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# Isco Nickel-Cadmium and Lead-Acid Battery Comparisons

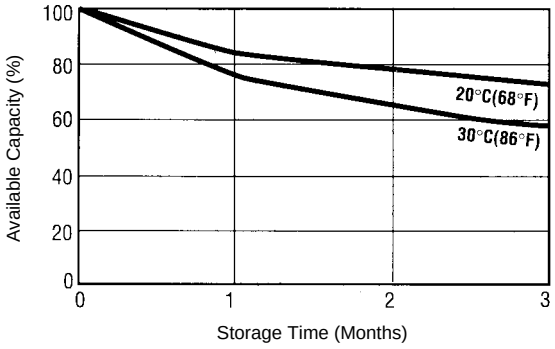
Isco wastewater samplers, flow meters, portable pumps and other environmental monitoring equipment operate from a 12V DC power source. This source can be a 12V DC battery or a voltage converter changing voltage from nominal 117 or 234V AC into 12V DC. Isco offers two types of batteries, nickel-cadmium and sealed lead-acid. Each battery type has distinct advantages and disadvantages. This comparison will acquaint you with their characteristics and help you select the best battery for your environmental application.

## *Battery Discharge Rates*

In certain applications, such as waiting for a storm event to occur, equipment may remain in an inactive state for an extended period of time. A lead-acid battery should be used for this application. Fully charged lead-acid batteries have a higher output capacity and a lower self-discharge rate than nickel-cadmium batteries. A battery with a high self-discharge rate can discharge substantially before power is needed. *Figures 1 and 2* show the comparative self-discharge rates of nickel-cadmium and lead-acid batteries over a three month period.

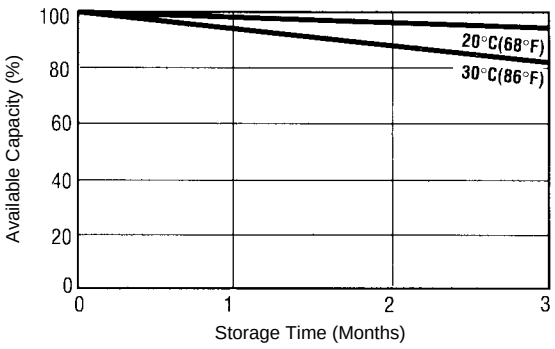
*Model 946 Lead-Acid (top) and Model 934 Nickel-Cadmium (bottom) batteries.*

Figure 1.
*Isco Nickel-Cadmium Battery*




*Average self discharge at 20°C (68°F) is 7% per month*

Figure 2.
*Isco Lead-Acid Battery*




*Average self discharge at 20°C (68°F) is 2% per month*

## *Recharge Cycle Life*

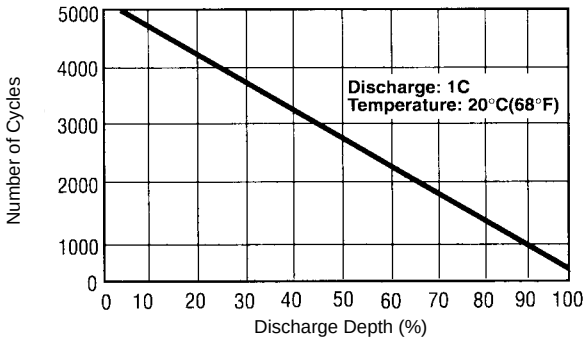
A nickel-cadmium battery has a greater recharge cycle life than a lead-acid battery (*see Figures 3 and 4*). Nickel-cadmium batteries can be discharged and recharged more times than lead-acid batteries before battery cell failure occurs. Recharge cycle life for a lead-acid battery is primarily a function of how deeply it is discharged and how long it is left in that state before recharging. Typically, and depending on other conditions of use, a nickel-cadmium battery can be charged and discharged over twice as many times as a lead-acid battery. Although as the accumulated number of charge and discharge cycles increase on a nickel-cadmium battery, the usable capacity for powering instruments will decrease.

Nickel-cadmium batteries are the preferred power source for samplers, flow meters, portable pumps and other environmental monitoring equipment. When being charged with an Isco battery charger, nickel-cadmium batteries will accommodate an overcharge for an indefinite period of time without damage or serious battery performance deterioration.

Lead-acid batteries, on the other hand, must be protected from overcharge because oxidation of the plates will occur, damaging the battery. In addition, if a lead-acid battery is left for several days with a discharge of 80% or more, it may be permanently damaged and unsuitable for further use.

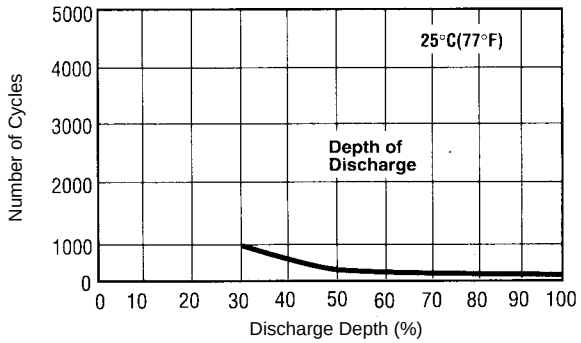
A nickel-cadmium battery can be stored in a fully discharged condition without any detrimental effects. This is particularly valuable in applications where the battery will be used only occasionally, with long periods of time at rest in a discharged state. If lead-acid batteries are left in a fully discharged state, they undergo a process of "sulfation" which increases the battery's internal resistance, making it more difficult to recharge. This may cause the cells to short out, making the battery useless.

