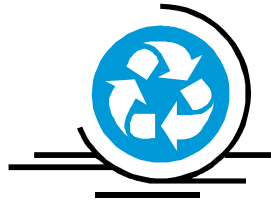


Necessity of Copper Recycling



Copper plays an integral part in our lives, making computers, skyscrapers, and cars possible. This metal has a wide range of uses because it has properties like ductility, malleability, and conductivity. Because copper is such an important element to today's society, we must ensure that we keep a constant supply available for our use. Maintaining our supply comes easy because, unlike other metals, copper does not need to be continually extracted from the earth. Current technology utilizes chemistry to allow copper to be recycled over and over again. When recycled, it will still maintain most of its chemical properties ("Copper: the recycling"). In fact, 40% of the copper that is currently in use has been recycled at least once during its lifetime ("Extracting").

Chemical Properties, Physical Properties, and Applications

The success of copper is based largely on its chemical and physical properties, which allow copper to serve a variety of functions. As we see when looking at a penny that has rusted green, copper reacts well with other elements. This reactivity is created by the one to two valence electrons in the outer shell of a copper atom (the oxidation state of the copper atom, either +1 or +2, is

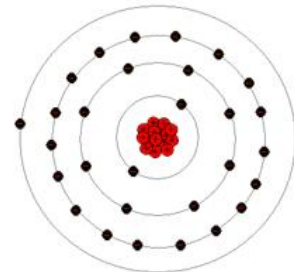
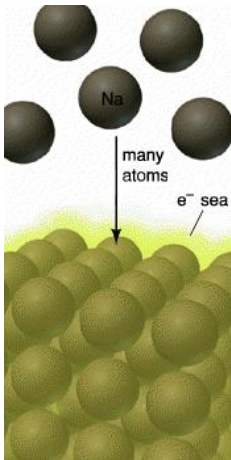


Figure 1. Atomic Structure of Copper ("Atomic")

determined by the number of valence electrons in the outer shell of the atom) and it allows copper to react with other metals and combine to form compounds called alloys ("Copper (element)"). These alloys, like brass and bronze, are combinations of metals (created by melting the different metals together) that can serve even more functions because they combine the best properties of the metals they contain. Like all metals, copper has properties like ductility (ability to be drawn into a wire or string) and malleability (ability to be pounded into a flat form), but copper's most important property is conductivity (ability to carry electricity and heat) ("Copper (element)"). This conductivity is especially useful because it also allows copper to carry data, like video signals.



The ability to carry data makes copper an excellent element to be used in electronics, like computers (which use copper as a component of microchips) and televisions (“There’s”). The properties of malleability, ductility, and conductivity are created in copper and other metals by metallic bonds, where the atoms of copper are bonded to a sea of electrons, instead of just one set of electrons (“Metallic bonds”). These bonds are very strong compared to other types of bonds (covalent, in which electrons are shared and ionic, in which electrons are transferred), but are also flexible and can

Figure 2. *Metallic bonding (Metallic bonding)*

carry a flow of energy. Copper is also a strong and sturdy metal in that it can support a large amount of weight without faltering.

When used in construction, copper supports large skyscrapers and other buildings. Because of these properties and applications, copper plays a valuable role in both industry and consumer life.

History and Milestones in Copper Recycling

Humans have extracted copper from the earth for thousands of years (“Copper (element)”), but it was only recently that we discovered that it was possible to recycle the copper and save the earth’s resources. Although no official record exists of when copper was first recycled, we can estimate this event to have occurred in the 19th century (“Recycling timeline”). During this time period, much came to be known about the benefits of recycling as the world’s population increased and landfills became increasingly overcrowded. The invention of large-scale metal recycling occurred almost simultaneously with the Industrial Revolution, the shift in industry from manual labor as the main source of work to machines as the main source of work (Hooker). Fewer workers were needed and more work could be accomplished because of the power from the machines. Tasks that had once seemed impossible could now be accomplished quickly and easily. Metal recycling was a product of the Industrial Revolution because it required machines to manipulate large pieces of metal, heat them, and mold them into new shapes. Accomplishing these tasks is difficult by hand and impossible to do on a large-scale. The need for machines best explains why metal recycling did not become widespread in earlier times. Today, recycling is much more common as we have more technology. One of the largest-

scale metal recycling operations occurred in the 1990s when some of the countries who had decided to join the European Union sent their pre-Euro coins to plants for recycling, as they no longer wished for the coins to be in circulation. One German copper recycler received an excess of 100,000 tons of coins to recycle (“Copper recycler”). These coins contained a variety of different metals, but most contained at least some copper. Each state needed to abandon its previous currency to make room for the Euro, the standardized currency of European Union, and most of the states decided that recycling would be the best option for disposing of the coins.

