

Battery Technologies

Alessandro Volta pioneered the primary electric cell at the turn of the 19th Century. It wasn't until 1859 that the first rechargeable battery was created. Its inventor, Gaston Plante, employed a Lead Acid chemistry. It would take another 40 years before the advent of the nickel-cadmium battery. This was an open design and wasn't economically viable due to high material costs. The Ni-Cd battery was successfully sealed in 1947 and has been used in a variety of applications ever since. The nickel-metal hydride battery became commercially available in the late 1980's. The early 1990's saw the release of rechargeable lithium based cells. The unstable nature of lithium led to the development of the safer non-metallic lithium ion chemistry.

Each battery chemistry has its own strengths and weaknesses. The following section provides a brief overview of the different chemistries available for PMR users.

Ni-CD Battery

Nickel-cadmium batteries have been the workhorses of the professional mobile radio industry since its inception. This mature battery chemistry is the most robust of all and has the widest operating temperature range. Ni-Cd batteries can accept the fastest recharge rate and is the best value in terms of initial cost and the total number of charge/discharge cycles. The main limitation associated with Ni-Cd batteries is its susceptibility to the 'memory' effect. This results in low capacities and unreliable performance. The chemical processes that contribute to 'memory' are caused by outdated charging methods and compounded by poor user discipline.

Benefits

Inexpensive, robust and mature
Highest number of charge/discharge cycles
High current draw capability
Widest temperature range
-40 to 60C Operating
-30 to 50C Storage
5 to 30C Charge
Allows for the fastest charge
Long storage life

Limitations

Memory effect
Lowest energy density (<2400maH)
Relatively heavy
Environmental concerns

NI-MH Battery

Nickel-metal hydride batteries became popular in the late 1980's. They were sold at the time as the solution to the traditional shortcomings of the Ni-Cd chemistry. Time has shown that Ni-MH does indeed provide a few marginal improvements over Ni-Cd. However it could be argued that the additional drawbacks of Ni-MH negate these benefits.

Ni-MH batteries are still prone to memory though generally not to the same extent as Ni-Cd. The Ni-MH chemistry allows for a higher energy capacity than Ni-Cd but provides fewer charge/discharge cycles. The performance of Ni-MH batteries can drop dramatically after a few hundred cycles especially when high load currents are used. This phenomenon is caused by an increase in the battery's internal resistance. Ni-MH batteries have a higher self-discharge rate and take longer to charge than the Ni-Cd alternative.

Benefits

Up to 40% higher capacity than Ni-Cd
 Fewer environmental issues
 Less prone to memory effect

Limitations

Lower cycle life
 Highest self discharge rates
 Limited current draw - impedance creep
 More expensive than Ni-Cd
 Limited temperature range
 Slower charge

Li-Ion Battery

The lithium-ion chemistry and its variants offer the highest energy densities currently available. This capability has allowed the size of handsets to be drastically reduced. Most modern mobile phones operate from just a single cell. Replacement Li-ion batteries are now offered for many PMR handsets and are provided as standard for the latest digital handsets.

While this chemistry has the lowest self discharge rate the actual cells tend to deteriorate relatively quickly over time. Battery capacity can worsen to such an extent that failure is not uncommon within 1-2 years. To combat the ageing process manufacturers recommend that Li-ion batteries be partially charged and stored at 15C. The major drawback with lithium based chemistries is the inherent fragility of the materials used. For safe operation Li-ion batteries are built with a protection circuit. This monitors the cell's temperature and limits the input and output voltage and current. Li-ion's recent introduction into PMR coupled with the requirement for a protection circuit means that it is currently the highest cost chemistry for PMR.

Benefits

Highest energy densities
 Lowest self discharge rate
 Variety of packaging options
 Low maintenance
 Consistent current draw

Limitations

Lowest number of charge/discharge cycles
 High initial cost
 Immature chemistry with new variants under development
 Fragile requiring protection circuit to ensure safety
 Reacts with oxygen
 Slowest charge rate
 Short shelf life due to relatively fast ageing
 Prefers partial discharge

Summary

	Ni-Cd	Ni-MH	Li-ion
Cell Voltage	1.2V	1.2V	3.6V
Cycle Life possible	Highest	Moderate	Lowest
Operating Temp range	Widest	Moderate	Moderate to Low
Cost per cycle	Lowest	Low to Medium	Highest
Possible Capacity	Lowest	Low to Medium	Highest
Commercially available	1950's	1980's	Late 1990's
Typical ACT charge times	30mins/Ah	60mins/Ah	120mins/Ah