Figure 3.
*Isco Nickel-Cadmium Battery*




Cycle Life vs. Depth of Discharge

Figure 4.
*Isco Lead-Acid Battery*




Cycle Life vs. Depth of Discharge

Charged to 100% capacity delivery rate using appropriate charge cycle.

## Maintenance

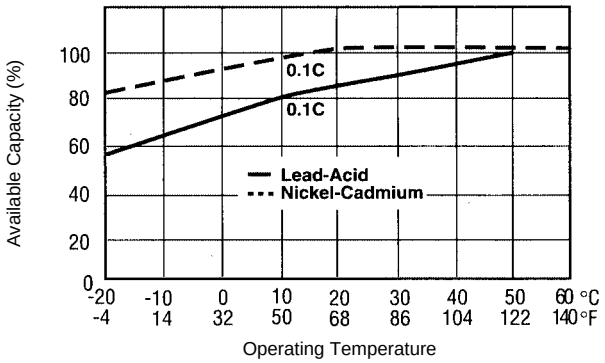
Isco Nickel-Cadmium Batteries perform repeatedly throughout normal duty cycles with no loss of active material or electrolyte, therefore, requiring no maintenance. They can be mounted and operated at any altitude, because of their sealed construction.

The Isco Lead-Acid Battery is also a sealed maintenance-free battery. Like the Isco Nickel-Cadmium Battery, the lead-acid battery can be operated at any altitude and in any position.

## Operating Temperature

Nickel-cadmium batteries have excellent performance characteristics at low temperatures and will deliver usable capacity when temperatures drop to -20°C. As *Figure 5* illustrates, the nickel-cadmium battery maintains available capacity over a wide temperature range while the lead-acid battery capacity decreases dramatically as temperature decreases. Figure 5 shows the available capacity of nickel-cadmium and lead-acid batteries from -20°C to 60°C discharged at a 0.1C rate.

Figure 5.
*Nickel-Cadmium and Lead-Acid Batteries*




Available capacity of nickel-cadmium and lead-acid batteries vs. temperature. Cell discharge rate is (0.1C).*

**C is the current in amperes equal to the numerical value of the nominal ampere-hour capacity of the battery; e.g., for the Isco Nickel-Cadmium Battery which is rated at 4.0 ampere-hours (AH), the C rate by definition is 4.0 Amps and the 0.1C for that battery is 400 milliamps (mA). For the Isco Lead-Acid Battery which is rated at 6.5 ampere-hours (AH), the C rate by definition is 6.5 Amps and the 0.1C for that battery is 650 milliamps (mA).*

*Isco Lead-Acid Batteries are your best choice for applications that require equipment to be in a dormant state for an extended period of time before operation.*

*The Isco Nickel-Cadmium Battery is your best choice for battery powered, general purpose applications.*

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## Discharge Time

A nickel-cadmium battery's output voltage diminishes gradually throughout its discharge cycle. The voltage of a lead-acid battery, on the other hand, decreases much more noticeably as it is used. By measuring the voltage of a lead-acid battery, its state of charge can be accurately determined. *Figures 6 and 7* show the discharge voltage curves of nickel-cadmium and lead-acid batteries.

The more stable voltage output of nickel-cadmium batteries is of particular value for samplers that use pump speed to estimate volume. When the voltage to the pump motor decreases, motor speed decreases. If the sample volume to be collected is controlled by timing pump operation, as is the case with some non-Isco wastewater samplers, sample volumes decrease as the battery voltage decreases. Isco samplers use a patented liquid detector and pump revolution counter to overcome this problem. This exclusive Isco Sample Volume Delivery System ensures accurate, repeatable sample volumes regardless of battery charge condition.

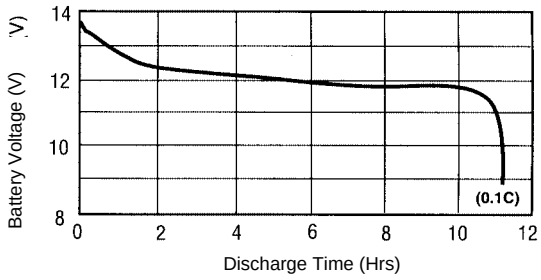
## Cell Design

A great deal of research has gone into the construction of Isco batteries. They are designed to assure optimum performance under the worst of operating conditions. All cells used in Isco Nickel-Cadmium and Lead-Acid batteries are wired in series and environmentally sealed in a rugged housing designed to provide protection from harsh environments.

## Conclusion

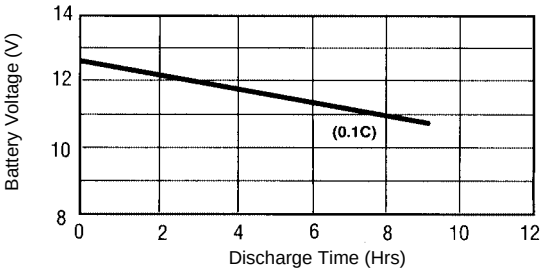
Isco Nickel-Cadmium Batteries are rated at 4.0 amp-hours (4.0AH) and Isco Lead-Acid Batteries are rated at 6.5 amp-hours (6.5AH). For all-around, general purpose applications, the nickel-cadmium battery is the best choice. If applications require equipment to be in a dormant state for an extended period or time before operation, a lead-acid battery should be used.

Figure 6.
*Isco Nickel-Cadmium Battery*




Discharge characteristics of Isco Nickel-Cadmium battery at 25°C over a 10-hour period (0.1C rate)

Figure 7.
*Isco Lead-Acid Battery*




Discharge characteristics of Isco Lead-Acid battery at 25°C over a 10-hour period (0.1C rate)

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