Comparison of Key Li/SO_2 and Li/MnO_2 Battery Properties

Property	Lithium Sulfur Dioxide	Ultralife Lithium Manganese Dioxide
Cathode	Liquid	Solid
Voltage delay phenomenon	Yes	**No**
Pressurized before discharge	Yes	**No**
Pressurized when discharged	No	No
Pressure containment/bulging	Good	Good
Low pressure safety vent	No	**Yes**
High pressure safety vent	Yes	**No**
Toxic electrolyte	Yes	**No**
Flammable electrolyte	No	Yes
Corrosive electrolyte	Yes	**No**
Safety shutdown separator	No	**Yes**
Low temperature capability ➢ High rate discharge ➢ Pulse discharge	 Good Good	 Good Good
Shelf/operational life	10 years	10 years
Open circuit voltage	3.0 volts	3.2 volts
D-Cell Capacity	7.5 Ah	**11.1 Ah**

As shown in the table, lithium/manganese dioxide batteries have many desirable advantages over lithium-sulfur dioxide batteries. These include the following:

Voltage delay phenomenon. The Li/MnO_2 cell uses a solid cathode while the other system uses a liquid cathode. Liquid cathode systems such as Li/SO_2 suffer from a voltage delay phenomenon causing the cell voltage to be suppressed when a load is applied, particularly after extended periods of storage with no use. This condition is exacerbated at low temperatures resulting in the possibility that a liquid cathode battery will not start up when called into use. The Li/MnO_2 system does not suffer from the voltage delay phenomenon.

Pressurized before or during discharge. The Li/MnO_2 chemistry is a non-pressurized system, unlike Li/SO_2, which contains pressure before and during discharge, resulting in a potentially less-safe system than Li/MnO_2.

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High-pressure safety vent. Because they are either pressurized before or during discharge, the liquid cathode systems must contain a high-pressure release vent to release the electrolyte from the steel can should the cell become overheated due to internal or external short circuit or external heating.

Toxic and corrosive electrolyte. Liquid cathode systems such as Li/SO_2 contain toxic and corrosive electrolytes, which can result in safety problems and equipment damage in the event of cell leakage or venting. These electrolyte solvents are also noxious, quickly replacing oxygen when released in an enclosed space. The Li/MnO_2 chemistry is less toxic, non-corrosive and contains no noxious gases.

Safety shutdown separator. Ultralife's Li/MnO_2 cell electrodes are assembled with a safety shutdown separator, which activates at a predetermined design temperature due to heating when the cell is overloaded, short circuited or exposed to elevated temperatures. When the cell internal temperature reaches 135° C, the separator activates, closing off most of the pores in the microporous separator, significantly reducing ion flow. The resultant reduction in current flow permits the cell to accept a short circuit or overload condition and discharge without venting. The safety shutdown is a non-reversible process. Once the cell has shut down it is no longer usable. Li/SO_2 cells are not available with this important safety feature.

Low temperature, high rate discharge operation. While this characteristic is considered good for both chemistries, it should be noted that in cases of long storage periods the liquid cathode system will experience a voltage start-up delay phenomenon as described above.

Capacity. Ultralife's Li/MnO_2 cells provide up to 50% more capacity in the same amount of space than Li/SO_2 cells.

Lithium-Sulfur Dioxide batteries are being phased out. Because of a number of incidents resulting in soldier injuries, and the possible venting of toxic and noxious sulfur dioxide gas, the Li/SO_2 battery chemistry is losing favor for military applications and is starting to be replaced by Li/MnO_2 batteries.