COPPER AND COPPER ALLOYS

Copper is a d- block element and placed below Hydrogen in the reactivity series.

Copper is found as native metal in minerals copper pyrite ,ruby copper, and copper glance.

Extraction of Copper from Copper pyrite

-Crushing-

-Concentration (Froth floatation)

- **Roasting (passing hot air)**
- **- smelting-Electrolytic refining**

- **Crushing –Use jaw crushers**

<u>Roasting</u>

-Moisture is removed

-Volatile matter removed

$$S + O_2 \rightarrow SO_2$$

$$P_4 + 5O_2 \rightarrow 2P_2O_5$$

$$2CuFeS + O_2 \rightarrow Cu_2S + FeS + SO_2$$

Smelting (Blast Furnace)

$2FeS + O_2 \rightarrow 2FeO + 2SO_2$

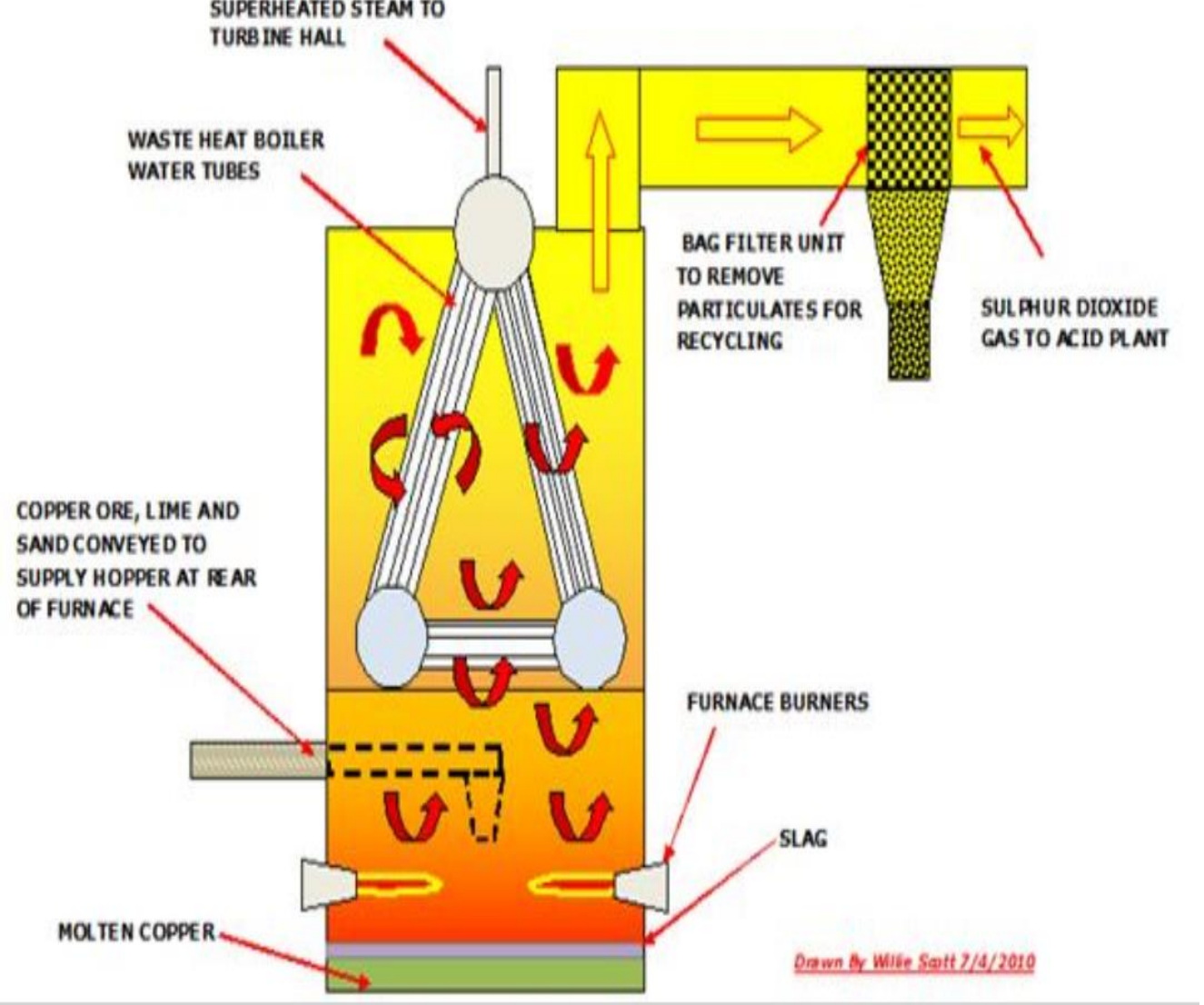
$FeO + SiO_2 \rightarrow FeSiO_3(Slag)$

$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO2$

$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$

-Copper produced at this stage is 98% Pure (Blister copper)

Blister copper is then electrolyzed using acidified copper sulphate solution as the electrolyte(Add some sulphuric acid to copper sulphate solution)



Copper smelting Furnace

Source : https://www.google.com/search?q=copper+extraction+blast+furnace&tbm=isch&source=iu&ictx=1&fir=qn0A_Rc71FBo6

- **At the Anode is placed the impure copper (Blister copper)**
- **At Cathode we place pure copper**
- **Pure copper from the anode will be deposited onto the cathode**
- **Impurities settle down near Anode.**

General Properties of Copper

- Atomic number 29
- Atomic mass 63.54
- FCC
- A noble metal, it has inherent properties similar to those of silver and gold.

(POSOCAMALZIL(H)C)

-Density of copper is 8.89 g/cm^3,

-Melting point is 1083°C.

