Clevertronics
Emergency Lighting Innovation

Emergency Lighting Discussion Paper

Is the search for a battery that is harmless to humans and the environment finally over?

In recent years the advancements in LED lamp technology has enabled the development of a new breed of low energy and low maintenance exit and emergency lighting products. The rapid uptake of this technology has been driven by the enormous energy, maintenance and environmental benefits that this delivers.

On the flip side these same products use batteries that contain materials that are toxic to both human health and the environment. The nature of the manufacture and disposal of these batteries are real issues that need genuine attention. After all emergency lighting is about saving lives- but at what cost to the environment and risk to human health? However, probably due to the lack of alternatives for our industry, discussion on the environmental damage and risk to humans through battery manufacturing and disposal has received limited exposure.

The three battery technologies used today are Nickel Cadmium, Lead Acid and Nickel Metal Hydride. All contain one or more of the toxic heavy metals Nickel, Lead or Cadmium[1, 2, 3.] Nickel and Cadmium are "known" carcinogens and Lead is categorized as a "probable" carcinogen[4]. Battery collection and recycling programs around the world are still in very early stages and unfortunately almost all of the batteries we supply in Australia are destined for landfill or incineration.[19]

An alternative battery technology featuring better emergency lighting application performance- Lithium Iron Phosphate (LiFePO4 or LFP) - contains no toxic heavy metals and no carcinogens.[4, 5, 9] A variant of LiFePO4 batteries using a patented "nanophosphate" for the cathode material achieves at least twice the calendar life of the existing battery technologies and because it features a much higher energy density, is less than half the size and weight. These LFP batteries have a much lower self-discharge rate, and that translates to lower power charging circuitry than ever before possible. The environmental impact of LFP battery technology is tiny compared with the damage caused by any of the three current technologies.

The LFP battery represents a quantum leap in terms of sustainability outcomes, not to mention more than halving maintenance costs. It may even qualify as the single biggest leap in emergency lighting performance ever. But is it "environmentally friendly"? Is it actually "harmless" to the environment?

There is an abundance of published studies and technical evidence that support the assertion that Lithium Iron Phosphate batteries are less harmful to humans and our environment by a long, long way. But our view is that making outright claims that LFP (or any) batteries are actually "harmless" or "environmentally friendly" is impossible and plain silly and should be met with the scepticism those types of claims deserve. Environmental impact issues are far too complex for such closed statements, and comparative statements like "far less harmful" or "more environmentally friendly" are more sensible.

Clevertronics specialise in emergency lighting- we are not a battery manufacturer. But crucial to the performance of our product is a quality rechargeable battery. Our aim is to use the best technology available to deliver the best performance outcome for the specific application of emergency lighting. In this respect when choosing battery technologies we are consumers like everyone else- and this discussion is an insight into some of the specific human and environmental considerations we had in the search for a better battery alternative.

Battery Toxicity Comparison

Comparing the toxicity of the three battery technologies used today: Nickel Cadmium, Lead Acid and Nickel Metal Hydride with Lithium Iron Phosphate.

Relative threat to human health - toxic heavy metals and carcinogens

Toxic heavy metals are dangerous because they tend to bioaccumulate.[6] Bioaccumulation occurs when an organism (like a human or plant) absorbs a toxic substance at a rate greater than that at which the substance is lost- increasing the risk of chronic poisoning. Batteries can leach toxins (such as cadmium, lead or mercury) into the ground, contaminating soil and water. If groundwater is contaminated, it carries the contaminants with it as it moves.

In the US, the Agency for Toxic Substances and Disease Registry (ATSDR) produces a Priority List of Hazardous Substances which are "determined to pose the most significant potential threat to human health due to their known or suspected toxicity and potential for human exposure" at NPL (National Priority List) hazardous waste sites1. Listed at number 2 (only behind Arsenic) is Lead. Cadmium is listed at 7 and Nickel at 57. Lithium is listed at number 334 and Iron doesn't make the list.

The Australian Federal Government has a similar list called the National Pollutant Inventory and produces Substance Fact Sheets on the 93 priority hazardous substances based on possible health and environmental effects.[2] Ranked by environmental and health risk Lead is at number 11, Cadmium at number 6 and Nickel at 32. Lithium is not ranked on the master list of 400 substances. These low or non-rankings are not because Lithium is absolutely harmless to humans in every situation, but because it is not rated in the same risk category as other materials on the list.

Both Nickel and Cadmium are Group 1 "known" carcinogens, and the International Agency for the Research on Cancer lists Lead in the next group down, as a Group 2A "probable" carcinogen[4]. There is no evidence that Lithium is a potential carcinogen and research concludes that it is highly unlikely to be carcinogenic.[5, 9]

The manufacture of Nickel Metal Hydride, Nickel Cadmium and Lead Acid batteries pose a significant risk to production workers and the environment.[16, 17] The toxic heavy metals used and the additional risk of exposure to carcinogenic materials in the two Nickel batteries require strict OH&S measures and emission and waste material control. In comparison, Lithium Iron Phosphate batteries contain no toxic heavy metals and no carcinogens. CSIRO and other LFP related research concludes that human and environmental toxicity is low9, 18 and general research and information articles refer to LFP battery material as non-toxic or benign.

In Europe the Restriction of Hazardous Substances Directive 2002/95/EC (RoHS) is part of a legislative initiative to solve the problem of huge amounts of toxic electronic waste by restricting the use of certain hazardous substances in electrical and electronic equipment. Although the three battery technologies used today contain toxic heavy metals all batteries are exempted from RoHS, and instead fall under the Batteries Directive 2006/66/EC. This aims to reduce the impact on the environment of the manufacture, distribution, use, disposal and recovery of batteries.

The Battery Directive prohibits the marketing of all batteries with more than 0.0005% mercury and 0.002% cadmium by weight. This is why you cannot find NiCd batteries in the supermarket anymore. But emergency lighting has been specifically exempted from this requirement, along with some other "critical use" or "essential security" applications like medical equipment, space, military and munitions. In an acknowledgment of the specific requirements of exit and emergency lighting- a life safety product- and the lack of alternative battery technologies with the long term reliable performance of Nickel Cadmium, emergency lighting is still permitted to use Nickel Cadmium batteries.

On the other hand, with none of the hazardous materials targeted by these EU regulations, Lithium Iron Phosphate batteries are RoHS compliant. This was a major reason why LFP technology was selected for the One Laptop Per Child project, which has distributed over 2.4 million laptops throughout the developing world8. With the stated aim of empowering the world's poorest children through education, long life and environmental sustainability were critical considerations when building the laptops.

Battery Disposal And Recycling

Recycling batteries of all types makes sense as it keeps both toxic and non-toxic materials out of landfills and incineration and reduces the volume of raw material extraction and refining. The net environmental and human impact of disposal versus recovery involves measuring the damage caused through extracting, transporting and refining raw materials compared to the damage caused by the complexity of the recycling process itself. The fact that in many cases recovering materials from recycling is more expensive than extracting those materials from the ground adds another layer of complexity – who should pay?

In Australia, battery recycling is at a very early stage and almost all batteries sold are destined for landfill or incineration. A 2010 study commissioned by the Australian Battery Recycling Initiative (ABRI) estimated that around 345 million "handheld" batteries (batteries weighing less than 1kg) are consumed each year.[19] It found that only 6% by weight and 4% by number are recycled at present. We estimate that the emergency lighting industry accounts for around 5 million of those batteries each year and 500 tonnes of emergency lighting batteries find their way in to landfill each year.

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