Recycling Process

Copper recycling occurs at plants and factories located across the globe. Companies such as Noranda Recycling work with other companies to obtain copper from consumers and the industry for recycling and processing. Once the copper is obtained, it is recycled through a process called smelting, a process that is also used to treat mined copper. This process requires powerful and expensive machinery and trained workers must work in the plants for operations and repairs. Smelting uses heat and a variety of chemical processes

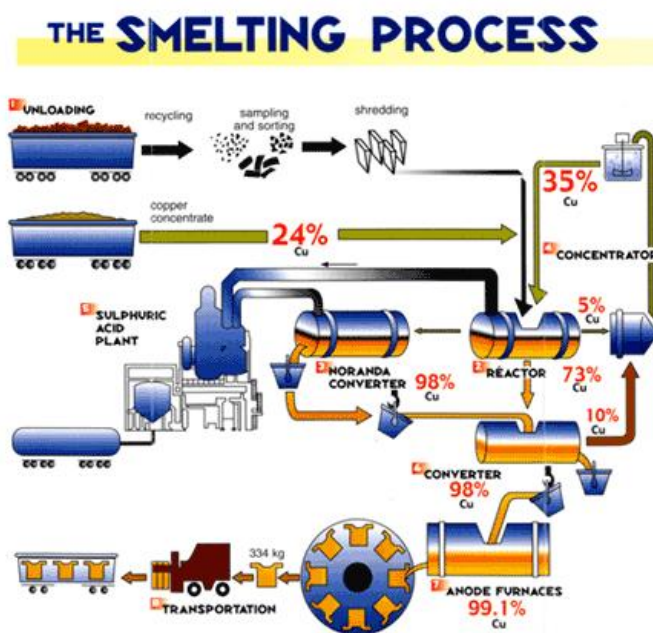


Figure 3. Demonstration of Copper Smelting Process (Noranda)

to extract high-quality copper out of alloys and lower-quality copper. The copper begins by being separated between usable copper and copper that will not be able to be recycled. It is shredded

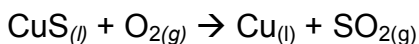


Figure 4. Reaction that occurs in converter (Zumdahl)

into manageable pieces. At this point, the copper still contains sulfur and iron (these are naturally found in copper), among other metals. It is placed in the reactor,

which works to remove the iron and some of the other impurities. The concentrator combines the copper particles together into liquid form for easier processing. The copper is placed inside the converter, which reacts copper sulfide and oxygen gas to yield blister copper and sulfur dioxide

(see Figure 3), the latter of which is used later in the sulfuric treatment process. The sulfuric treatment involves a process called leaching, in which a substance (copper) is obtained from a solid by dissolving the solid with a liquid. The copper is formed as a precipitate during this leaching reaction. The final step in the smelting process is the use of the anode furnace, which uses electricity between anodes and cathodes to create an electric field that removes any oxygen

that remains in the copper ("Copper processing"). At

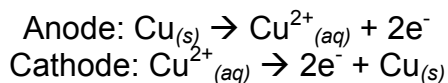


Figure 5. Reactions that occurs in the anode and cathode (Zumdahl)

each step in the smelting process, the copper becomes more and more like pure copper and eventually reaches a quality of about 99.9% copper, the closest quality to pure copper that can currently

be obtained. ("Extracting").

Benefits of Recycling

Consumer electronics contain relatively large amounts of copper and are thus commonly used in recycling. Computers, commons objects in many homes and offices, contain copper and other metals in their circuit boards. When recycled, these metals can be used to make more computers or stranger things: one man discovered a way to make wedding rings out of the metals he found in computers ("There's"). This idea shows the creative and amazing products that can come from recycling. More importantly, though, recycling helps to maintain our environment for our generation and for the generations that will live after we are gone. When we recycle copper, we reduce the amount of copper that must be extracted from the environment. Extracting anything from the environment, especially metals, requires energy and labor and produces pollution, because of the machinery and processes involved. By reducing the amount we must extract, we can help fight the greenhouse effect and ozone depletion. ("Extracting"). Also, processed metals are often toxic to our sources of water and our crops. It is important to recycle electronics and other items that contain these metals so that our sources of food and water are not harmed.

