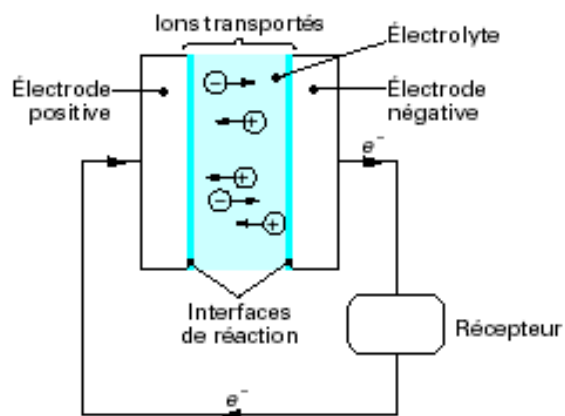
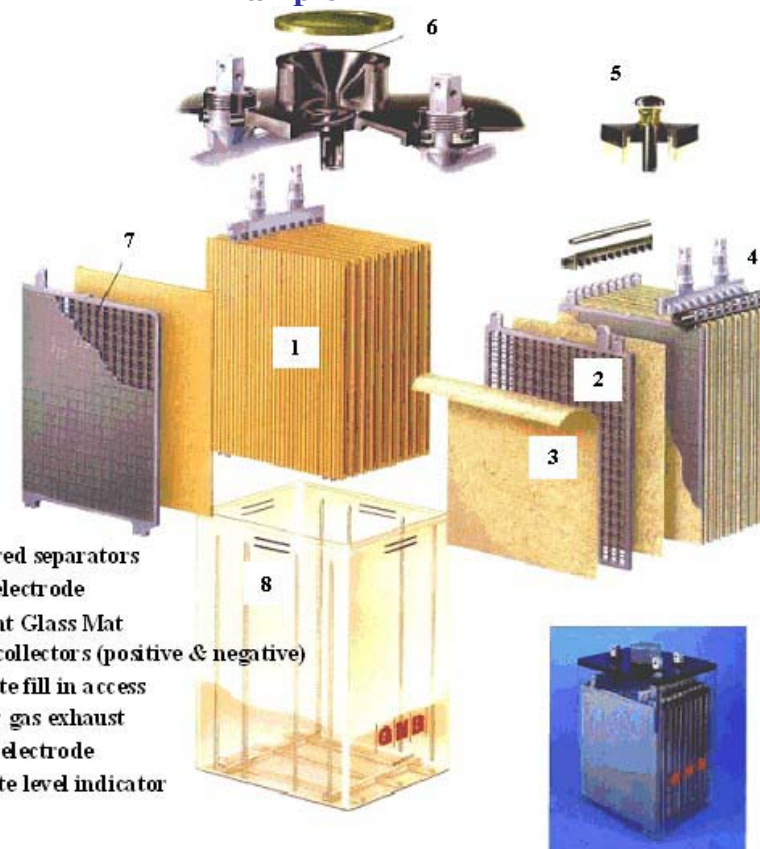


Lead acid batteries

Principle of operation



Example



1. Micropored separators
2. Positive electrode
3. Absorbant Glass Mat
4. Current collectors (positive & negative)
5. Electrolyte fill in a access
6. Valve for gas exhaust
7. Negative electrode
8. Electrolyte level indicator

