MECONTECH

Zinc:

Zinc is the 24th most abundant element in the crust of the Earth. Its color is grey metallic and can be polished to a silver shine. In nature, zinc is not found as a pure deposit, but as a chemical compound. The most commonly exploited zinc ore is a sulfide named sphalerite, with a zinc concentration of around 61% percent. The largest deposits of zinc are found in North America, Australia and Asia.
Currently identified zinc resources total about 1.9 billion tonnes, which are estimated to be depleted between 2027 and 2055 at the current rate of consumption.

Applications

Zinc is used in a number of applications

Galvanizing against Corrosion

Zinc is commonly used to coat iron or steel to protect these metals against corrosion. As it is more reactive than iron or steel, zinc will attract almost all oxidation until corrosion completely erodes the coated sheet. What is left is a surface protection layer of oxide and carbonate. This protection even functions after minor scratches and dents and can survive for many years.
Galvanization is used on metal roofing, bridges, guard rails, light posts, heat exchangers and most visible to the consumer: car bodies. Coating zinc on another metal is accomplished by electrolytic plating of the metal – much like chrome plating a metal – or dipping it into molten zinc.

Intricate Machine Parts

An alloy made of very high grade zinc and aluminium is used to create die-cast parts which require little machining before they are used in an assembly. By injecting the alloy under pressure into the cavity of a two-part steel die, it fills the entire void within the mold. After the metal cools and the die halves are taken apart, the resulting zinc-alloy part is very close to the desired shape. Die-casting is used, among others, to create parts for aircraft, medical instruments and car parts like emblems and door handles.

Electrodes

An unique application of zinc uses its ability to transfer its corrosion resistance properties by electrical contact. In this manner, zinc is used as a sacrificial electrode. An example application for this kind of electrode is when it is attached to aluminium marine engines. Especially in salt water, the oxidation process of the metals on the ship forms a weak electrical current, which may lead to corrosion of the hull and engine parts. By having a zinc sacrificial electrode present, it sacrifices itself by corrosion, negating the electrical current and thus protecting the aluminium hull and/or engine. Similarly, zinc is used as a component to produce batteries. In a dry cell battery, the zinc is housed in a metal can and creates a chemical reaction that results in a voltage potential between two contacts. An electrical device can be connected to the battery and powered by the electricity produced, until the available chemical reactants are spent.

<u>Alloys</u>

One widely used alloy which contains a large amount of zinc is brass. Brass is an alloy of copper mixed with 3% to 45% zinc, depending on the type of brass. Brass is superior to copper in areas like ductability, strength and corrosion resistance. This makes it useful in water valves, musical instruments and communication equipment. Other used alloys that contain substantial amounts of zinc include aluminium solder, commercial bronze and nickel silver. It is also the primary metal used in producing one cent coins in the United States. The zinc coin is coated with a layer of copper to give the false impression of a copper coin.

Trading

The trading of Zinc futures takes place mainly on the London Metal Exchange (LME). This exchange regulates and monitors (electronic) trading of various metal types.

<u>Price Factors</u>

Zinc futures prices are influenced by a number of factors. Global supply of zinc is a major price determining factor. In the case of over-production, prices will rapidly fall. Mining activities will consequently drop which will eventually cause a deficit in supply. This will again raise prices to a standard level and this cycle will repeat itself.
Substitutes can also greatly influence the demand for zinc. Metals such as aluminum and magnesium are alternatives as die-cast materials and as such can influence price movements of zinc. In the event of rising prices of aluminum and magnesium the demand for zinc will increase.
Production and refining methods for zinc are also influencing prices as these processes are becoming ever increasingly cost-effective. This will increase the supply of available zinc and thus lower the price of this metal.
Limited remaining deposits can cause difficulties on the supply of zinc in the future. In comparison to various precious metals and base metals, zinc has a lower return yield which is why very limited budget is spent on the exploration of new zinc deposits. This may cause a deficit in the long term, which will eventually raise prices.

Zinc Recycling:

Zinc brings a multitude of economic and social benefits to society. Humans have found a wide range of uses for this versatile natural element whose properties are valued in many industries. The most common application of zinc is protecting steel from corrosion by hot-dip galvanizing. The zinc-steel combination has significant economic benefits in terms of life-cycle costs. Improved air quality in many industrialized countries, with diminishing levels of sulfur dioxide (SO2), means today zinc coatings provide even longer protection for steel.

Presently, approximately 70% of the zinc produced originates from mined ores and 30% from recycled or secondary zinc. The level of recycling is increasing in step with progress in zinc production and zinc recycling technologies. Zinc is recycled at all stages of production and use - for example, from emissions that arise during the production of galvanized steel sheet, from scrap generated during manufacturing and installation processes, and from products at the end-of-life.

Zinc & the Environment:

Zinc, like all metals, is a natural component of the Earth's crust and an inherent part of our environment. Zinc is present not only in rock and soil, but also in the air, water, and the biosphere - plants, animals, and humans. Zinc makes up an estimated 0.004% of the Earth's crust and ranks 24th in order of abundance.

Zinc is constantly being transported by nature, a process called natural cycling. Rain, snow, ice, sun, and wind erode zinc-containing rocks and soil. Wind and water carry minute amounts of zinc to lakes, rivers, and the sea, where it collects as sediment or is transported further. Natural phenomena such as volcanic eruptions, forest fires, dust storms, and sea spray all contribute to the continuous cycling of zinc through nature.

During the course of evolution, all living organisms have adapted to the zinc in their environment and used it for specific metabolic processes. The amount of zinc present in the natural environment varies from place to place and from season to season. For example, the amount of zinc in the Earth's crust ranges between 10 and 300 mg/kg, and zinc in rivers varies from less than 10 µ g/L to over 200 µ g/L. Similarly, falling leaves in autumn lead to a seasonal increase in zinc levels in soil and water.

There has been some concern introducing additional zinc to the environment, through hot-dip galvanized steel elements and other sources, is detrimental to organisms in the surrounding area. However, as organisms are used to varying levels of zinc naturally, they are able to regulate the uptake of zinc through homeostasis. Though taking in excess zinc is possible, a number of studies have been done to show the small amounts of additional zinc from hot-dip galvanizing added to the environment over decades of service is not enough to harm any organisms or exceed criterion levels. This has been of particular concern where zinc enters water environments during storm events.

Zinc Health Effects:

Zinc is considered an essential element because all living organisms need zinc. Because the amount of zinc present in nature varies widely, living organisms have natural processes that regulate their uptake of zinc. Toxicity can occur when an excessive amount of zinc is ingested; however, it is very uncommon to have too much zinc.
Of much more concern is zinc deficiency which occurs when the amount of zinc available is insufficient to meet the needs of a given organism.Zinc is essential for human health. Adequate daily intake of zinc is vital for the proper functioning of the immune system, digestion, reproduction, taste, smell, and many other natural processes. Analysis of diet and nutritional needs have led researchers to estimate a staggering 49% of the world's population is at risk from zinc deficiency.
Unfortunately, many people in developing countries do not have enough zinc in their diet. The World Health Organization (WHO) estimates 800,000 people die annually because of zinc deficiency. Even more troubling – 450,000 of those are children, which prompted

the International Zinc Association (IZA) to partner with UNICEF and develop the Zinc Saves Kids program.