Future of Copper Recycling

The past and current success of copper recycling suggests that its future will be successful as well. As more high-tech products and buildings are made that will require copper, more copper will be mined from the earth. The necessity of preserving our copper supply will become even more important. Recycling is becoming more popular and people are beginning to fully understand its benefits. Both of these reasons will contribute to an increase in the operations of the copper recycling industry.

References

- "Copper (element)." MSN Encarta. 2006. 10 Nov. 2006
<[http://encarta.msn.com/encyclopedia_761561391/Copper_\(element\).html](http://encarta.msn.com/encyclopedia_761561391/Copper_(element).html)>.
- "Copper Processing." Illinois Waste Management and Resource Center. 14 Nov. 2006
<http://www.wmrc.uiuc.edu/main_sections/info_services/library_docs/manuals/primmetals/chapter5.htm>.
- "Copper recycler anticipating large intake of pre-euro coins." *American Metal Market* 109.157 (August 14, 2001): 7. *General Business File ASAP*. Thomson Gale. Seminole County Public Schools ESC. 20 Oct. 2006
<http://find.galegroup.com/ips/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T003&prodId=IPS&docId=A77337490&source=gale&userGroupName=fl_seminoleesc&version=1.0&contentSet=IAC-Documents&retrieveFormat=PDF&isAcrobatAvailable=true>.
- "Copper: the recycling champion.(International News)(Brief Article)." *Furnaces International* 1.3 (Sept-Oct 2003): 6(1). *Expanded Academic ASAP*. Thomson Gale. Seminole County Public Schools ESC. 26 Oct. 2006 <http://find.galegroup.com/ips/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T003&prodId=IPS&docId=A113756265&source=gale&userGroupName=fl_seminoleesc&version=1.0>.
- "Extracting Copper." Schoolscience. The Assn. for Science Education. 27 Oct. 2006
<<http://www.schoolscience.co.uk/content/3/chemistry/copper/index.html>>.
- Hooker, Richard. World Civilizations. Course home page. Washington State U. 6 Nov. 2006
<<http://www.wsu.edu/~dee/ENLIGHT/INDUSTRY.HTM>>.
- "Metallic Bonds." Integrated Publishing. 10 Nov. 2006
<http://www.tpub.com/content/doi/h1015v1/css/h1015v1_49.htm>.
- "Recycling Copper." Copper Development Centre. 11 July 2002. 26 Oct. 2006
<<http://www.copper.com.au/cdc/article.asp?CID=48&AID=89>>.
- Recycling Timeline. 13 Nov. 2006 <<http://members.aol.com/Ramola15/timeline.html>>.
- "There's gold in them thar PCs!(Last Byte)(Good Point Recycling)(American Retroworks Inc.)(computer recycling)(Brief Article)." *Washington Technology* 19.9 (August 2, 2004): 34(1). *General Reference Center Gold*. Thomson Gale. Seminole County Public Schools ESC. 20 Oct. 2006
<http://find.galegroup.com/ips/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T003&prodId=IPS&docId=A120975776&source=gale&userGroupName=fl_seminoleesc&version=1.0&contentSet=IAC-Documents&retrieveFormat=PDF&isAcrobatAvailable=true>.
- Zumdahl, Steven S, and Susan A Zumdahl. Chemistry. Ed. Richard Stratton, Marianne Stepanian, and Cathy Labresh Brooks. 5th ed. N.p.: Houghton, 2000.

Images

- Atomic Structure of Copper. Photograph. 12 Nov. 2006 <<http://www.ndt-ed.org/EducationResources/HighSchool/Electricity/Graphics/copperatom.gif>>.
- Metallic bonding. Photograph. 10 Nov. 2006
<http://www.chem.ufl.edu/~chm2040/Notes/Chapter_11/bond.html>.
- Noranda Recycling. Flowchart of copper smelting process. Photograph. 27 Oct. 2006
<<http://www.norandarecycling.com/flowsheets/bknd.gif>>.