QUESTION:

What types of batteries are usually used in portable gas-detection devices? Are there any that are more suited to certain environments?

Atmospheric monitors use sensors to measure gas. Some types of sensors need more power, while other types need less power. Very low power sensors may use so little power that a set of disposable or rechargeable batteries can last for months or years of operation. But no matter what kind of sensors are installed, portable atmospheric monitors need power, and that means the instrument depends on batteries.

There is no perfect type of battery. Each type of battery has benefits and liabilities. Very importantly, how well the instrument performs is a combination of the type and capacity of the batteries, the type of sensors installed, the environmental conditions in which the instrument is used, and the power requirements of the instrument electronics.

There are three major types of batteries that are commonly used in portable instruments: disposable alkaline, rechargeable lithium ion (Li-ion) and rechargeable nickel metal hydride (NiMH) batteries.

Portable instruments can be powered by disposable alkaline batteries, rechargeable batteries, or may be able to use both types of batteries. A primary advantage of rechargeable batteries is overall cost effectiveness. Frequent (or daily) replacement of disposable batteries can be expensive; and is increasingly viewed as environmentally objectionable. Some instrument designs offer interchangeable rechargeable and alkaline battery packs. Other designs allow the optional use of either alkaline or “off the shelf” rechargeable batteries.

Contractors who only use their instruments occasionally often find disposable batteries are an easier solution than charging and maintaining rechargeable batteries. For other instrument users, simply having the ability to use disposable batteries “in a pinch” is a strong design advantage.

Make sure any disposable or rechargeable off-the-shelf batteries you use are approved by the manufacturer. The owner’s manual will list the batteries which are approved for use. Using a non-approved battery, even if it fits the instrument and seems to work, can void intrinsic safety and other certifications carried by the instrument.

Alkaline batteries have the benefit of convenience, but they suffer from poor performance in low temperatures. Generally, when the temperature is below freezing, instrument users should avoid alkaline batteries. The batteries may work for a while, but once the internal temperature in the battery drops below freezing, the amount of available power drops as well.

The most common types of rechargeable batteries are lithium ion (Li-ion) and nickel metal hydride (NiMH) batteries. Each type of rechargeable battery has specific advantages and limitations. The weight of the instrument, run time, time to recharge the battery and the number of charging cycles that the battery can survive without loss of capacity are all affected by the type of battery included in the design. Less obviously, the temperature code and operating ambient temperature range over which the instrument’s certification for intrinsic safety applies are also affected (or limited) by the type of batteries used in the design.

Battery and battery charger manufacturers have made major improvements in their designs over the last few years. Today's "smart" battery chargers contain electronics for assessing the condition of the battery pack during charging and are able to drop from a "fast" charge rate to a "trickle" the moment charging is complete. The "trickle" charging rate is too low to produce damage or loss of capacity due to heating. As a result, instruments containing rechargeable batteries can be recharged in a very short period, while still being left on the charger for long periods of time without damage.

Li-ion batteries do not suffer from charging “memory” issues, and they do not lose capacity as a function of over-charging or lack of exercise. Li-ion batteries do not require periodic cycling to prolong life. **Li-ion** batteries have low internal self-discharge rates and lose power only very slowly in storage. The materials used in Li-ion batteries are environmentally friendly, and Li-ion batteries are better in cold temperatures than alkaline batteries.

Lithium ion batteries share a major concern. The electrolyte is a flammable liquid, and Li-ion batteries are prone to internal short-circuiting if mechanically damaged.

If you slice a Li-Ion battery in half it looks like a jelly roll with many extremely thin layers. A non-conductive separator layer is used to keep the cathode and anode layers apart. The electrolyte consists of salts and other additives in a solvent solution. It serves as the conduit of **lithium** ions between the cathode and anode layers. Mechanical damage that allows the anode and cathode material to directly come into contact can lead to run-away short circuiting, which causes the battery to heat. When the internal temperature reaches the auto-ignition temperature of the electrolyte, the battery can burst into flame.

Li-ion battery fires are extremely difficult to put out! This is the reason that airlines prohibit electronic devices equipped with rechargeable Li-ion batteries being checked in baggage. While you are allowed to take Li-ion battery equipped devices with you into the cabin, the safety briefing warns you to be careful you do not do anything that could mechanically damage the device, (like getting it caught in a reclining seat mechanism). If you have ever seen video footage of a burning Li-ion battery pack, you will know why the airlines are so concerned.

Nickel metal hydride (NiMH) batteries have several safety advantages over Li-ion batteries. The electrolyte is not flammable, and they are not prone to run-away short circuiting. NiMH batteries are generally the best choice for low temperature operation. While all types of rechargeable batteries are affected by cold temperatures, NiMH batteries are typically usable down to -20°F (-29°C) with only a modest loss of operation time. They can be used for shorter periods of time in even colder temperatures.

NiMH batteries are durable and able to survive up to 500 complete charging cycles without a significant loss of capacity. To avoid harming the battery, compared to Li-Ion battery chargers, NiMH chargers can take a little longer to fully recharge depleted batteries. While rechargeable NiMH batteries can be left on the charger for prolonged periods of time without damage, they still benefit from periodically being deep-discharged, and most instruments that include this type of battery also include an automatic deep discharge cycle.

For maximum flexibility, being able to use disposable batteries is a strong design advantage. But when battery safety, cold temperature operation, and / or the certifications carried by the instrument are the major concerns, NiMH batteries are usually the best choice.