The recycling of metals engineering essay

In our report we are discussing about recycling of metals and why we go in for recycling it. Also we have chosen five metals namely steel, aluminum, copper, lead, and tungsten which are recycled efficiently during the recycling process and discuss about the method of processing and benefits of recycling process.

Metals play an important part in modern societies and have historically been linked with industrial development and improved living standards. Society can draw on metal resources from Earth’s crust as well as from metal discarded after use in the economy [1]. Metals are highly recyclable materials because their intrinsic properties don’t change much on repeated recycling. If we increase their reuse and recycling the metals have a potential to improve resource productivity, and to reduce energy use, some emissions, and waste disposal. Improper recovery of metals from the economy increases reliance on primary resources and can impact nature by increasing the dispersion of metals in ecosystems.

What is metal recycling?

Metal recycling is the process of reusing old metal material, mainly aluminum and steel, to make new products. Recycling old metal products uses 95% less energy than manufacturing it from new materials [2].

Why metal recycling?

It is easy and cost-effective to recycle metal, and metal can be recycled continuously without losing its properties. Therefore recycling metal reduces the environmental impacts associated with metal mining and production.

2. Materials and Methods

a. Aluminum

Aluminum is the most abundant metal in the world and also one of the most recycled a fact that can be attributed to the strong price it commands in worldwide commodities markets. It is estimated that over 50% of aluminum cans produced will be recycled, with some countries having a recovery rate of greater than 90%. Aluminum is a sustainable metal because of its high recovery rate and recyclability, with 2/3 of all the aluminum ever produced in use today.

i. Applications of aluminum

Electrical conductors, transport, packaging, building and architecture, miscellaneous applications such as high pressure gas cylinders, machined components, sporting equipment, road barriers and signs and lithographic plates

ii. Recycling of Aluminum

The recycling of aluminum provides many environmental and economic benefits. Aluminum recycling saves a substantial amount of energy. Aluminum is a sustainable metal and can be recycled repeatedly for any number of times. It is also the most valuable recycled product that we humans consume. The marketing of aluminum enables the municipalities to reduce some of the cost of recycling of other less valuable products, which provides an economic necessity to recycle. In these days, it is cheaper, faster and more energy saving and also efficient to recycle aluminum than the olden days. Aluminum, being 100 percent recyclable can be recycled indefinitely.

The process of recycling aluminum cans is described below [3];

Aluminum cans and other such wastes are collected from house wastes and by municipal garbage. Using a device called eddy current separator, the wastes are sorted when it arrives to company. The eddy current electrically charges and causes it to repel from the device in to a sorting stream and then is passed on in to an awaiting bin. Then these are condensed into highly dense, briquettes weighing 30-pound or bales of 1, 200-pound. This is then shipped off to aluminum companies for melting and further processing.

Once the condensed briquettes and bales arrives to the aluminum companies, it is shredded, crushed and torn off of their inside and outside decorations through a simple process of burning. Then, these palm sized pieces of aluminum are loaded into furnaces for melting, where the recycled metal is blended along with the new, virgin aluminum.

Aluminum is melted and then poured ingot moulds and is cast in to ingots. It is then arranged in to 25-foot long ingots that weigh over 30, 000 pounds. These ingots are then fed into rolling mills which reduce the thickness of the metal from about 20 inches into sheets that are about 10/1, 000 of an inch thick.

These metal sheets are then coiled and shipped to can makers that produce cans and other related products. These processed cans are then delivered for the filling of beverages to companies.

Molten furnaceThe filled cans are then distributed to stores and supermarkets for sales. The consumers then consume it and is then put in to

bins or collecting centres. Then the cans enter the recycling cycle and the whole process repeated. A used can gets back in to the stores shelves in as little as 60 days.

Reverse mill

products

aluminum

Aluminum plant

plant

Aliuminum plant process scrap

Used aluminum products

Aluminum ingot output

Ingot cast

Molten aluminum

Aluminum scrap are collected

iii. Applications of recycled aluminum

Transportation Equipment, Containers and Packaging, Construction Materials, Durable Goods

iv. Benefits of recycling aluminum [4]

Conserves energy

Manufacturing aluminum from virgin ore consumes a huge amount of energy in each and every step from metallurgy to casting which increases our dependence on fossil fuels. Recycling aluminum saves 92 percent of the energy needed to produce aluminum from bauxite ore. A single aluminum can, when recycled saves the amount of energy that is equivalent to the energy that is needed to power a television set for 3 hours.

Conserves raw material

Main source for the aluminum industry is the aluminum scrap because of its recycling nature. The recycled aluminum saves 4 tons of bauxite ore and 1, 500 pounds of petroleum coke and pitch for every ton of re-melted aluminum instead of extracting.