Sealed batteries (VRLA, Valve Regulated Lead Acid) : no maintenance

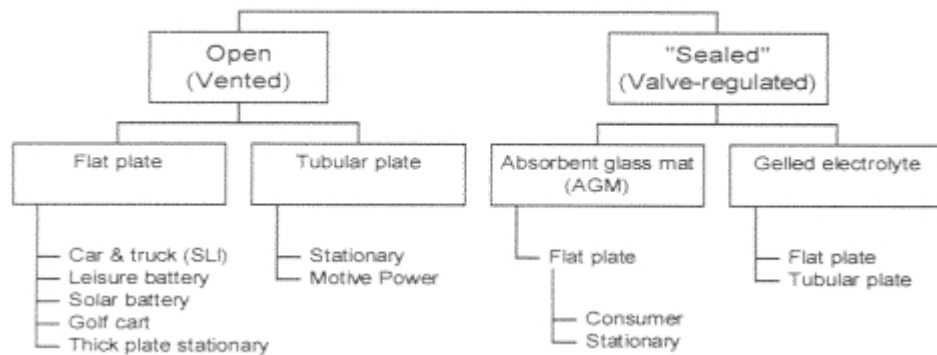
Technical data

Temperature of operation	Energy	Number of deep cycles	Power at steady state/ 30s	Charge/discharge efficiency	Self discharge
-20 to +50 °C	25/45 Wh/kg 60/120 Wh/dm ³	300/1500	80/150 W/kg	- energy: 60 to 95% - faradic : 65% to 100%	2 to 5 % /month
Maintenance - maintain the electrolyte at the proper level (for vented batteries) with adding water every 2 months. - Electrolyte stratification when long time storage ⇒ agitating		Environmental impact Lead is toxic ⇒ recycling - Lead oxide reduction Plastics (polypropylene) hydraulic or pneumatic sorting		Safety - Sulphuric acid is corrosive - H ₂ evolution when overcharge	

Lead acid batteries

Applications

Lead-acid Batteries



Economic data

Cost of the device : 50 to 150 €/kWh

Additive investment costs : 80 to 240 €/kW ; 100 to 180 €/kWh

Cost evolution with installed power is strongly application type dependant.

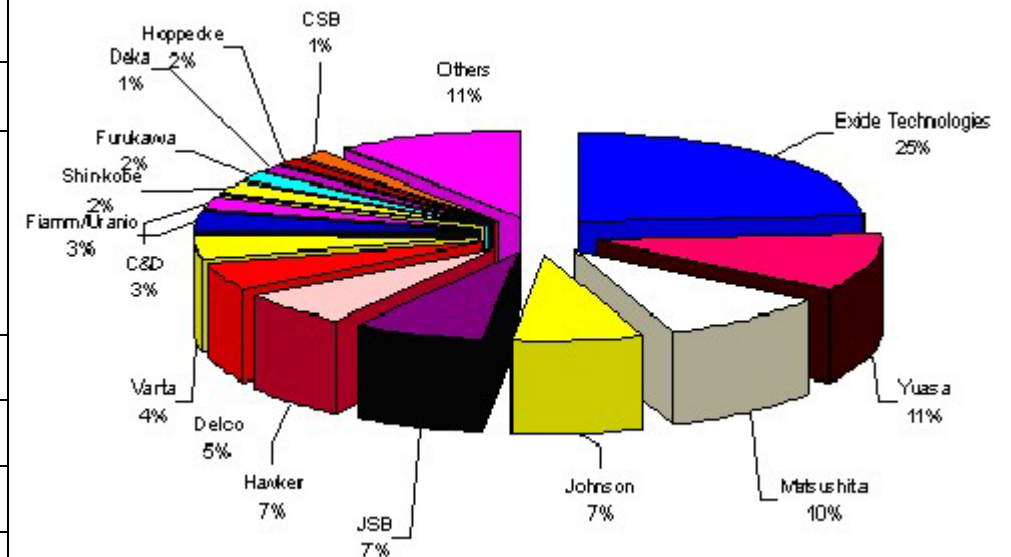
Manufacturers :

- EnerSys Inc : Hawker / VB Batterien / Oldham ..
- Exide Technologies : Tudor / Fulmen / Sonnenschein / Chlorie Motive Power / CEAC
- C&D Technologies
- Johnson Control : Hoppecke / Varta
- Fiamm
- Yuasa

Role	Power	Capacity
Production carry over Spinning reserve	40 to 1700 MW	Few hours to few weeks
IRE Production	100 W to 10 kW (small consumption isolated systems)	Few kWh to few 10 kWh
	100 kW to 10 MW (grid connected)	Few minutes to few hours
Grid stability	10 to 100 MW	<30 seconds
Load levelling	100 kW to 10 MW	2 to 4 hours
Security	100 kW to 10 MW	10 minutes to 10 hours

R&D Perspectives

- to increase the life time and energy efficiency and to reduce the production cost by improving :
 - active material composition,
 - battery design and technology,
 energy management system



Worldwide production: around 180 millions of SLI batteries / year

Research Institutes (not exhaustive) :

- GENEC – CEA (Cadache, France)
- CENERG (Sophia-Antipolis, France)
- University of Nancy
- ZSW (Germany)
- CLEPS (Bulgaria)

Lead acid batteries