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DRAWBACKS OF Li IONS BATTERIES FOR ENVIRONMENT

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Abstract: Air travelers ask the question, "How much lithium in a battery am I allowed to bring on board?" We differentiate between two battery types: Lithium metal and lithium-ion. Most lithium metal batteries are non-rechargeable and are used in film cameras. Lithium-ion packs are rechargeable and power laptops, cellular phones and camcorders. Both battery types, including spare packs, are allowed as carry-on but cannot exceed the following lithium content: 2 grams for lithium metal or lithium alloy batteries - 8 grams for lithium-ion batteries Lithium-ion batteries exceeding 8 grams but no more than 25 grams may be carried in carry-on baggage if individually protected to prevent short circuits and are limited to two spare batteries per person.

I. THE LITHIUM POLYMER BATTERY

The lithium-polymer differentiates itself from conventional battery systems in the type of electrolyte used. The original design, dating back to the 1970s, uses a dry solid polymer electrolyte. This electrolyte resembles a plastic-like film that does not conduct electricity but allows ions exchange (electrically charged atoms or groups of atoms). The polymer electrolyte replaces the traditional porous separator, which is soaked with electrolyte.

The dry polymer design offers simplifications with respect to fabrication, ruggedness, safety and thin-profile geometry. With a cell thickness measuring as little as one millimeter (0.039 inches), equipment designers are left to their own imagination in terms of form, shape and size.

Unfortunately, the dry lithium-polymer suffers from poor conductivity. The internal resistance is too high and cannot deliver the current bursts needed to power modern communication devices and spin up the hard drives of mobile computing equipment. Heating the cell to 60°C (140°F) and higher increases the conductivity, a requirement that is unsuitable for portable applications.

To compromise, some gelled electrolyte has been added. The commercial cells use a separator/ electrolyte membrane prepared from the same traditional porous polyethylene or polypropylene separator filled with a polymer, which gels upon filling with the liquid electrolyte. Thus the commercial lithium-ion polymer cells are very similar in chemistry and materials to their liquid electrolyte counter parts.

Lithium-ion-polymer has not caught on as quickly as some analysts had expected. Its superiority to other systems and low manufacturing costs has not been realized. No improvements in capacity gains are achieved - in fact, the capacity is slightly less than that of the standard lithium-ion battery. Lithium-ion-polymer finds its market niche in wafer-thin geometries, such as batteries for credit cards and other such applications.

Advantages

- Very low profile - batteries resembling the profile of a credit card are feasible.
- Flexible form factor - manufacturers are not bound by standard cell formats. With high volume, any reasonable size can be produced economically.
- Lightweight - gelled electrolytes enable simplified packaging by eliminating the metal shell.
- Improved safety - more resistant to overcharge; less chance for electrolyte leakage.

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Limitations

- Lower energy density and decreased cycle count compared to lithium-ion.
- Expensive to manufacture.
- No standard sizes. Most cells are produced for high volume consumer markets.
- Higher cost-to-energy ratio than lithium-ion

II. Restrictions on lithium content for air travel

Air travelers ask the question, "How much lithium in a battery am I allowed to bring on board?" We differentiate between two battery types: Lithium metal and lithium-ion. Most lithium metal batteries are non-rechargeable and are used in film cameras. Lithium-ion packs are rechargeable and power laptops, cellular phones and camcorders. Both battery types, including spare packs, are allowed as carry-on but cannot exceed the following lithium content:
- 2 grams for lithium metal or lithium alloy batteries
- 8 grams for lithium-ion batteries

Lithium-ion batteries exceeding 8 grams but no more than 25 grams may be carried in carry-on baggage if individually protected to prevent short circuits and are limited to two spare batteries per person.

How do I know the lithium content of a lithium-ion battery? From a theoretical perspective, there is no metallic lithium in a typical lithium-ion battery. There is, however, equivalent lithium content that must be considered. For a lithium-ion cell, this is calculated at 0.3 times the rated capacity (in ampere-hours).

Example: A 2Ah 18650 Li-ion cell has 0.6 grams of lithium content. On a typical 60 Wh laptop battery with 8 cells (4 in series and 2 in parallel), this adds up to 4.8g. To stay under the 8-gram UN limit, the largest battery you can bring is 96 Wh. This pack could include 2.2Ah cells in a 12 cells arrangement (4s3p). If the 2.4Ah cell were used instead, the pack would need to be limited to 9 cells (3s3p).

III. Restrictions on shipment of lithium-ion batteries

- Anyone shipping lithium-ion batteries in bulk is responsible to meet transportation regulations. This applies to domestic and international shipments by land, sea and air.
- Lithium-ion cells whose equivalent lithium content exceeds 1.5 grams or 8 grams per battery pack must be shipped as "Class 9 miscellaneous hazardous material." Cell capacity and the number of cells in a pack determine the lithium content.
- Exception is given to packs that contain less than 8 grams of lithium content. If, however, a shipment contains more than 24 lithium cells or 12 lithium-ion battery packs, special markings and shipping documents will be required. Each package must be marked that it contains lithium batteries.
- All lithium-ion batteries must be tested in accordance with specifications detailed in UN 3090 regardless of lithium content (UN manual of Tests and Criteria, Part III, subsection 38.3). This precaution safeguards against the shipment of flawed batteries.
- Cells & batteries must be separated to prevent short-circuiting and packaged in strong boxes.

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