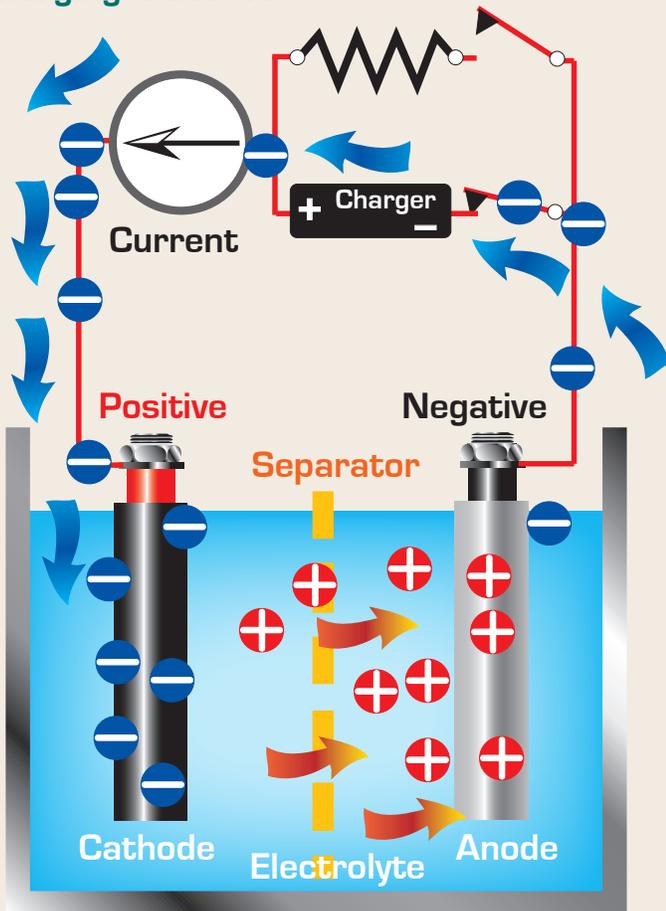


1.0 Introduction:

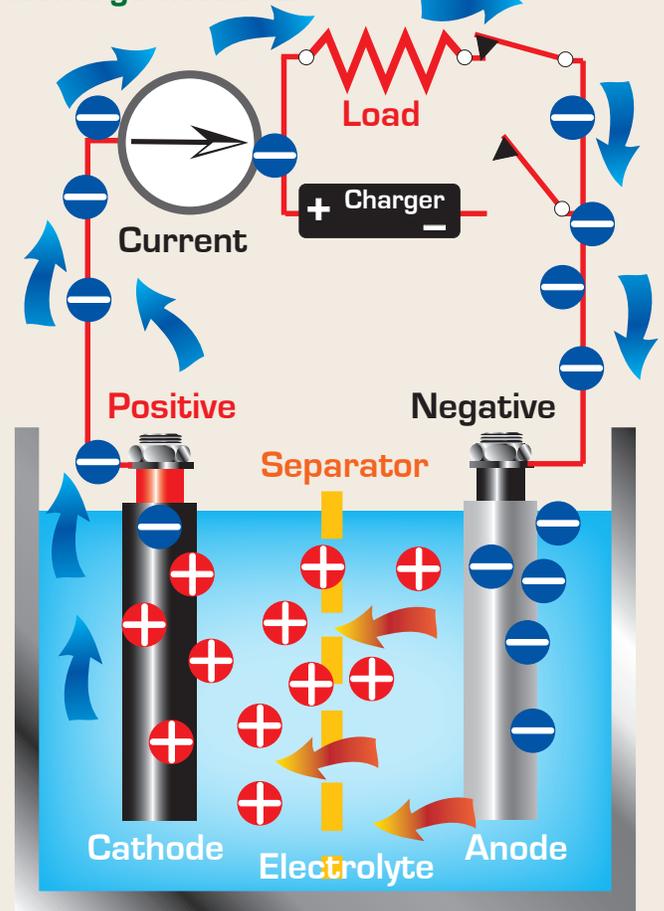
Apart from a few special applications that use mechanical cranking, such as spring starters, the greatest percentage of generator set systems utilize 12-volt or 24-volt starter motors. For prime power and standby applications, the two most commonly used battery types are lead acid or nickel cadmium (NiCd).

This info sheet discusses the differences between NiCd and Lead Acid starter batteries for generator systems.