Between 1.4 and 2.3 grams of zinc are found in the average adult and the recommended daily allowance (RDA) is 15 milligrams. Through the Zinc Saves Kids program, less than $5 USD will pay for zinc nutrition for one child for an entire year.

Zinc is also used in a variety of medical and pharmaceutical products, such as bandages, cold lozenges, skin treatments, sun block creams and lotions, burn and wound treatments, baby creams, shampoo, and cosmetics.

For many food crops, zinc is an essential micronutrient. Zinc deficiency in agricultural soils is common on all continents and constitutes a major problem in many parts of the world because it causes serious inefficiencies in crop production. Relatively small amounts of zinc compounds, however, can cure deficiency and last for several years before they need to be repeated. This treatment is highly cost-effective when the costs of the zinc application and the value of the extra yield are considered.

Sustainability:

Zinc is uniquely positioned as one of the few resources that can contribute meaningfully for below 9 elements:

1. people's values,
2. human development,
3. economy,
4. agriculture,
5. forests,
6. energy & power,
7. buildings,
8. mobility, and
9. materials.

Values:

IZA understands that environment and sustainability programs are integral to the future of the zinc industry and it is committed to contributing scientifically sound facts in response to societal concerns and market trends.

Understanding the environmental footprint of zinc starts with documenting the resource requirements and environmental releases associated with upstream metal production operations, but it also involves understanding the impacts and the benefits of using zinc during other stages in the product life cycle. These benefits can arise in use (e.g. extending the life of steel products) and through end-of-life recycling (e.g. by utilizing recycled zinc to create new products). In order to develop this information, IZA launched the Zinc for Life program that resulted in the first global life cycle assessment (LCA) for special high-grade zinc. In 2014 IZA completed updated zinc LCA incorporating the most recent data from Member companies, and, more importantly, an expanded geographic range and percentage of global production. Results for the principle categories show a 20% or better reduction in impacts related to global warming, energy demand, and environmental emissions from the prior LCA.

Human Development:

Zinc is essential for all living things and plays a key role in numerous aspects of cellular metabolism. It is required for the catalytic activity of approximately 100 enzymes and it plays a role in immune function, protein synthesis, wound healing, DNA synthesis, and cell division. Zinc also supports normal growth and development during pregnancy, childhood, and adolescence. A daily intake of zinc is required to maintain a steady state because the body has no specialized zinc storage system.

Zinc deficiency is an enormous problem impacting an estimated 2 billion people worldwide. Children under five years of age are affected most suffering from retarded growth and development and high susceptibility to infectious diseases due to a poor performing immune system. An estimated 450,000 children between the ages of one and five die each year due to complications arising due to early childhood zinc deficiency. Even in areas where zinc deficiency is uncommon, there are still groups at higher risk such as the elderly, pregnant and lactating women and vegetarians, among others.

In addition to being a nutritional supplement, zinc is also considered a 'life saving commodity' by the United Nations and is the only promoted adjunct treatment to oral rehydration salts (ORS) for childhood diarrhea episodes. Diarrhea remains a leading cause of death globally among children under five years of age, accounting for 9% of child mortality, second only to pneumonia. Zinc + ORS is proven to reduce the duration and severity of diarrhea, and to prevent subsequent episodes. In addition to being effective and safe, it is also inexpensive and has been touted as one of the "best buys" in child health. The World Health Organization, UNICEF and others have strong outreach programs aimed specifically at including zinc on national Essential Medicines Lists and incorporating zinc as part of the routine public sector care offered to children with diarrhea.

The zinc industry has entered into a variety of partnerships with Governments and NGOs to fund critical child health and diarrheal treatment programs. IZA is supporting UNICEF through its Zinc Saves Kids initiative and also working with the Clinton Health Access Initiative (CHAI) and Bill & Melinda Gates Foundation on zinc deficiency programs in India. IZA member companies are involved in similar partnerships through the Mining Compact for Child Health and other programs.

Economy:

In today's world, population growth, urbanization, social and economic development and even demands for a green economy are all contributing to an increase in demand for zinc. Within the metal and mining sector, zinc is relatively modest when compared to say, steel, but the two metals are closely linked – especially in the major markets of construction, automotive and appliances as zinc servers the critical role of protecting steel from corrosion. According to the World Corrosion Organization, the estimated cost of corrosion to all the world's economies is $2.2 trillion USD ($2,200,000,000,000) annually. This worldwide cost of corrosion is currently in the same order of magnitude as the cost to produce and distribute food worldwide. The difference is that the public is somewhat aware of issues related to hunger and the cost of food, but totally unaware of the cost of corrosion today and its effect on sustainability of our infrastructures in the future. Today, over 50% of the zinc consumed each year is for the purpose of reducing the cost of corrosion (galvanizing).

The zinc industry also touches many interests including governments, investors, contractors and suppliers, service providers, Indigenous Peoples and their organizations, civil society organizations, academia and research institutions and downstream users, among others. These sectors also provide employment and economic growth opportunities, as does the zinc industry itself. The World Steel Association, for example, notes that the steel industry employs more than 2 million people directly around the world, with a further 2 million contractors and 4 million in supporting industries.

Agriculture:

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food. Nutrition security means access by all people at all times to the adequate utilization and absorption of nutrients in food, in order to be able to live a healthy and active life. Zinc fertilizers contribute to food and nutrition security by:

- Providing a key micronutrient required for the growth and health of all plants;
- Maintaining an optimal balance of available zinc for plant growth;
- Increasing yields to ensure food production keeps pace with population and income growth and hunger reduction objectives;
- Maximizing nutrient uptake of crops to address human zinc deficiency;
- Maximizing agricultural productivity without increasing land surface use;
- Addressing zinc deficiencies that undermine both public health and economic growth.

It is estimated that in the next 50 years, farmers will have to produce more food than was produced in the last 10,000 years combined. Most of this will have to come from increasing production on existing farmland requiring continual improvement of today's farming techniques. This means higher crop yields, better incomes, and more sustainable land, air and water management and zinc fertilizers will be a major part of the solution to making this happen.

The zinc industry, through the Zinc Nutrient Initiative, is partnering with farmers, agronomists, scientists and governments to share knowledge, develop policy support and further innovations for zinc fertilizers to enable farmers around the world to grow more on their land and provide food and nutrition for all.

Forests:

Galvanized steel framing studs, as well as electric transmission, telephone and sign poles are highly sustainable replacements for their wooden counterparts. Not only do they require less maintenance and offer longer service life, but according to a Life Cycle Stressor-Effects Assessment (LCSEA) conducted by the International Iron and Steel Institute, using galvanized steel studs in place of wood studs would result in a 100-fold reduction in land area eco-system disruption when building an equivalent number of single-family homes. Or worded differently, habitat depletion realized from steel framing production and use is less than one percent of that for wood. A similar case can be made when comparing galvanized steel utility and sign poles with their wood counter parts.