Reduces Pollution

Recycling aluminum requires only less energy than manufacturing so, it means reduced greenhouse emissions. Also it reduces secondary effects on the environment, such as global warming and acid rain. Therefore recycling aluminum instead of extracting virgin ore eliminates nearly about 95 percent of air pollution and 97 percent of water pollution.

b. Copper

Copper is the ancient and most used metal by man. After iron and aluminum, copper is the most leading metal produced in the market. Copper is very commonly used in electrical and plumbing applications. Since number of electrical components are used in our day to day life, the application of copper increases day by day. Copper is used directly or as an alloy with iron (Bronze). Many ancient aircrafts are made of bronze. Most of the raw materials have alloys added to their base metal.

i. Applications of copper

Comparing to other metals, copper is more often used in its pure form than alloys. Copper have high resistance to corrosion and high electrical and thermal conductivity in the pure form which makes it suitable for most of the electrical, heating and plumbing applications.

ii. Recycling of copper

Casting the molten metal Temp 11600C into billets

Molten furnace

99% pure Cu

Extrusion process into tubes

Collection and sorting of the scrap In Europe, 41% of copper for its applications are obtained from recycling [5]. Recycling of copper is done by the following steps. The scraps rich in copper are waste electrical and electronic equipments, old taps, plumbing pipes and scraps from copper/copper alloy production and manufacturing. So these scraps are first

collected, sized and sorted. These sorted scraps are then melted, casted and then made into new copper products. When the copper scraps are received for recycling, it is first visually inspected, graded and analyzed chemically if necessary. Loose scraps are baled and stored until processed. High grade copper scraps are melted directly, but in some cases it is brought to higher purity when it is in a molten state while refining. It is then followed by deoxidization and then casted into billets or ingots for further production process.

Temperature is reduced to 6000C optimal extrusion

Wired into different diameters for several applications

iii. Benefits of copper recycling [5]

Environment

Continuous mining may reduce the strength of the soil. The refining process will emit some dust particles along with some waste gases such as sulphur dioxide etc which will have some harmful effects on the environment. Even though many copper producers are involved in minimizing these harmful effects (sulphur dioxide is captured and used to make sulphuric acid) it is not possible to eliminate them completely. So the recycling process will enhance for this as a whole.

Landfill costs

If the used materials are not recycled, it will be sent for landfills. It is same in the case of copper where the non recycled copper materials are dumped as a whole in the earth called landfill. Once if we are continuously involved in

increasing the content of landfill, it becomes very difficult to dispose those materials if it becomes full.

Energy saving

In general, the energy required for extracting one ton of copper from its ore is approximately 100GJ. But the energy required for producing same amount of copper from recycling is only 10GJ, which is only 10% of the energy needed for extraction. This results in saving a number of valuable reserves such as coal, natural gas etc.

Conservation

Currently 12% of known copper resources have been mined. However the number is finite and it makes sense to conserve these ores by recycling. The recycling efficiency of copper is about 40 to 60%.

Economics

Recycling copper is very economical compared to mine and extract new copper. Recycled copper saves 90% of the cost of the original copper which obviously helps to keep the cost of copper products down.

c. Steel

Steel is an alloy mostly consists of iron and carbon content between 0. 2% and 2. 1% by weight [7]. Steel is normally produced by smelting iron ore which is a commercial process where it contains more carbon and to become steel, it must be melted and reprocessed to reduce the amount of carbon and other elements are added, the liquid is then continuously cast into long slabs or cast into ingots . Steel is mostly used in engineering and

construction materials. It is very friendly to the environment and completely recyclable due to high durability, less energy consumption.

i. Applications of steel

Iron and steel are most widely used in the construction of roads, railways, other infrastructure appliances and buildings. Steel is used in variety of other construction materials, such as bolts, nails, and screws [10].

ii. Recycling of steel

The unique magnetic properties of steel make it an easy material to recover from the waste so it can be recycled. The properties of the steel remain unchanged no matter how many times they are recycled. Steel recycling saves 75 percent of the energy which would be used to create steel from raw materials, enough to power 18 million homes. Over 65 percent of the steel produced in the U. S. is recycled into new steel every year. Steel is recycled in the following process.

Collecting:

The steel scraps are collected first from the companies; households etc… Then are taken to the recycling industry.

Shredding:

After it has reached the recycling plant the collected scraps are shredded into pieces.

Magnetic Separation:

The shredded pieces reach the magnetic separation process where the steel is attracted to magnet and gets separated from other metals.

De tinning:

Steel cans normally have a layer of tin on them, where tin can is recycled on its own. This is usually carried out in specialized steel company, such as a steel mill or a scrap dealer.

Melting:

The separated steels scarps are the kept in a furnace for melting and hence the melted steel is casted and rolled into flat sheets.