-All properties, and characteristics are modified with alloying.

- Non-magnetic

- Has a reddish Pleasing color

- Can be welded, brazed, and soldered

NOTE: Most of the copper that is used for electrical conductors contains over 99.9 percent copper and is identified as electrolytic tough-pitch copper (ETP) or oxygen-free high-conductivity copper (OFHC).

Specific Properties of copper

a) Conductivity

-Highest rating- both electrical and thermal conductivity.

- Its alloys are used as **conductors of electricity, connectors in electrical/electronic products** due to its high conductivity coupled with intrinsic strength, good formability and corrosion resistance

b) Strength

-It is relatively soft and malleable with excellent **formability**

hence ideal for architectural applications such as **roofs, wall cladding, gutters and downspouts**.

c) Formability

Cu has exceptional formability. It is able to produce micro meter -sized wires.

-It's alloys exhibit increased strength proportional to the amount and the nature of the alloying element.

.

- **Deep drawing**
- **Stretching**
- **Bending**
- are common methods used to form components such as bathroom fixtures and other household products.

d) Joining

Copper and copper alloys can be easily joined by the common methods

– **soldering,**

-brazing,

-welding,

-bolting,

-riveting,

-adhesive bonding.

e) Corrosion

Cu alloys have excellent corrosion resistance.

- Several architectural fittings and fixtures are made from copper

-brass and bronze continue to provide service in both indoor and outdoor environments.

Copper alloys corrode at negligible rates in unpolluted air, water and deaerated non-oxidizing acids.

Note: in halogen environment, it corrodes or degrades

-NOTE: Many copper alloy artifacts have been found in good condition after having been buried in the earth for millennia.

-Copper roofing has been found to corrode at rates of less than 0.4mm/200 years.

f) Antimicrobial property

The antimicrobial attributes are intrinsic and have been exploited for centuries. copper alloys are able to kill 99.9% of the following listed organisms within two hours:

- **Vancomycin-resistant *enterococci* (VRE),**
- ***Staphylococcus aureus***
- ***Pseudomonas aeruginosa* and Methicillin-resistant**
- ***Staphylococcus aureus* (MRSA).**

No other solid metal surfaces have EPA(Environmental Protection Agency) registration to make public health claims.

Brasses

Alloys made from copper and zinc,

-Exhibit good strength and ductility

-are easily cold worked

-properties improve with increased zinc content up to 35%.

Brass coloration ranges from red to golden yellow, depending on the amount of zinc the alloy contains.

Gilding Metal, Commercial Bronze, Jewelry Bronze, Red Brass and Cartridge Brass are common names given to brass alloys with specific zinc contents.

-Brasses containing between 32% and 39% zinc exhibit excellent hot working characteristics but limited cold workability.

-Brasses containing more than 39% zinc, such as Muntz Metal, have high strength and lower ductility at room temperature than alloys with less zinc.

Tin Brasses are alloys made from copper, **zinc (2% to 40%) and tin (0.2% to 3%). This family of alloys includes admiralty brasses, naval brasses and free-machining tin brasses.**

-used for making high-strength fasteners, electrical connectors, springs, marine hardware, pump shafts, and corrosion-resistant screw machine parts. They provide increased corrosion resistance and lower sensitivity to dezincification

Silicon Bronzes **are part of the subgroup of high-strength brasses.**

-Contain less than 20% zinc and up to 6% silicon and are solid solution strengthened.

Silicon red brasses are used for valve stems where corrosion resistance and high strength are critical.

- **Included in this category are the silicon red bronzes, which are similar to silicon red brasses except for their very low concentrations of zinc.**

They are used to make bearings , gears and intricately shaped pump and valve components

Nickel Silvers,

also called nickel brasses, are alloys containing copper, nickel, and zinc.

Though they do not contain silver, they have an attractive silver luster, moderately high strength and good corrosion resistance. They are used to make

- **Food and beverage handling equipment, decorative hardware**
- **Electroplated tableware**
- **Optical and photographic Equipment**
- **Musical instruments.**

Copper Nickel alloys containing between from 2% to 30% nickel, are highly corrosion-resistant and thermally stable.

- The addition of iron, chromium, niobium and/or manganese can improve their strength and corrosion resistance.
- They are virtually immune to stress corrosion cracking and exhibit high oxidation resistance in steam and moist air.

Identification of Copper Alloy

- **Copper alloys are identified by the Unified Numbering System (UNS) that categorizes families of alloys based upon their elemental make-up.**
- **Wrought products range from UNS C10000 through UNS C79999;**
- **Cast products are assigned numbers between UNS C80000 and UNS C99999**

Measurement of conductivity

Conductivity is the primary characteristic that distinguishes copper from other metals. The electrical conductivity of materials is measured against that of a standard bar of "pure" copper that in 1913 was assigned a value of 100% IACS **(International Annealed Copper Standard).** Since that time, improved processing techniques and higher purity ingots have resulted in commercial copper with electrical conductivity values slightly above 100% IACS.

- Most coppers used for electrical transmission and interconnection have electrical conductivity of 85% IACS or greater.
- Commercially pure copper has 101% IACS as do several of the oxygen free (pure) coppers like C10100 and C10200.
- Note the conductivity of Phosphorous Deoxidized Copper; has a copper content of 99.9%, yet its conductivity is “only” 85% IACS.

Phosphorous is one of the elements that severely depresses conductivity

(Read more about these numbering systems and uses of copper)

https://www.youtube.com/watch?v=KBPv2p7T1wo

https://www.youtube.com/watch?v=I6f6xZsrLCg

Thank you for listening