Zinc fertilizers can also help mitigate deforestation by significantly increasing crop health and crop yields. Growing more on smaller tracts of land conserves natural habitats and forests from being converted into farmland.

Energy and Power:

Sustainability considerations have already brought about a more diversified blend of fuels. As a result, the materials needed to generate energy are also changing. A growing portion of energy now comes from renewable and alternative fuels with implications for zinc and other metals. For example, the 25% reduction in Primary Energy Demand realized in the 2014 LCA for primary zinc was accompanied by a 22% increase in the use of renewable energy resources (hydro, wind and solar). Furthermore, wind and solar technologies, require significantly more steel than other energy sources.

Time in service becomes a critical factor in the economic viability of these installations. Zinc coatings (galvanizing, thermal spray and zinc-rich paints) significantly extend the service life of windmills, for example, and also greatly limit costly maintenance and downtime caused by corrosion, especially in hostile near-shore and off-shore environments.

Zinc also plays a critical role in solar energy. Galvanized steel is the material of choice for the structures that support and align solar panels, while zinc is also a component of the solar cells themselves. Researchers using thin layers of zinc oxide have recently fabricated the highest efficiency solar cells ever created.

Greater use of hydrogen fuel cells and nuclear power means increased demand for metal catalysts such as zinc and platinum. With regard to fuel cells, zinc's very high energy potential has made it a leading candidate in a range of fuel cell and battery designs for grid storage and micro-grid generation. Additionally, nickel zinc batteries have been developed for use in hybrid electric vehicles, while zinc-air has been demonstrated across a range of electric vehicles. Researchers at Stanford University have identified zinc-air as a next generation replacement for lithium ion due to its far higher energy density and lower cost.

Buildings:

Due to their intrinsic properties, metals are widely used in the building and construction sector. Zinc sheet and zinc-coated steel sheet are excellent materials for cladding, roofing, window frames, rain-water collection systems, heating equipment and counter tops. Brass and zinc diecastings are used extensively in plumbing, builder's hardware and many other applications. Zinc is equally at home in old and historic buildings as well as in new, modern architecture. Zinc building components are weatherproof, corrosion resistant and immune to the harmful effects of UV rays, ensuring a very long service life without degradation.

In addition to durability, zinc coated steel framing can bear higher loads with less material than dimensional lumber. This imparts a high degree of design flexibility but also saves considerably on material usage.

When a building reaches the end of its life, a considerable proportion of its zinc-containing products can be directly re-used and the functional life of these parts can be extended. When a zinc-containing building product eventually reaches the end of its life, it can be fully recycled. Today, more than 95% of the zinc products used in buildings are collected at end-of-life. This collected zinc can be recycled without loss of quality. Because metallic bonds are restored upon re-solidification, metals continually recover their original performance properties, even after multiple recycling loops. This allows them to be used again and again for the same application. By contrast, the performance characteristics of most non-metallic materials degrade after recycling.

Mobility:

Zinc coatings play a key role in public transportation and infrastructure by extending the life of steel used in bridge rails and support beams, railway tracks and public transportation hubs and terminals. Zinc also extends the life of, and time between maintenance of concrete bridges, car parks and piers by protecting the steel reinforcing bar contained within from early failure by corrosion. Zinc also protects the lighter and stronger next generation steels that enable vehicle designs with greater fuel efficiency and lower emissions. Through its Galvanized Auto body Partnership (GAP), IZA is working with the global steel industry and auto manufacturers on next generation steels to enable automakers to produce steel-based vehicles that meet targets of increasing the corporate average fuel economy (CAFE) in the US from the current 29 miles per gallon to 54.5 mpg in 2025 and reducing CO2 emissions from 160g per kilometer today to a maximum of 95g by 2020 in the European Union.

Zinc oxide is an ingredient in modern low rolling resistant tires and zinc batteries are poised to be a game-changing technology in future electric vehicle.

Materials:

Growth brings economic prosperity and welfare – but also a continuously growing demand for materials. Thus, a trade-off arises between societal benefits and the depletion of natural resources. In order to make this growth sustainable, the materials used need to be either renewable or recyclable. The transition to a ‘closed loop’ or circular economy involves adopting a systems approach of understanding the performance attributes of materials and products throughout entire product chain; from raw material to use of the finished product and further to the end-of-life management.

Aluminium

Aluminium is one of the most common substances found in the earth's crust. After oxygen (47%) and silicon (28%), Aluminium comprised about 8% of the soil and rocks of our planet. It is found only in chemical compounds with elements like oxygen, silicon and Sulphur. From these, the pure metal aluminium can only be economically produced from the compound with oxygen.
Aluminium as a metal has countless of properties that makes it very useful in a wide range of application. It is very strong for its weight, but easy to transform its shape. Aluminium forms its own barrier against corrosion and is not influenced by magnetism, but conducts electricity. It can cope very well with extreme cold without becoming brittle. As an important last note, aluminium can be recycled into new products with ease. It is the most widely used non-ferrous metal with a production of around 32 million tons.

Applications

Aluminium can be used in almost any application you can think of, but some of the more common uses are described below. It is usually alloyed with another metal, like zinc or copper to give it some distinct property that is needed.

Electronics:
Aluminium with a very high purity (99,999%) is used in electronics and CD's, while normal aluminium is used for heatsinks and casings of processors and appliances.

Construction and transportation:
Because of its light-weight and strength, aluminium is used widely in construction and transportation as a lighter substitute of steel or cheaper substitute of carbon fibre. Doors, windows, siding and building wires can be made from aluminium. In the transportation industry, bodies of cars, trucks, railway cars and airplanes are made from aluminium. When it is made into a thin sheet, it can be mechanically molded in any form.

Household items:
Many ordinary items around the house are crafted from aluminium. Not only outer casings of all kinds of appliances, but also things like: baseball bats, cutlery, door handles, aluminium foil and cans. Some countries have made coins containing a significant amount of aluminium, usually alloyed with copper.

Compounds:
The vast majority of alumina is converted into the metal aluminium, but around 10% is used for other applications. It can be used as an absorbent: it will remove water from hydrocarbons, enabling further processing. It also has value as a catalyst in producing sulfur. Aluminium sulfate is mainly used in water treatment plants and the manufacturing of paper. It can also be used as a food additive, fire extinguisher and in leather tanning. Aluminium chloride is used in the production of synthetic rubber and in petroleum refining.
Trading

Trading of aluminium takes place primarily on the London Metal Exchange (LME), similar to many of the other metals. Prices of this exchange are used as a benchmark for the pricing of contracts and their historical price curve can provide some insight into possible future prices.

Price Factors

Aluminum production requires a large amount of energy, hence the price of energy will have a direct impact on the final price of aluminum. Producers are also constantly improving their production techniques in order to improve the quality of aluminum as well as reduce the energy demand and consequently cost.

The demand for aluminum is steadily increasing over the years due to the many advantages it presents in the auto and construction industry. This increasing demand for aluminum will also continue to push up the price. Monitoring the expected demand is therefore a suitable indicator for the future price of aluminum.