Reformation:

Once the steel is in sheet form, it can be molded into products such as new steel cans, car parts or construction materials. Steel can be recycled infinitely without losing its strength or quality.

iii. Applications of Recycled steel

The recycled steel are used in appliances, Bridges Cans, Cars/trucks, Construction materials, Desks, File cabinets, Fire hydrants, Guard rails, Utility poles.

iv. Benefits of recycling steel [9]

Conservation of Natural Resources

The recycling process in less expensive when compared with the manufacturing and also ecofriendly. Therefore using scrap steel helps preserve natural resources and energy. According to the Steel Recycling

Institute, for every ton of steel recycled, 2, 500 pounds of iron ore, 1, 400 pounds of coal and 120 pounds of limestone are conserved. By recycling, the steel industry also conserves a huge amount of energy, thus the energy can be used for other useful purposes.

Landfill Space

Recycling steel helps in saving landfill space by diverting steel from the waste stream.

Reduces Air and water pollution

Manufacturing steel from its virgin ore involves the emission of greenhouse gases, which contribute to global warming. Therefore using recycled steel generates 85 percent fewer emissions.

Using scrap steel as a raw material in a steel mill can diminish water pollution by 76 percent and its mining waste by 97 percent said by Institute of Scrap Recycling Industries.

Economically Advantageous

Recycling the old steel into new steel than manufacturing steel completely from virgin ore is more profitable.

d. Lead

Lead is an element with a symbol Pb and has an atomic number of 82. It is very soft and malleable in nature. It comes under the category of heavy metals. Lead as a metal has a bluish-white color when it is freshly cut, but the color soon tarnishes to a dull grayish color when it is exposed to air. Lead forms in to a shiny chrome-silver luster when it is melted into a liquid.

Melting point of lead is 327. 46 degree Celsius and a boiling point of 1749 degree Celsius. It is also known for its density which is 11. 34g/cubic meter. Another important property of lead is that it is resistant to corrosion [11]

i. Applications of lead

Lead is used in ballast keel of sailboats and also in scube diving belts due to its property of high density. It is also used to cast small arms and ammunition and shotgun pellets. Lead is also used in printing. Since it is a non corrosion metal it suitable for outdoor applications when in contact with water. It is used in statues and sculptures and also in construction industry. Apart from all these, more than half of the worldwide lead production is used as electrodes in the lead-acid battery used extensively as a car battery.

ii. Recycling of lead [13]

Following are the recycling process.

Receiving

Batteries and recyclable raw materials are unloaded, weighed and sent to raw material processing center.

Separation

Batteries are broken apart in the hammer mill, and separated into three main components-leads, plastic and acid-by screening and gravity separation. Each component moves into a separate processing stream.

Containment

After initial processing, recovered lead and other lead wastes are stored in a specially designed containment building with a double-lined floor and leak-detection system.

Purification

The Waste water purification and treatment system neutralizes, purifies and converts the sulphuric acid into a pH- neutral liquid that is safely released into the sewer system.

Smelting and refining

After the lead is melted in blast furnaces, we mix the reclaimed lead with other materials to produce lead alloys.

Casting

Refined lead is poured into molds and cooled. Ingot molds come in three size large blocks (hogs), rectangular bars (pigs), and tube-shaped (billets).

iii. Benefits of recycling lead

Mining of lead requires energy of about 1000 TJ whereas recovering of lead from batteries and other sources requires only about 12. 9 TJ. We clearly see that we save nearly 77 times the energy in the recovering process.

Recycling lead also releases less amount of carbon dioxide when compared to the process of mining of lead from ore. To be accurate, recycling process gives 1. 5Kt CO_2 while the mining process gives 163Kt CO_2 . This clearly shows the reduction in the amount of emission of green house gases to more than 100 times.

Mineral resources are saved. Land resources are also saved from making it in to landfills.

Lead recycling gives almost 100% efficiency.

e. Tungsten recycling [14]

Tungsten is a chemical element with a chemical symbol W and an atomic weight of 74. Tungsten is a whitish-gray metal and is one of the heaviest metals that have the highest melting point of any element except carbon; excellent high-temperature mechanical properties. The average concentration of tungsten in the Earth’s crust is estimated to be approximately0. 0001%. The available ores for extracting tungsten are Scheelite (CaWO4) and Wolframite [(Fe, Mn) WO4]. The leading use was as tungsten carbide in cemented carbides are use to make cutting tools and also as wear-resistant components by the construction, metalworking, mining, and oil drilling industries. Tungsten alloy or pure tungsten metal contacts, electrodes, and wires are used in electrical, electronic, heating, lighting, and welding applications. Tungsten alloys and composites are used as a substitute for lead in bullets and shot. Tungsten chemicals are used to make catalysts, corrosion-resistant coatings, dyes and pigments, fire-resistant compounds, high-temperature lubricants, and phosphors. As on today, the market rate for the tungsten ore is $16. 25 per pound. This clearly shows the demand and the necessity for the metal. We have seen previously that only 0. 0001 percent of ore is present over the earth’s crust and the price too being very expensive brings about the necessity of recovering and recycling from used mediums. This can save a lot of resources, energy required for mining ores and it’s processing to get the metal. Thus we clearly

see recycling and recovering serves a great way for saving tungsten recourses.