Charging Mode "A"



Discharge Mode "B"



Negative ion and positive electron flow in charge mode "A" and discharge mode "B"

Diagram showing a simplified action of a rechargeable battery cell

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Comparison Chart of Nickel Cadmium (NiCd) versus Lead Acid (LA) for Generator Starting Batteries

Characteristics	Nickel Cadmium (NiCd) nominal cell voltage 1.2V		Lead Acid (LA) nominal cell voltage 2.0V	
	Advantages	Disadvantages	Advantages	Disadvantages
Charge and discharge rate	Within 8 hours			Greater than 10 hours
Self discharge per month		20%	3% to 4%	
Temperature range °C	-40°C to + 60°C			-20°C to + 45°C
Average energy cost		More due to Self Discharge	Less due to Self Discharge	
Maintenance cost	Low			Higher than NiCd
Energy by Volume Wh/L	50-150			60-75
Cell voltage through discharge	Remains constant			Drops away
Maintenance top-off 5 years	Little to none			Check electrolyte every month
Cycle Life Cycles	2000			500-800
Electrolyte	Potassium Hydroxide			Corrosive Acid
Hazardous Metal		Cadmium		Lead

Summary: NiCd batteries are more often found in data and phone centers because their life expectancy is longer than LA and little maintenance is required. While NiCd costs 2 to 4 times that of LA it can be recharged 3 to 5 times more often and requires less maintenance with lower life cycle costs.

2.0 Description of the battery types and their ability to be recharged:

Batteries are categorized as primary or secondary cell and either wet or dry cell. For generator systems, the starter batteries selected are wet cell, which indicates a fluid electrolyte is required.

Primary Cells - This type of battery uses an irreversible electrochemical reaction to supply electricity. It is not used for generator set starting systems.

Secondary Cells - The generator set industry selects secondary cells because their electrochemical reaction is reversible. Original chemical compounds can be reconstituted by applying an electrical potential between the electrodes injecting energy into the cell. Such cells can be discharged and recharged many times. The two most commonly chosen secondary cell or rechargeable batteries for generator set systems are lead acid and NiCd. *(Continued over)*

3.0 Charging Process:

The charger strips electrons from the cathode leaving it with a net positive charge and forces those electrons onto the anode giving it a negative charge. The energy pumped into the cell transforms the active chemicals back to their original state. The generator set industry primarily uses an automatic type battery charger for standby applications.

(See diagram on page-one for details of charge and discharge of secondary cell battery)

4.0 Characteristics of Lead Acid and Nickel Cadmium Batteries:

The system designer selects the battery type on its merits for a given application. This sheet details the operation and make of the two battery types and their various advantages and disadvantages.

Lead Acid - This battery produces a voltage by the reaction of lead and lead oxide with a diluted sulfuric acid electrolyte wet cell. When a load is connected across the negative and positive electrodes, the negative lead electrode reacts with the sulfate in the electrolyte to form lead sulfate. The negative lead electrode supplies positive ions and is left negative.

When a charge is applied across the electrodes, the reaction is reversed with the energy from the charger, the lead sulfate is broken down with oxygen from ionized water. Lead oxide is deposited on the positive electrode and lead is deposited on the negative electrode.

Advantages of Lead Acid Batteries: Lead acid is the most widely used battery for starting engines due to its dominance in the automotive industry. Initial purchase cost is low but life cycle costs may be higher depending on the application (See comparison chart above). Other advantages include its ability to deliver high current, to be left on trickle/float charge for long periods and its universal availability in many varieties.

Disadvantages of Lead Acid Batteries: They are not suitable for fast charging. They have a lower cycle life than NiCd, lower temperature limit and require more maintenance due to gassing.

Nickel Cadmium - NiCd batteries used for power generation are also the wet cell type but the electrolyte is a potassium hydroxide (alkaline) electrolyte. The positive electrode is nickel hydroxide Ni(OH) and the negative electrode is cadmium (Cd). The potassium hydroxide electrolyte takes no part in the charge-discharge reactions and acts only as a charge carrier. At the negative electrode (cathode), the cadmium oxidizes to cadmium hydroxide on discharge while the hydrated nickel compounds at the positive electrode (anode) are reduced to nickel hydroxide.

Nickel-cadmium batteries for industrial uses are of the vented (open) or semi-sealed type and may be of pocket plate, sintered plate or fiber structured construction.

Advantages of Nickel Cadmium: NiCd is often chosen for telephone systems and standby generators because of its ability to operate through a high temperature range, its higher recycle life with recharging 3 to 5 times more than lead acid, fewer maintenance requirements (topping off is not required for many years) and a faster charge and discharge rate.

Disadvantages of Nickel Cadmium: NiCd batteries initially cost more than lead acid, include cadmium, a potentially hazardous material, and have a higher self discharge rate (which on large battery systems could represent higher float charge energy costs).