Aluminium Recycling and Sustainability:

Aluminium recycling benefits present and future generations by **conserving energy** and other natural resources. It requires up to 95% less energy to recycle aluminium than to produce primary metal and thereby avoids corresponding emissions, including greenhouse gases.

Today, recycling of post-consumer aluminium products saves over 90 million tonnes of CO2and over 100,000 GWh of electrical energy, equivalent to the annual power consumption of the Netherlands.

For most aluminium products, the metal is not actually consumed during the product's lifetime, but simply used, with the potential to be recycled without any loss of its inherent properties. Therefore, the life cycle of an aluminium product is not the traditional "cradle-to-grave" sequence, but rather a renewable "cradle-to-cradle".

This property of infinite recyclability has led to a situation where today around 75% of the almost one billion tonnes of aluminium ever produced is still in productive use, some having been through countless loops of its lifecycle.

Through the use of only 5% of the original energy input, this metal can be made available not just once but repeatedly from these material resources for future generations. The growing global markets for aluminium products are supplied by both primary (around 65%) and recycled (around 35%) metal sources. The increasing demand for aluminium and the long lifetime of many products, limiting their availability for short term recovery but maximising their in-use benefits, mean that the overall mass of primary metal consumed will continue to be around double that of recycled metal, for the foreseeable future.

However, improving the overall collection rates of used products is an essential element in the pursuit of sustainable development. Industry continues to recycle, without subsidy, all the aluminium collected from end-of-life products as well as from fabrication and manufacturing process scrap. With a growing number of industry initiatives and the help of appropriate authorities, local communities and society as a whole, the amount of aluminium collected could be increased further.

Environment: Minimizing the impact of Aluminium recycling processes.

Sorting and separation of scrap is a mechanical and/or manual process, for which electricity or labour is the main input.Dust is the main air emission, from equipment such as shredders, which is collected inside the plant via vacuum systems. Thermal pre-treatment of scraps, such as de-coating, removing of oil or other impurities, requires the input of fuel. Organic compounds and dust are the main emissions to air. These air emissions are controlled through process optimisation or after burners. Dust can be collected as filter dust.

Melting and refining of scrap requires the input of fuel and, in many cases the use of salt fluxes. The organic contaminants in the input scraps are the main source of volatile organic compound (VOC) emission. Polychlorinated Dioxins and Furans (PCDD/F) may be formed due to the use of salt fluxes and chlorine mixtures in the process. Furnace design and optimisation provide effective control of these emissions, afterburner treatment of waste gases can also be used to limit such air emissions. Dust is again collected via air filters. Salt slag, when salt fluxes are used, is the main solid waste generated in the melting and refining process. It is treated to recover aluminium metal, metal oxides, and salts, which are used as input material in various industries. CO2 emissions are the result of fuel combustion. From a life cycle point of view, the amount of fuel required to process scrap into aluminium alloys is approximately 5% of that required for the production of primary ingot.

Aluminium and Sustainability

In many of its applications, aluminium provides environmental benefits. Its light weight helps improve the fuel economy of cars and planes and reduces emissions. When those vehicles are eventually scrapped, 95 percent of the aluminium can be recycled.

Because aluminium can be infinitely recyclable, 75 percent of all aluminium ever produced is still in use, with no loss in quality. Recycling aluminium uses only 5 percent of the energy – and produces only 5 percent of the greenhouse gas emissions – of the average primary production rate. Beverage cans are among the most recycled aluminium products in the world, and can be back on the shelf just six weeks after their first use.

Despite these benefits, there are also a number of sustainability challenges specific to the aluminium industry. These include:

- energy and greenhouse gases;
- waste management;
- biodiversity and land management;
- resource efficiency and recycling; and
- Indigenous rights and local communities.

Energy and greenhouse gases

Existing primary aluminium production processes are energy intensive by nature. The main source of energy consumption during production is the electricity used for the electrolysis process. During the refining of alumina from bauxite ore, a significant amount of energy is also required to produce the solution of bauxite in caustic soda, for the calcination process and for the recovery of caustic soda after use. As energy costs are a major part of overall production costs, improved energy efficiency is essential for the aluminium industry, both from an economic and environmental point of view. Improved energy efficiency will also reduce indirect emissions from production of the electricity used in the electrolysis process.

Primary aluminium production results in associated direct greenhouse gas emissions from the use of fossil fuels in the alumina calcination process, as well as indirect emissions from production of electricity used in the electrolysis process. Direct greenhouse gas emissions also arise from process-related conditions in electrolysis, such as consumption of anodes (CO_2) and PFC emissions (PerFluoroCarbon) from anode effects. Reduction of greenhouse gas emissions from energy use and from the electrolysis processes is thus important to reduce the overall carbon footprint of primary aluminium.

Waste management

Between two and four tonnes of bauxite are required to produce one tonne of alumina. Once the alumina is extracted from the bauxite, the remaining bauxite residue is stored in landfills. Disposal of the bauxite residue is a challenging aspect of alumina production due to relatively large volumes, occupation of land areas, and the alkalinity of the residue and the run-off water. The way of storing of bauxite residue and handling of run-off water is critical.

Aluminium smelters also generate significant quantities of solid waste. One of the main sources of waste production during the smelting process is from the relining of pots, which takes place every five-to-eight years. The carbon portion of the spent pot lining (SPL) and refactory materials are considered a hazardous waste because of fluoride, cyanide and reactive metal content. It is thus important both to minimize the generation of SPL by extending life times of the pots, as well as to ensure proper handling of SPL waste through treatment or use by other industries.

Biodiversity and land management

The vast majority of the world's bauxite comes from surface mines in tropical areas, where bauxite occurs in horizontal layers, normally beneath a few meters of overburden. Because bauxite is located close to the surface and with relatively shallow thickness, bauxite mining involves disturbance of relatively large land areas, which can include natural and critical habitats. As a result, mining sites may overlap with, or be adjacent to, protected areas and/or areas of conservation value (particularly in tropical areas), and may result in significant deforestation. Effective mitigation of biodiversity impacts from bauxite mining will involve avoiding negative impacts (including avoidance of invasive species) to protected areas and areas with natural and critical habitats, as well as rehabilitation of mined areas.

For logistical reasons, most alumina refineries are located close to a bauxite mine, or at the nearest harbour from which the alumina can be shipped out. Thus, there may be similar biodiversity challenges at refinery sites, landfills for bauxite residue deposits or bauxite slurry pipelines.

Resource efficiency and recycling

Minimising losses of aluminium wherever they might occur in the value chain is a high priority for the aluminium industry. The concept of resource efficiency is a guiding principle, and actions to minimise losses can include optimisation of material use in the first place, tailoring the material use to specific applications, design for environment and recycling, or recycling of scrap.

In most cases, recycling of aluminium is economically and environmentally beneficial. Aluminium can be recycled an infinite number of times with no loss of quality. As a result, there is a very large and growing global aluminium material pool, and a well-developed global refining and recycling capacity, which itself creates a strong demand for scrap.

