

Open Road

Aluminum

WHAT WOULD MOTORCYCLES be like without aluminum? It's everywhere you look; engines, radiators, wheels, handlebars, whole chassis, parts of the suspension, etc. Some bikes contain so little ferrous metal they can barely trip the embedded magnetic coils in the road to change a stoplight.

Just one-third the weight of a similar volume of steel, aluminum is a relatively soft, malleable, non-magnetic metal that's easy to machine, extrude or cast into complex shapes, has excellent thermal and electrical conductivity and is extremely resistant to corrosion. In fact, it's the thin oxide that quickly forms on the surface of aluminum when it's exposed to the air that protects the underlying metal from any further chemical attack.

Aluminum is the third most abundant metallic element in the Earth's crust, estimated as 8.1%, after oxygen (47%) and silicon (28%). Because of its reactivity and special affinity for oxygen, except for volcanic mud (a rare oxygen deficient environment), it's almost never found alone, like flakes of gold are in a riverbed, but almost always in combination with other elements, and it makes up a part of over 270 different minerals.

Alas, although its many forms are extremely common, most of them are not economical sources for production of the raw metal. Almost all commercial aluminum is recovered from bauxite, a clay-like ore that results from the weathering of low iron and silica bedrock, chiefly occurring in tropical zones. Bauxite contains 45–60% alumina and is mined around the planet, but primarily in Australia, China, Brazil, Guinea and Jamaica.

The process of extracting aluminum from bauxite is particularly difficult, compared to the production of iron, for instance, and aluminum was deemed more valuable than gold in the 19th century.

In the Bayer process, the ground and washed ore is first dissolved in caustic soda (sodium hydroxide) under high temperature and pressure to create a slurry. Undissolved bauxite residues called "red mud" sink to the bottom and are removed. Next the resulting sodium aluminate solution goes to a "digester" where it undergoes further chemical reaction at 300° F for 30 minutes to several hours. This slurry is then passed through settling filters to remove solids, and the clarified solution is sent to giant precipitation tanks six stories tall which grow crystals of pure alumina. The result is dried at 2000° F in rotating kilns to produce alumina powder.



Disassociating the oxygen from the alumina powder is done in smelters, and the Hall-Heroult electrolysis process is the preferred technique. The powder is mixed with molten cryolite at 1800° F and enormous direct electrical currents cause the pure metallic aluminum to be deposited on carbon electrodes—two tons of alumina giving one ton of metallic aluminum. Oddly, a pressure of just 5.25 volts is all that's needed, but the current is almost unbelievable, approximately 150,000 amps. In fact, the power consumed by aluminum production is estimated as 3% of all the power produced on the planet, or more than is used by the entire continent of Africa. China, Russia, Canada, the US and Australia are the top producers of aluminum by volume.

Once an aluminum smelter is built, at a cost of well over a billion dollars, it must run 24 hours a day, seven days a week and must never stop running. A power interruption of even four hours can cause its hundreds of smelting pots to "freeze," requiring elaborate rebuilding.

Because 20-40% of the cost of aluminum production is electrical power, that power must be cheap, and hydroelectric dams are often built in primitive locations, flooding huge areas, just to supply smelters. About half of the world's aluminum production uses hydroelectric power; a third uses electricity created from coal; 10% depends on oil and natural gas and 5% comes from nuclear power.

It is estimated that 95 million tons of greenhouse gases were released by the global aluminum industry in 2005. Smelting specifically creates sulfur dioxide

and nitrogen oxides, potent components of smog and acid rain. About four tons of ore are needed to create a ton of aluminum, and the byproduct is another four tons of the caustic chemical brew called red mud, which is sequestered in ever-larger lifeless ponds adjacent to the refineries where it tends to contaminate both above and underground water supplies. The mining, which is typically above ground, entails large shallow cuts across vast areas. The resulting environmental impact, according to the California Integrated Waste Management Board, is the worst of any product on the planet. Even styrofoam and plastic (which take 500–1000 years to decompose in landfills) rate a step better.

The good news is that aluminum is the only material that's regarded as 100% recyclable—it can be reused indefinitely without losing any of its properties. And recycling aluminum requires as little as 5–10% of the energy required to obtain the metal from virgin sources and does far less damage to the environment.

The primary uses of aluminum are in packaging (cans, trays, containers, foil, etc.) and transportation (airplanes, automobiles, motorcycles, bicycles, etc.). Of these, aluminum containers consume approximately one-third of global production, and beverage cans are by far the biggest single use. It is estimated that in the US alone, 100 billion aluminum cans are produced each year.

While recycling of most materials has increased, it seems the recycling of aluminum cans has actually decreased. In 2005, it was estimated that 50.7 billion aluminum cans ended up in American landfills, where many were incinerated, releasing dioxins, furans, hydrogen chloride and chlorine gases. This was enough aluminum to replace the entire US fleet of commercial airliners four times over and wasted enough power to supply 1.3 million homes for a year.

Researching the subject, I found some slightly conflicting data but learned without doubt that recycling is our best recourse for the future. In fact, they say if our recycling efforts were 100%, we'd never have to mine bauxite again, forever.

Aluminum is a key part of our favorite activity. Let's do our best to keep it as clean as possible. Recycle!

DAVE SEARLE

—Dave Searle
Editor