



Hazardous waste

Household batteries: discharging toxins

It is a hallmark of modern times that we are so occupied with conveniences and efficient methods of doing things that we do not pause to ask the most basic of questions. We are, as a result, ill-informed about the products that we use on a daily basis. How are they manufactured? What resources do they use up? How do they affect the environment? Do they disappear when we throw them away? These are questions to which we almost never seek the answers.

Batteries are a case in point. We all use batteries of different kinds and makes, in scores of daily appliances. They are a handy source of energy that undoubtedly enhance our quality of life. But with the same certainness, they are poisoning our environment, and our future.

True to their structure, batteries have a positive and a negative aspect. On the positive side, they help us communicate, travel, entertain, research, educate and do a multitude of daily tasks. On the negative side, batteries leak dangerous heavy metals –

cadmium, mercury, copper, zinc, lead, manganese, nickel and lithium – into the environment. These metals settle into the soil, water and air and threaten the well-being of generations. There are several other minor disadvantages associated with batteries: their misuse and mishandling can lead to fires, injury and the release of toxic gases.

What is a battery?

Simply put, a battery is an electrochemical device which converts chemical energy into electrical energy. It consists of an anode (the positive terminal), a cathode (the negative terminal) and an electrolyte (the chemical solution through which the electrons flow from anode to cathode, creating an electrical charge).

There are two types of batteries:

- ◆ Primary batteries: those that can not be reused. These include alkaline/manganese, carbon-zinc, mercuric-oxide, zinc-air, silver-oxide, and other types of button batteries.

AT A GLANCE

- ❖ Due to the presence of various heavy metals, batteries fall in the category of hazardous waste.
- ❖ Industrialised nations dispose off batteries in special landfills meant for hazardous waste.
- ❖ India has no such measures for the safe disposal of batteries, which land up in dump yards that are not equipped to contain harmful leachates.
- ❖ Heavy metals are harmful to our health in many ways. They can damage the lungs, kidneys and the nervous system.
- ❖ Recycling of batteries is one way of minimising the generation of heavy metal waste.
- ❖ As in developed countries, the Indian battery industry also needs to initiate recovery systems for used batteries, and research safer alternatives.



Batteries are a source of dangerous heavy metals such as cadmium, mercury, copper, zinc, lead, manganese, nickel and lithium

The battery industry in India

Almost two to three billion batteries are sold in the Indian market annually, at an average of about three batteries per person. It is estimated that a person living in urban India owns two button batteries, five normal batteries and discards six household batteries per year. Eveready dominates the Rupees 13 billion battery market with a 43 per cent market share in the dry cell battery segment (where the electrolyte is either in non-liquid form – a paste or gel – or absorbed in a porous separator material). Other major players are Lakhanpal National, Indo National and Geep (now owned by Gillette). With the emergence of the alkaline battery (a variant of the dry cell in which the electrolyte is in solution form, generally potassium hydroxide), the dry cell battery segment has been witnessing low growth rates. Key brands in the alkaline segment are BPL's Excel, Gillette's Duracell and Eveready's Energizer. The alkaline segment has also slowed down after a strong growth witnessed in the initial years. Eveready markets the entire spectrum of batteries, and accounted for 710 million units in 2000. The dry cell segment constitutes 1.7 billion pieces per year. The Indian battery industry had faced a significant threat from low-priced Chinese batteries. However, the anti-dumping duty imposed by the government has helped the cause of the battery industry.

Industry market shares

Company	Market share (%)
Dry cell batteries	
Eveready	41
Indo-National	29
Lakhanpal	22
Geep	8
Alkaline batteries	
Gillette	47
Eveready	28
BPL	25

- ◆ **Secondary batteries:** those that can be reused or recharged. These include lead-acid, nickel-cadmium and potentially nickel-hydrogen batteries.

Types of batteries

Nickel-cadmium batteries

Nickel-cadmium batteries consist of a nickel cathode, a cadmium anode, and an alkaline solution that serves as an electrolyte.

These batteries are rechargeable and are found in traditional cylindrical battery sizes as well as in a wide variety of battery packs. The battery packs are used in portable gadgets such as cordless telephones, video cameras, hand-held vacuum cleaners and cordless power tools.

