

Batteries

Introduction

Electricity is the most useful form of energy ever harnessed, and the wish to have it always on tap has inspired a long search for storage methods, which have included pumped water, compressed air, thermal devices, flywheels, superconducting magnets, fuel cells, and of course the oddly named “battery.” The term was coined by Benjamin Franklin in 1748 and referred to the “beating”—shock—delivered by his experimental contraption of charged glass plates. Franklin evidently thought this entertaining.

Devices unearthed near Baghdad in 1936 and dated to 224–640 may have been crude batteries, but most experts are unconvinced. Modern battery history begins with Alessandro Volta around 1800 and includes the work of Galvani, Ampère, Davy, Faraday, and Edison. Lead-acid batteries (now in almost all automobiles) and dry cells were invented in the 1860s. Nickel-cadmium (NiCd) batteries (found in two-way radios, power tools, and video cameras) date to 1899, and the ubiquitous household alkaline battery to 1959. Commercial nickel-metal-hydride (NiMH), used in many of the same devices as NiCd batteries, and lithium-ion batteries (cameras, laptops, cellphones) are less than 20 years old.

Disposal

Battery components such as paperboard, carbon, steel, and plastics are relatively benign when landfilled. But the heavy metals cadmium, mercury, and lead are highly toxic and can vaporize if incinerated or leach into groundwater if landfilled improperly. These problems have spurred a variety of efforts to keep heavy metals out of the environment. Common alkaline batteries once contained significant amounts of mercury, but over the last two decades manufacturers have radically reduced their mercury content. The U.S. auto industry has evolved a system that recycles 98 percent of the more than 2 million tons of automotive lead-acid batteries discarded each year. On the other hand, only one in six North American families recycles its spent household batteries.

In some countries battery recycling requires much manual labor and exposes workers to significant health risks. Many industrial nations use a mix of mechanical and high-heat processes that are very energy intensive; recycling a battery takes up to 10 times the energy required to make a new one. In the United States, the non-profit Rechargeable Battery Recycling Corporation was started in 1994 to collect spent batteries and forward them to recycling firms. Their website (www.rbr.org) offers information on recycling programs and drop-off locations.



Camera batteries on the march, Shanghai, China.



Auto batteries for sale, Tonle Sap Lake, Cambodia.

Manufacture

The global battery industry, which is dominated by Japan, China, and Korea, earns about \$50 billion annually from sales of 15 billion batteries in over 50 sizes; in rectangular, cylindrical, coin, and button shapes; and as disposable or rechargeable types. Ordinary household cylindrical batteries begin as a steel can, into which are inserted various chemicals and metals depending on the type, a fabric membrane (often paper or cardboard) to separate the electrodes, an electrolyte to allow movement of ions within the cell, and a brass pin that conducts current to the outside circuit. Other cell types incorporate similar parts in different configurations.

Manufacturing of primary batteries will be increasingly tilted toward alkaline types, according to projections of demand. Among rechargeable batteries, the familiar lead-acid battery is expected to account for about half of projected sales, partly because of its dominance in automotive applications. Lithium-ion batteries are improving significantly in cost and performance and should continue as the choice power source for portable devices. NiCd batteries, despite some advantages, may be on their way out, in part due to the hazards of cadmium.