i. Recycling process

Recycling of tungsten has been done since early 90s. We evidently are having a good progress in this recycling process. There are many ways to recycle the metal. But it depends on the type of scrap we choose to recover it from. The types of scraps are given below:

Old scrap

It consists of tungsten-bearing products that are worn out. Used cemented carbide parts like metal cutting tools, some tungsten metal and tungsten alloy parts from electrical equipments. Old super alloy scrap includes used turbine blades and other parts removed from jet engines. It also includes some tool steel components.

New scrap

It is generated during the processing of tungsten concentrates, scrap, and chemicals to make metal powder and during the fabrication of tungsten products from these materials. This includes hard scrap consisting of solid pieces, such as sub specification alloy parts and cemented carbide parts, soft scrap consists of fine particles, such as bag house dust from steel and alloy manufacture.

Unrecovered scrap

It represents tungsten in scrap that has not been recycled. Some of its examples include burned out lamps and lighting fixtures, electrical contact disks, land filled spent catalysts and low-grade grinding swarfs, non

collectable carbide parts, tungsten carbide hard facing materials, and welding electrode stubs.

Processing of alloy scraps

The oxidation-reduction process is the preferred method for recycling tungsten heavy metal alloy turnings and powders. In this direct recycling process, the scrap is oxidized by heating it in air at 800° C, milled and screened, hydrogen reduced between 900° to 1, 000°C, screened, blended, and then mixed with virgin heavy metal alloy powder to make a ready-to-press powder for the production of new products.

Processing of cemented carbide scrap

Cemented carbide producers supply scrap directly to converters, who return recycled powders to them for reuse. The processing method involves oxidation followed by alkali leaching. Cemented carbide scrap could be recycled by semi direct methods, such as acid leaching, bloating followed by leaching, electrolysis, or leach-milling.

Processing of pure tungsten powder scraps

Pure tungsten metal scrap could be recycled by using the following method. Electrolysis, which uses the scrap as an anode in an electrolytic solution, then chemical processing in which melting is followed by oxidation-reduction.

Processing of thoriated tungsten scrap

Thoriated tungsten electrodes are also used in a variety of high-performance and special application lighting products, such as high-intensity discharge lamps. The scrap is oxidized in air and then either reduced with iron by using

a silicothermic or aluminothermic process to make ferrotungsten or processed chemically to make APT. The thorium oxide, which ends up in the slag in the production process is sent to a low-level radiation depository. Cleaned thoriated tungsten powders, solids, and turnings, which are generated as new scrap during the production of thoriated tungsten products or, in the case of solids, as old scrap by consumers, are processed by using the oxidation-reduction method.

ii. Benefits of recycling tungsten

•Recovering tungsten this way enables us to save two-third of energy we spend for mining new tungsten from the ore. That is we spend only one-third of energy for recovering

Tungsten when compared to mining.

•Recycle efficiency of tungsten is 66%

•CO2 emission is sustained there by contributing its merit to green house effect.

•Saves mineral resource i. e 0. 0001% of tungsten in earth’s crust

What are the Benefits of metal recycling?

Get paid for you give to scrap metal recycling facilities.

Emission of green house gases gets reduced.

Aluminum and steel can be recycled repeatedly.

Decreases environmental damage caused by mining

Conserves land and water resource.

Things to be done

The secondary metal production is been affected by environmental regulation through laws that control emissions and govern the classification and treatment of metal-loaded wastes. Also industry must develop better technology to isolate and recover maximum value from metals in waste streams, and governments must institute policies that remove barriers to their economically and environmentally. Only through a cooperative effort can society recover a maximum amount of metal from the industrial/social system to benefit the environment.

Conclusions

Recycling of metals helps us to make sustained use of metals. It conserves energy, natural resources, therefore reduces pollution. Due to the unique valuable properties metals will remain an integral part of future industrial society. Decades of increased productivity and more efficient technologies for metals production and use has decreased the share claimed by the primary and secondary metals industries. Many recycling techniques should be carried out so that the environmental benefits gets increasing on the reliance on secondary metal production include conserving energy, landscapes, and natural resources, and reducing toxic and nontoxic waste streams. If every country embraces it, a global impact will be achieved.