While minimization of process scrap in the production and fabrication stages is the first step towards improving environmental performance (energy consumption and emissions per ton of product), the minimization of post-industrial and post-consumer scrap and waste is also a priority. Collection and recycling of process as well as post-industrial and post-consumer scrap is also important to minimize waste and bring scrap back to useful products. This is relevant for all process steps, from primary aluminium production, through to production of end-user products and end-of-life management. Post-consumer aluminium scrap is generally recycled very successfully, with significant energy and emissions reductions compared to primary metal production. In addition, recycling of post-consumer products helps to significantly minimise resource use and reduce waste going to landfill.

Overall aluminium recycling rates are impressive and growing: The International Aluminium Institute (IAI) reports end-of-life recycling rates for aluminium used in building and transportation at 90 percent. In Europe, consumer packaging recycling/recovery rates are at about 60 percent, with some packaging forms such as beverage cans as high as 70 percent, while other forms are below 50 percent. Robust data on material collection and recycling are not available in many countries, however.

In order to optimise and improve collection and recycling of post-consumer aluminium scrap, products need to be designed in a way that enables and supports efficient collection and recycling. This is especially challenging for complex products that utilise combined materials (such as composites used in buildings and transportation or multi-material laminated packaging), as these products need to be dismantled into separate material streams before re-melting.

The majority of aluminium is used in products with very long use phases, for example transportation products that have a typical lifetime of 20 years or buildings with lifetimes of approximately 50 years. The IAI reports that 75 percent of aluminium ever produced is still in circulation. Even with growing volumes of aluminium recycling and increasing end-of-life recycling rates, the strong overall global demand for aluminium means that the production of primary aluminium is required to support this growth.

Recycling of post-consumer scrap and waste requires a number of conditions, including the availability of systems to collect and sort used materials, and the adequate design of products that enable classification and recycling, among others. Collection infrastructure is not available everywhere in the world or for all types of products. Millions of people depend on collecting recyclable materials from streets, dumps, abandoned sites and even landfills. It will be a challenge to maintain the vital role they perform while supporting them with improvements to the health and safety conditions of their work.

Indigenous rights/local communities

Mining and mining-related activities (exploration, development, resource extraction, processing, transportation and waste disposal) often take place on, or near, indigenous lands. Mining or large-scale industrial development requires access to land and water that is often the basis of livelihoods for local communities.

Major industrial developments can have significant adverse impacts on indigenous groups and/or vulnerable groups and individuals, affecting their rights to self-determination, infringing on their lands, territories and resources, and threatening their ability to maintain their culture, including their cultural heritage and recognition of their distinct identities.

The possibility of project-related resettlement holds the potential for human rights infringements. It is important to ensure that indigenous groups be given sufficient opportunity and resources to be able to offer their free, prior and informed consent (FPIC) in decisions that may affect them, particularly in relation to projects that may impact their lands, territories and natural resources.

At the same time, mining and industrial activities can have positive benefits for local communities, creating both direct and indirect employment and wage-earning opportunities, and can also generate government revenue and net foreign exchange earnings. Closure or major restructuring of a mine or large industrial facility can have major impacts on the livelihood of affected employees, suppliers and local communities. In areas of political instability and conflicts, the manner in which security of assets and employees is maintained can also pose risks to the rights of local people. Upholding the rights of indigenous peoples and local communities, and supporting shared benefits from resource developments, remains an important priority for upstream producers.

Aluminium Grades

Alloy 1100: This grade is commercially pure aluminum. It is soft and ductile and has excellent workability, making it ideal for applications with difficult forming. It can be welded using any method, but it is non heat-treatable. It has an excellent resistance to corrosion and is commonly used in the chemical and food processing industries.

Alloy 2011: High mechanical strength and excellent machining capabilities are the highlights of this grade. It is often called – Free Machining Alloy (FMA), an excellent choice for projects done on automatic lathes. The high-speed machining of this grade will produce fine chips that are easily removed. Alloy 2011 is an excellent choice for production of complex and detailed parts.

Alloy 2014: A copper based alloy with very high strength and excellent machining capabilities. This alloy is commonly used in many aerospace structural applications due to its resistance.

Alloy 2024: One of the most commonly used high strength aluminum alloys. With its combination of high strength and excellent fatigue resistance, it is commonly used where a good strength-to-weight ratio is desired. This grade can be machined to a high finish and it can be formed in the annealed condition with subsequent heat treating, if needed. The corrosion resistance of this grade is relatively low. When this is an issue, 2024 is commonly used in an anodized finish or in clad form (thin surface layer of high purity aluminum) known as Alclad.

Alloy 3003: The most widely used of all aluminum alloys. A commercially pure aluminum with added manganese to increase its strength (20% stronger than the 1100 grade). It has excellent corrosion resistance, and workability. This grade can be deep drawn or spun, welded or brazed.

Alloy 5052: This is the highest strength alloy of the more non heat-treatable grades. Its fatigue strength is higher than most other aluminum grades. Alloy 5052 has a good resistance to marine atmosphere and salt water corrosion, and excellent workability. It can be easily drawn or formed into intricate shapes.

Alloy 6061: The most versatile of the heat-treatable aluminum alloys, while keeping most of the good qualities of aluminum. This grade has a great range of mechanical properties and corrosion resistance. It can be fabricated by most of the commonly used techniques and it has good workability in the annealed condition. It is welded by all methods and can be furnace brazed. As a result, it is used in a wide variety of products and applications where appearance and better corrosion resistance with good strength are required. The Tube and Angle shapes in this grade typically have rounded corners.

Alloy 6063: Commonly known as an architectural alloy. It has reasonably high tensile properties, excellent finishing characteristics and a high degree of resistance to corrosion. Most often found in various interior and exterior architectural applications and trim. It is very well suited for anodizing applications. The Tube and Angle shapes in this grade typically have square corners.

Alloy 7075: This is one of the highest strength aluminum alloys available. It has an excellent strength-to weight ratio, and it is ideally used for highly stressed parts. This grade can be formed in the annealed condition and subsequently heat treated, if needed. It can also be spot or flash welded (arc and gas not recommended).

MECONTECH

Copper

Pure copper is soft and malleable; an exposed surface has a reddish-orange tarnish. It is used as a conductor of heat and electricity, a building material, and a constituent of various metal alloys.
Copper alloys are metal alloys that have copper as their principal component. They have high resistance against corrosion. The best-known traditional types are bronze; where tin is a significant addition, and brass, using zinc instead. Both these are imprecise terms, and today the term copper alloy tends to be substituted, especially by museums.

Applications

The major applications of copper are in electrical wires (60%), roofing and plumbing (20%) and industrial machinery (15%). Copper is mostly used as a metal, but when a higher hardness is required it is combined with other elements to make an alloy (5% of total use) such as brass and bronze. A small part of copper supply is used in production of compounds for nutritional supplements and fungicides in agriculture. Machining of copper is possible, although it is usually necessary to use an alloy for intricate parts to get good machinability characteristics.