In many developed countries it is mandatory to recycle these batteries due to their high level of toxicity. Cadmium from these batteries is a toxic metal that is harmful to human health and the environment.

Nickel-cadmium batteries can be reprocessed to reclaim the nickel. However, approximately 80 percent of all nickel-cadmium batteries are permanently sealed in appliances.

Alkaline and zinc-carbon batteries

Alkaline and zinc-carbon batteries represent about 70 per cent of the batteries market. Typically, they contain a manganese-dioxide cathode and a zinc anode. The electrolyte is usually potassium-hydroxide or sodium-hydroxide, while in a zinc-carbon battery the electrolyte is ammonium-chloride or zinc-chloride.

In the past, mercury was used in these batteries to prevent the creation of hydrogen gas which is corrosive in nature. The presence of mercury made recycling of these batteries unviable and therefore laws in developed countries have restricted the levels of mercury allowed in alkaline and zinc-carbon batteries. In fact, alkaline batteries are required to have zero per cent mercury in developed countries. In India, however, there is no law for mercury reduction. While batteries manufactured in the organised sector are required to have zero mercury, there are a significant number of such batteries manufactured in the unorganised sector in India. Also, such batteries manufactured before 1992 have been determined to have mercury and should be considered hazardous household waste.

With the advent of zero-mercury alkaline batteries, the economics of recycling them should be more favourable and we may begin to see more recycling facilities for such batteries.

Sealed lead-acid batteries

Sealed lead-acid batteries are rechargeable and are used in camcorders, cordless phones and power tools. They contain a lead-dioxide or lead-sulphate cathode, a lead anode and a sulphuric acid electrolyte.

Lead-acid batteries used in cars and two wheelers contain high amounts of lead. According to the Battery (Management & Handling) Rules 2000, used lead-acid batteries should be returned only to authorised battery dealers.

Silver-oxide batteries

Silver-oxide batteries are used in watches, calculators and hearing aids as button cells. They contain a zinc anode, a silver-oxide cathode and an alkaline solution as the electrolyte. They also contain mercury to prevent the formation of hydrogen gas.

Most jewellery stores recycle silver-oxide batteries to recover the silver component. But the recycling of these batteries is hampered owing to the fact that identifying them takes time since they appear similar to other button cell batteries. Sorting is a labour-intensive and potentially dangerous activity which requires familiarity with various types of batteries.

Lithium batteries

Lithium batteries are used primarily for cameras and contain a lithium anode and various types of cathodes and electrolytes.

A fully discharged lithium battery converts the lithium into various lithium compounds that are inert and non-toxic. But if lithium is present it may combine with other material since it is a highly reactive metal and, when collected with other button cells, may present a hazard if not fully discharged.

Unlike other button cells, lithium batteries do not contain mercury. Lithium batteries are currently not being recycled.

Zinc-air batteries

Zinc-air batteries are used primarily for hearing aids. They have a zinc anode, while oxygen from the atmospheric air acts as the cathode. The electrolyte is made up of an alkaline solution. They contain about one per cent mercury by weight, which acts as a gas suppressant.

The hazards of batteries

Due to the presence of various heavy metals, batteries fall in the hazardous waste category. The heavy metals are extremely harmful, and can produce the following problems if disposed in open dumps:

- ◆ They may pollute lakes and streams.
- ◆ The heavy metals may leach from landfills.
- ◆ When burned, some heavy metals such as mercury may vapourise and escape into the air, and cadmium and lead may end up in the ash.



The specific effects of heavy metals on our health are discussed here:

- ◆ **Cadmium:** occupational exposure to high concentrations of airborne cadmium can damage the lungs. Exposure to low levels over a long period of time can cause severe and irreversible damage to the kidneys. There is no medical treatment that can prevent the accumulation of cadmium in the kidney, nor is there a way to reduce or eliminate the amount of cadmium once it is stored in the kidney.
- ◆ **Copper:** copper can pose chronic toxicity problems leading to debilitation or even death. Acute-onset gastrointestinal irritation and inflammation are common indicators of copper toxicity at sufficient levels of exposure. Symptoms associated with copper toxicity may include nausea, abdominal cramping, diarrhoea, vomiting, and headaches.
- ◆ **Lead:** lead damages the central and peripheral nervous systems, blood systems, kidney and reproductive systems. Effects on the endocrine system have been observed and its serious negative effects on children's brain development are well documented. Lead also accumulates in the environment and has high acute and chronic effects on plants, animals and micro-organisms.
- ◆ **Lithium:** the substance is corrosive to the eyes, the skin and the respiratory tract. Inhalation of lithium may cause lung oedema. The symptoms of lung oedema are manifested after a few hours and are aggravated by physical effort. Heating may cause violent combustion or explosion. The substance may spontaneously ignite on contact with air when finely dispersed. Heating also results in toxic fumes. Lithium reacts violently with strong oxidants, acids and many compounds (hydrocarbons, halogens, halons, concrete, sand and asbestos) causing fire and explosion hazard. Reacts violently with water, forming highly flammable hydrogen gas and corrosive fumes of lithium hydroxide.
- ◆ **Mercury:** mercury can cause damage to various

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organs including the brain and kidneys, as well as the foetus. Most importantly, the developing foetus is highly susceptible to mercury through maternal exposure.

- ◆ **Nickel:** the health effects are highly dependent on the manner and degree of exposure and on the exact chemical 'species' in which the nickel atoms are present. The health effects include allergy of the skin, resulting in dermatitis and allergy of the lung, resulting in asthma. Nickel tetracarbonyl – an intermediate in the Mond process for refining nickel – is very toxic to the lungs and heart.
- ◆ **Zinc:** prolonged consumption of excess zinc may decrease serum high-density lipoprotein levels; damage the pancreas; cause irritability, muscular stiffness and pain, loss of appetite, nausea, vomiting, and anemia; and interfere with the ability of the body to absorb and use other minerals.

How to regulate household batteries

India does not have any guidelines for disposing of batteries. As a result they end up in landfills or open dumps as part of the solid municipal waste. This results in large quantities of heavy metal either leaching into the ground water, or ending up in the air due to open burning in landfills.

Some municipalities, like those of Suryapet, Andhra Pradesh and ITC Bhadrachalam have started separating household batteries from municipal solid waste. But they are not sure what to do with them after collecting them.

In developed countries, batteries that are collected through household battery collection programmes are disposed off in specially constructed hazardous waste landfills.

In India too, the industry needs to organise such collection programmes that can practically and cost-effectively reclaim all types of household batteries.

Recycling and disposal methods in developing countries

Batteries with high levels of mercury or silver are recycled to recover the mercury and silver for the refining process. Recycling programmes for household batteries are still not widespread due to the limited number of processing facilities available in the developed countries. Most of the battery waste is disposed in specially constructed hazardous waste landfills.

In developed countries, mercury-oxide and silver-oxide button batteries are sometimes collected by jewellers, pharmacies, hospitals and electronic or hearing aid stores for shipping to companies that reclaim mercury or silver.

Source reduction changes in household batteries

The world over, mercury reduction in batteries began in 1984 and continues today. During the last five years, the industry has reduced the total amount of mercury usage by about 86 per cent. Some batteries such as alkaline batteries have had upto 97 per cent mercury reduction in their mercury component.

Newer alkaline batteries may contain about one-tenth the amount of mercury previously contained in alkaline batteries; some alkaline batteries have zero mercury. Several mercury-free, heavy-duty, carbon-zinc batteries are also available in the market.

Mercuric-oxide batteries are being gradually replaced by new technology such as silver-oxide and zinc-air button batteries that contain lesser mercury. Alternatives to nickel-cadmium rechargeable batteries are being researched: cadmium-free nickel and nickel-hydride systems are being studied, but nickel-cadmium is unlikely to be totally replaced.

Reduction of household battery waste

To reduce waste, prevention is a must. The following steps will help you in reducing the amount of battery waste:

- ◆ Check to see if you already have the batteries in stock, before buying more.
- ◆ When suited to the task, buy hand-operated items that function without batteries.
- ◆ Look for batteries that have less mercury and heavy metals.
- ◆ Consider rechargeable batteries. They have a longer life-span, but remember that they also contain heavy metals such as nickel and cadmium. As of 1992, the percentage of cadmium in nickel-cadmium batteries was higher than the percentage of mercury in alkaline batteries, so substitution might only replace one heavy metal for another.

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