The Future of Battery Technologies – Part V Environmental Considerations for Lithium Batteries

The fifth and final installment of Intertek's series of white papers on "The Future of Battery Technologies" focuses on the impact of lithium batteries on the environment. Which batteries are classed as environment friendly, what does the EU Battery Directive address and how are materials inside the batteries recycled?

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Environmental Considerations for Lithium Batteries

There is a growing awareness of and interest in environmental issues across all sectors of society in recent years. Many people argue that our long-term survival depends upon reducing our impact on nature and that we must stop releasing toxic materials into the environment. Batteries are not yet covered by legislation on chemicals, but the "Regulation on Batteries," which is based on the EU Battery Directive, governs the use of certain heavy metals in batteries. Unfortunately, this legislation has not kept pace with technological developments in the battery field. This is also the case when it comes to environmental labeling requirements on batteries, such as the Swan Label.

There are at least three key factors that can be used when determining how environment friendly a battery is:

- Battery lifespan and the number of cells required to achieve the desired battery function in the equipment or apparatus
- Recyclability
- Chemical content

Upper Limits and Labeling Requirements

The EU Battery Directive is currently the most far-reaching Directive on the regulation of hazardous elements that are used in batteries. The Directive includes both fixed upper limits by weight for how much cadmium (20 ppm) and mercury (5 ppm) batteries can contain, with the exception of military and certain industrial batteries, plus batteries for emergency and alarm systems, cordless power tools and a number of medical equipment products. The Battery Directive and all related national legislation within the EU also covers labeling requirements for batteries with mercury (5 ppm), cadmium (20 ppm) and lead (40 ppm) content along with requirements on the collection and treatment of spent batteries, irrespective of the particular type of battery.

Several countries in Asia (e.g. China, Japan and Singapore) have introduced regulation on heavy metals and batteries. Parts of the USA and Canada have also come a long way on the collection and treatment of batteries.

No Mercury, Cadmium or Lead

None of the listed elements (mercury, cadmium and lead) play a part in electrochemical cells in lithium batteries and therefore, there is no reason for manufacturers to deliberately include them. Where they are found, it is in the form of contamination of raw materials used. It is extremely unusual for lithium-based cells or batteries to contain problematically high levels of these elements. This has persuaded some manufacturers of these batteries to claim their products are "green" and environment friendly. The basis for such claims is debatable as lithium batteries, and rechargeable lithium-ion batteries in particular, are extremely complex and can contain a large number of different elements in varying degrees. This relationship is also reflected in the environment labeling requirements specified by Swan, which currently regulates these three heavy metals and, in the case of rechargeable batteries, arsenic.

Rechargeable Batteries are Preferable

Generally speaking, rechargeable batteries are more environment friendly than single-use batteries when used in the same application. This is because the total amount of battery waste will be lower as the same battery can be recharged numerous times, hundreds of times as a rule. Within the group of primary batteries (single use batteries), lithium cells offer an advantage in the form of higher energy density compared to alkaline batteries, which enable a longer operating time. Most primary lithium cells also have a higher cell voltage which also means they need fewer cells to achieved the desired operating voltage in the apparatus. Both these characteristics help make primary lithium cells appear more advantageous than other primary cells from an environment perspective, as fewer cells are required to achieve the same performance and lifespan. These same arguments can be used in favour of lithium-ion cells, as these have a higher cell voltage than other rechargeable cell types.

Nickel From the Toyota Prius Can be Recycled

Recyclability is totally dependent on the availability of efficient collection systems that ensure batteries do not end up in landfill sites and that there are financial incentives to recover the materials found in batteries. Here, traditional chemical batteries (e.g. lead, nickel cadmium and nickel metal hydride batteries) are actually an advantage compared to lithium-ion batteries, as traditional batteries have a high content of metals that have a second-hand value on the commodities markets. Exhausted lead batteries can be used directly in the manufacture of new lead batteries. Nickel from nickel cadmium and nickel metal hydride batteries is used by the steel industry in the manufacture of stainless steel. However, recycled nickel is not yet of sufficiently high quality to be used in new batteries.

Toyota has just announced that they have developed a method that enables them to recover nickel from old Prius batteries that can be used in new ones. It will be interesting to follow this development and whether this method can be used for nickel metal hydride batteries of the consumer type. Cadmium can also be recovered and recycled in the production of new nickel cadmium batteries.

Spent Cell Content Used in Construction Industry

Lithium-ion batteries contain relatively small quantities of elements that are financially viable to recover. The large variety of cell chemistries available on the market also makes recycling more difficult. There are recycling processes currently available for lithium-ion batteries that recover cobalt, nickel and copper from battery waste. The residual cell content is combusted and the ash can be used in the construction industry. The trend within lithium-ion technology is moving towards a development characterised by an increased use of materials that are not of interest to recover, such as manganese dioxide, iron phosphate and mixed oxide materials with little or no cobalt in the mix. As a consequence, the cost of collection and recycling of lithium-ion batteries can largely fall on users when the manufacturers attempt to recoup their manufacturer product liabilities.

Heavy Metals in Lithium Ion Batteries

Although lithium-ion batteries do not contain mercury, cadmium or lead, the content of these batteries does include other heavy metals that can be problematical for the environment. Cobalt, copper and nickel are examples of metals that occur in significant quantities in many cases. There are also a large number of trace element metals that can reach toxic levels if batteries are discarded in sufficiently large quantities in a limited area. To which can be added electrolytes in the form of organic solvents with various different ingredients, such as flame-retardants that can damage the environment if the batteries are not collected and disposed of in a professional way. In this respect, one can also include the original environmental impact of mining the minerals that are used in the cell manufacturing raw materials. Cobalt production in Congo-Kinshasa has been named as a potential problematical process from both an environmental and ethical perspective. It is not out of the question that the fast growing demand for lithium-ion batteries globally within the car industry can lead to the focus falling on other elements and manufacturing processes.

Product Life Cycle Must be Considered

The environment impacts of batteries is a very complex issue. In order to be able to evaluate and compare different batteries against each other, it is desirable to take the entire life cycle of the product into account: the extraction and refining of the raw materials, cell and battery manufacturing, product lifespan in operation plus waste disposal and recycling processes. Both manufacturers and consumers of battery-powered products should do their utmost to minimize the total number of batteries required during the lifetime of the product in order to minimize its environmental impact. It is also important to persuade users to take batteries to recycling points and to continue work on developing technology that enables as much recycled material as possible to be used.