Electronics

The electrical properties of copper are exploited in copper wires and devices such as electromagnets. Integrated circuits and printed circuit boards increasingly feature copper in place of aluminium because of its superior electrical conductivity; heat sinks and heat exchangers use copper as a result of its superior heat dissipation capacity to aluminium. Vacuum tubes, cathode ray tubes, and the magnetrons in microwave ovens use copper, as do wave guides for microwave radiation

Architecture and Industry

Because of the waterproof nature of copper, it has been used as the roofing material of many buildings since ancient times. The green color on these buildings is due to a long-term chemical reaction: copper is first oxidized to copper(II) oxide, then to cuprous and cupric sulfide and finally to copper(II) carbonate, also called verdigris, which is highly corrosion-resistant. The copper used in this application is phosphorus deoxidized copper (Cu-DHP). Lightning rods use copper as a means to divert electric current throughout the ground instead of destroying the main structure. Copper has excellent brazing and soldering properties and can be welded; the best results are obtained with gas metal arc welding.

Copper in Alloys

Numerous copper alloys exist, many with important uses. Brass is an alloy of copper and zinc and bronze usually refers to copper-tin alloys, but can refer to any alloy of copper such as aluminium bronze. Copper is one of the most important constituents of carat silver and gold alloys and carat solders used in the jewelry industry, modifying the color, hardness and melting point of the resulting alloys.
The alloy of copper and nickel, called cupronickel, is used in low-denomination statuary coins,

often for the outer cladding. The US 5-cent coin called nickel consists of 75% copper and 25% nickel and has a homogeneous composition. The 90% copper/10% nickel alloy is remarkable by its resistance to corrosion and is used in various parts being exposed to seawater. Alloys of copper with aluminium (about 7%) have a pleasant golden color and are used in decorations. Copper alloys with tin are part of lead-free solders.

Antimicrobial Applications

Copper-alloy touch surfaces have natural intrinsic properties to destroy a wide range of microorganisms (e.g., E. coli O157:H7, methicillin-resistant Staphylococcus aureus (MRSA), Staphylococcus, Clostridium difficile, influenza A virus, adenovirus, and fungi). Some 355 copper alloys were proven to kill more than 99.9% of disease-causing bacteria within just two hours when cleaned regularly. The United States Environmental Protection Agency (EPA) has approved the registrations of these copper alloys as “antimicrobial materials with public health benefits,” which allows manufacturers to legally make claims as to the positive public health benefits of products made with registered antimicrobial copper alloys. In addition, the EPA has approved a long list of antimicrobial copper products made from these alloys, such as bedrails, handrails, over-bed tables, sinks, faucets, door knobs, toilet hardware, computer keyboards, health club equipment, shopping cart handles, etc. Copper doorknobs are used by hospitals to reduce the transfer of disease, and Legionnaires’ disease is suppressed by copper tubing in plumbing systems. Antimicrobial copper alloy products are now being installed in healthcare facilities in the U.K., Ireland, Japan, Korea, France, Denmark, and Brazil and in the subway transit system in Santiago, Chile, where copper-zinc alloy handrails will be installed in some 30 stations between 2011–2014.

Other uses

Copper compounds in liquid form are used as a wood preservative, particularly in treating original portion of structures during restoration of damage due to dry rot. Together with zinc, copper wires may be placed over non-conductive roofing materials to discourage the growth of moss. Textile fibers use copper to create antimicrobial protective fabrics, as do ceramic glazes, stained glass and musical instruments. Electroplating commonly uses copper as a base for other metals such as nickel. Copper is one of three metals, along with lead and silver, used in a museum materials testing procedure called the Oddy test. In this procedure, copper is used to detect chlorides, oxides, and sulfur compounds. Copper is often alloyed with precious metals like silver and gold, to create, for example, Corinthian bronze, hepatizon, tumbaga and shakudo.

Trading

In contrary to most other metals, copper is being traded on both the London Metal Exchange (LME) and on the New York Mercantile Exchange (NYMEX). The prices on the LME still function as a benchmark for OTC contracts and deviations of this price on the NYMEX will usually only be minimal.

Price Factors

Due to the rising economies of China and India, the demand for copper is growing rapidly. These booming economies require enormous quantities of copper in order to continue their development, which will drive up the prices.

The remaining copper deposits are limited and current calculations determine they will be depleted between fifty and sixty years. This poses significant issues with consumption of copper still rising steadily. Consuming countries will start to look for alternatives or increase their recycling activities in order to increase their internal supply.

Copper Recycling:

Copper is a non-ferrous metal, and valued as the best non-precious metal conductor of electricity. The only metal with better conductive properties is silver. Copper holds as much as 90 percent of new copper value, and as such it is one of the basic targets for many scrap metal collectors.

For thousands of years, copper and copper alloys have been recycled. This has been a normal economic practice, even if regretted by some. One of the wonders of the old world, the Colossus of Rhodes, a statue spanning the entrance to Rhodes Harbour, was said to have been made of copper. No trace of it remains since it was recycled to make useful artefacts.

In the Middle Ages it was common that after a war the bronze cannons were melted down to make more useful items. In times of war even church bells were used to produce cannon.

The entire economy of the copper and copper alloy industry is dependent on the economic recycling of any surplus products. There is a wide range of copper based materials made for a large variety of applications. To use the most suitable and cheapest feedstock for making components gives the most economic cost price for the material.

Scrap Value - Copper

The usual commercial supplies of pure copper are used for the most critical of electrical applications such as the production of fine and superfine enamelled wires. It is essential that purity is reproducibly maintained in order to ensure high conductivity, consistent annealability and freedom from breaks during rod production and subsequent wire drawing. Since the applied enamel layers are thin but have to withstand voltage, they must have no surface flaws; consequently the basis copper wire must have an excellent surface quality. Primary copper of the best grade is used for producing the rod for this work. Uncontaminated recycled process scrap and other scrap that has been electrolytically refined back to grade 'A' quality may also be used.

The copper used for power cables is also drawn from high conductivity rod but to a thicker size than fine wires. The quality requirements are therefore slightly less stringent. The presence of any undesirable impurities can cause problems such as hot shortness which gives expensive failures during casting and hot rolling. For the same reason, scrap containing such impurities can only be used for this purpose if well diluted with good quality copper.

For non-electrical purposes, copper is also used to make large quantities of plumbing tube, roofing sheet and heat exchangers. High electrical conductivity is not mandatory and other quality requirements are not so onerous. Secondary copper can be used for the manufacture of these materials, though still within stipulated quality limits for impurities.

Where scrap copper is associated with other materials, for example after having been tinned or soldered, it will frequently be more economic to take advantage of such contamination than try to remove it by refining. Many specifications for gun metals and bronzes require the presence of both tin and lead so this type of scrap is ideal feedstock. Normally it is remelted and cast to ingot of certified analysis before use in a foundry. Scrap of this type commands a lower price than uncontaminated copper.

Scrap Value - Brasses

The recycling of brass scrap is a basic essential of the economics of the industry. Brass for extrusion and hot stamping is normally made from a basic melt of scrap of similar composition adjusted by the addition of virgin copper or zinc as required to meet the specification before pouring. The use of brass scrap bought at a significantly lower price than the metal mixture price means that the cost of the fabricated brass is considerably less than it might otherwise be.

The presence in brass of some other elements such as lead is often required to improve machinability so such scrap is frequently acceptable. Besides the common free-machining brasses, there are many others made for special purposes with properties modified to give extra strength, hardness, corrosion resistance or other attributes, so strict segregation of scrap is essential.

Brass scrap arising from machining operations can be economically remelted but should be substantially free from excess lubricant, especially those including organic compounds that cause unacceptable fume during remelting.

When brass is remelted, there is usually some evolution of the more volatile zinc. This is made up in the melt to bring it back within specification. The zinc is evolved as oxide that is drawn off and trapped in a baghouse and recycled for the manufacture of other products.

Brass to be made in to sheet, strip or wire form must be significantly free of harmful impurities in order to retain ductility when cold. It can then be rolled, drawn, deep drawn, swaged, riveted, spun or otherwise cold formed. It is normal therefore to make it substantially from virgin copper and zinc, together with process scrap arising from processing that has been kept clean, carefully segregated and identified.

Scrap Value - Other Copper Alloys

Copper alloys such as phosphor bronzes, gunmetals, leaded bronzes and aluminium bronzes are normally made to closely controlled specifications in order to ensure fitness for demanding service. They are normally made from ingots of guaranteed composition together with process scrap of the same composition that has been kept carefully segregated. Where scrap has become mixed, or is of unknown composition, it is first remelted by an ingot maker and analysed so that the composition can be suitably adjusted to bring it within grade for an alloy.

Good quality high conductivity copper can be recycled by simple melting and check analysis before casting, either to finished shape or for subsequent fabrication. However, this normally only applies to process scrap arising within a copper works. Where copper has been contaminated and it is required to re-refine it, it is normally remelted and cast to anode shape so that it can be electrolytically refined. If, however, the level of impurities in the cast anode is significant, it is unlikely that the cathode produced will then meet the very high standards required of grade 'A' copper used for the production of fine wires.

Where copper and copper alloy scraps are very contaminated and unsuitable for simple remelting, they can be recycled by other means to recover the copper either as the metal or to give some of the many copper compounds essential for use in industry and agriculture. This is the usual practice for recovery of useable copper in slag, dross or mill scale arising from production processes or from life-expired assemblies of components containing useful quantities of copper.

Environmental Considerations

Copper is an essential trace element needed for the healthy development of most plants, animals and human beings. In general, moderate excess quantities of copper are not known to cause problems. Every care is taken to avoid wasting copper and it is recycled where possible. Excess copper is not allowed to escape into the atmosphere as fume, nor into discharged process cooling water, all of which is generally treated to keep within agreed limits.

Other metals associated with copper alloys are generally not in a form that is dangerous. However, when fume is generated, for example by melting or welding, it may be necessary to use fume extraction equipment. Beryllium is sometimes used as an alloying element in copper to make some of the strongest copper alloys known, being invaluable for the production of heavy duty springs. When alloyed with copper and in the solid state this presents no health hazard. However, if present in the atmosphere, beryllium can cause a health hazard and should be controlled.

Product Value

If the scrap is pure copper and has not been contaminated by anything undesirable, a high quality product can be made from it. Similarly, if scrap consists only of one alloy composition it is easier to remelt to a good quality product, although there may have to be some adjustment of composition on remelting.

If scrap is mixed, contaminated or includes other materials such as solder then, when remelted, it will be more difficult to adjust the composition within the limits of a chosen specification. Where lead or tin have been included, but no harmful impurities, it is usually possible to adjust composition by the addition of more lead or tin to make leaded bronzes. For some scrap contaminated with undesirable impurities it is sometimes possible to dilute it when melting so that the impurity level comes within an acceptable specification. All these techniques retain much of the value of the scrap. The way in which alloys can be made from scrap is shown in simplified diagrammatic form in the figure.

Where scrap has been contaminated beyond acceptable limits it is necessary to re-refine it back to pure copper using conventional secondary metal refining techniques that provide a useful supplement to supplies of primary copper.

Copper in the Environment:

Copper's environment impact is important to understand. Humans and other organisms acquire copper from their environments such as air, water and soil.

Because it's an essential element, copper's environmental impact cannot be assessed in the same way as artificial chemicals. The chemical form of copper is very important in determining its biological availability or bioavailability to organisms in the environment. The forms, distribution, transport and potential organism uptake and effects of copper in water, sediment and soil depend largely on the chemical and physical characteristics of the local environment, as well as the bioavailability of different forms to each organism.

Copper's environmental impact affects many areas of nature. Many organisms have developed physiological or metabolic means for regulating, excreting and/or detoxifying excess amounts of internal copper and other essential elements. Thus, copper concentrations in tissues are not a good indicator of potential toxic effects on the organism, making the concept of "bioaccumulation" (i.e., as is used for organic compound classification as a persistent-bio accumulative-toxic [PBT] chemical) inappropriate.

COPPER BIOAVAILABILITY

Bioavailability is the amount of a substance available for intake by living organisms. Copper bioavailability measures the fraction of copper available to an organism's sensitive receptor or organ. As copper bioavailability increases, organisms may absorb too much copper. When organisms absorb more copper than they can safely use and eliminate, undesirable results may occur.

The bioavailability of copper depends on several key factors, including:

The chemical composition of different copper forms.

The concentrations of dissolved copper and copper adsorbed on particulate matter (i.e., suspended sediments).

Chemical factors in the local environment, including acidity/alkalinity, hardness (i.e., Ca, Mg), other cations (Na, K), anions, complexing agents (such as bicarbonate, chloride, sulfate, sulfide), binding agents that prevent copper from being available and dissolved organic matter.

Interactions with biological receptor sites ("biotic ligands") such as gills on aquatic organisms.

Measurements of total copper concentrations in the environment (i.e., in surface water, sediments, soils, etc.) cannot be used to predict risks to organisms. Only a small portion of the total amount of copper is bioavailable to organisms and, thus, potentially toxic. The bioavailability of copper is controlled by the environment's local chemistry and the mutual interactions of these chemicals and copper with each organism.

For almost two decades, ICA has co-sponsored scientific research (peer-reviewed) on the mechanisms that control the bioavailability of copper for an aquatic or terrestrial environment. Based on this research, predictive methods are now being adopted by governments to establish fully protective, site-specific environmental quality standards.

Accurate predictive chemical-mathematical models, such as the biotic ligand model (BLM), estimate the bioavailability of copper in various environmental media:

Freshwater environments: Much of the metal released in freshwater environments is bound to particulate solids or dissolved organic matter and is not available for uptake by organisms. Only a relatively small fraction of total copper is available to aquatic life.

Saltwater environments: The bioavailability of copper in saltwater bodies, including estuarine and marine environments, is determined by local water chemistries—just like freshwater environments. In near-shore saltwater bodies, variations in dissolved organic matter and, to a lesser extent, salinity, largely-govern copper bioavailability.

Soils (terrestrial) and sediments (aquatic): Almost all of the copper in soils and sediments is bound to particulate matter. Exposure to organisms depends only on the small amount of bioavailable copper in pore waters.

Copper and Sustainability

Why Copper is considered sustainable?

Copper's unique properties make it an invaluable component of our future. Copper is so good at managing heat and electricity, it is practically irreplaceable for use in sustainable energy — from solar panels to wind turbines. Copper can be 100% recycled — making it a perfectly green material. Just shy of 1 trillion pounds of copper have been mined since the dawn of human history — and most of it is still in circulation thanks to copper's recycling rate (which is higher than that of any other engineering metal).

Most certified sustainable buildings (often called LEED buildings) use a substantial amount of copper. Copper's durability and energy saving properties make it an excellent building material that can qualify a building for LEED credits and help lower its carbon footprint. Although not all uses of copper directly apply to LEED credits, overall copper is used to maximize energy efficiency and minimize impact on our environment.

Some facts:

1. A 2% spend in materials like copper in green buildings generates a 20% SAVING on total construction cost

2. Recycled copper saves up to 85% energy compared to original production. This is the annual equivalent of emissions from 16 MILLION CARS.

3. By 2030, copper could reduce the world's carbon footprint by 16%.

Lead

In solid form, lead has a dullish grey colour and in liquid form it gets a shiny chrome-silver colour. It melts at 327.5 °C and boils at 1740.0 °C, has a high resistance to corrosion and a high density. This makes lead very suitable in containing highly corrosive elements such as sulphuric acid. Pure lead is rarely found in the nature, it is more commonly found in combination with zinc, silver and most notably copper. The largest geographical deposits of lead are located in USA, Peru, Argentina, Bolivia, Australia, Zambia, South Africa, Germany, Spain, Sweden, Italy and Serbia. At the current rate of consumption, it is estimated that the remaining lead deposits will be depleted in 42 years.

Applications

Lead is still a common metal used in a number of functions. Due to its hazardous elements and consequently negative effects on the environment, scientists are looking for replacement materials in several applications.

Automobile Industry

The automobile industry is the biggest consumer of lead. Half of the world lead consumption is due to the automobile industry. In this industry the most common application is the use in car batteries where it functions as electrodes.

Construction

Lead is a very common material used in the construction of buildings. It is used for a number of specific tasks. Most notably is it used in the coating of rooftops and construction of gutters. The high resistance against corrosion makes it an ideal component for this function. High density combined with a favorable weight-to-volume ratio also makes it very desirable in the use of ballast keels for sailboats. Due to its high density, lead is also very effective as a radiation shield, for example in x-ray rooms. The high density is also very useful for the sound insulation of constructions.

Alloys

The best known alloy comprised of lead is solder. This is an alloy of lead and tin and in commercial use the balance of metals consists of 40% lead and 60% tin. This alloy is used to join metal pieces and is very useful because it has a lower melting point than most common metals. Solder is commonly used in electronica, plumbing and jewellery.

Trading

Trading of lead takes place primarily on the London Metal Exchange (LME). This exchange serves as a benchmark in price discovery for various contracts and provides a hedging platform for producers, traders and manufactures.

Price Factors

Demand for lead has been on the rise for the past years and will likely continue to rise for the upcoming years. The rate of this rise is however slightly decreasing, which may eventually lead to a stagnation of the demand.

The supply of lead has been fairly stable over the past few years, although there has been a shift in producing locations. Some countries have seen a decrease in production while others have experienced an increase in production numbers, resulting in a stabilized supply of lead. The demand and supply of lead is therefore a rather strong indicator for the price as they have been historically steady and has rarely seen high volatility levels.

In comparison to other metal commodities, lead production requires far less energy and energy costs will therefore have a slightly smaller effect on the price discovery of lead as opposed to aluminium and many other metals which require huge amounts of energy to produce.
Lead has the unique quality that it can be recycled indefinitely without the loss of physical or chemical properties. This allows lead to be recycled in huge quantities. About 60% of worldwide production of lead originates from recycling activities. Recycling will therefore be an important factor in the supply and consequently the price discovery of lead.

Lead Recycling and Sustainability

1. Lead has one of the highest recycling rates in the world, higher even than better known recycled items such as glass or newspaper. It is also the most recycled metal of all those commonly used, far greater than aluminium, copper or zinc.
2. Lead-acid batteries, the world's most recycled consumer product, are the main application for lead metal.
3. Unlike most materials lead can be recycled indefinitely without any reduction in quality, making it ideal for a circular economy.
4. Lead recycling makes an important contribution to sustainable development, easing the pressure on non-renewable resources and reducing carbon emissions through a simple and energy-efficient recovery process.

In 2013, global secondary lead production was 6.1 million tonnes, or 54% of total production. Secondary production accounts for all the lead produced in the USA and 74% of lead produced in Europe.

Lead is one of the most effectively recycled materials in the world and today more lead is produced by recycling than is mined. Recycling lead is relatively simple and in most of the applications where lead is used, such as lead-acid batteries, it is possible to recover it for use over and over again. In fact the quality of recycled lead is often similar to that of metal obtained from mining. The majority of primary lead is effectively used only to 'top up' the lead that is already circulating efficiently in the economy. This minimizes the pressure on the earth's natural resources to such an extent that lead is likely to be readily available as a sustainable resource in the future for as long as can be reasonably forecast.

How are lead-based batteries recycled?

Lead-based batteries account for more than 80% of present day worldwide lead usage and have an extremely high rate of recycling – in Europe and USA the recycling rate is greater than 95%. Lead is a valuable material so rather than send used lead-acid batteries (ULAB) to landfill at the end of their life many countries around the world send ULAB to recycling centers that operate under strict environmental regulations. ULAB are returned to car accessory dealerships, car workshops, recycling businesses, DIY stores and metal dealerships before being sent to collection points. The batteries are then picked up by specialized companies, who ensure the safe transport and delivery to secondary smelting plants.

At the smelter, the batteries are broken and the components such as the lead metal, paste, plastics and electrolyte (acid) are separated. The lead components are then smelted and refined. The refined lead produced from this process is either used to make new batteries or to make other leaded products such as those employed in building construction, cable sheathing and in healthcare as radiation shielding. Hardly any part of a lead-based battery goes to waste. In most cases the polypropylene plastic casing is recycled to produce plastic pellets that are used to make new battery casings and car bumpers, while the sulfuric acid in the batteries is recovered or made into gypsum for use in plasterboard, or as an agricultural fertilizer.

How does lead recycling contribute to a sustainable society?

The current 'take-make-use-throw away' model of consumption means that as the world population increases the demand for primary resources will become increasingly unsustainable. It is therefore essential to return materials at the end of their life back into the economy. Governments around the world are working to create closed loop economies and to ensure that more materials are recycled indefinitely5. Battery lead recycling already achieves this closed loop and has other positive environmental impacts. Lead recycling saves energy and reduces carbon emissions since it is far more energy-efficient to recycle than it is to produce lead from mining and processing ores. The vast scale of worldwide lead battery use would also pose significant supply challenges to any potential replacement materials, should they ever prove to be technically and economically viable alternatives. In Europe, for instance, lead is readily available with good security of supply, whereas massive imports from other regions of the world would be needed for some alternative technologies.

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