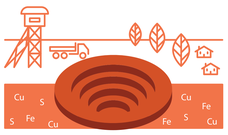
ATLANTIC COPPER
A Freeport-McMoRan Company

THE COPPER PRODUCTION PROCESS AT ATLANTIC COPPER

Copper ore enrichment in %



Ore extraction and concentration up to 25 - 30 %.

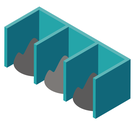
Copper ore concentrate

This is the raw material for the production of high purity copper.
It is a material that is almost black in color, resulting from the crushing and processing of the ores extracted from the mines.
Copper is generally present in nature in very low percentages (0.5 - 2%), but after a grinding and flotation process, a copper concentration of around 25-30% is achieved.
These grinding and flotation processes are carried out at the mine and it is this mineral, once concentrated (hence its name), which is received at the Huelva smelter.
The main components of this material are copper, iron and sulfur.

Transport to Huelva.

Reception and Processing

Copper concentrates are received by boat at Huelva's outer harbor and are transported to the plant in trucks, where *they are stored, separated into different grades.*
In order to achieve a balanced mix in the flash furnace, suitable amounts of the different grades are mixed together with a flux, silica, to facilitate the reaction.



Concentrate storage.

Dryers. Moisture removal.

Dryers

Copper concentrates arrive at the plant with a moisture content of approximately 8%, which must be reduced to 0.2% to be able to process them in subsequent phases. This is accomplished using *dryers* that take advantage of the residual heat generated in the process. After the drying process, the concentrate is analyzed to check its final moisture content.

*Mixture, **26%** copper.*

Mixture

Once the moisture has been removed, the mixture is ready for smelting in the flash furnace, with a copper content of around 26%. This percentage varies depending on the origin of the copper ore and ranges from 20% to 35%.

Melting in the flash furnace. Separation and oxidation of the different concentrate components.

Flash Furnace

The flash furnace is designed with three distinct parts: reaction chamber, settler and gas uptake shaft. *The reaction chamber* – a cylinder containing the concentrate burner – is where the dissociation and oxidation of the chemical elements present in the concentrate takes place, releasing a large amount of heat in the process. The molten materials fall into the *settler* where the matte (denser, rich in copper) and the slag (less dense, rich in iron) separate due to their difference in density. Finally, the gas produced when the sulfur present in the concentrate is oxidized is channeled to the waste heat boiler through the *gas uptake shaft*.
Melting the concentrate requires the use of oxygen-enriched air to cover the thermal deficit, and only a small amount of fuel is used to compensate for the furnace's heat losses and keep it hot.

Smelting: around 1,100,000 t/year.

*Matte, **62%** copper.*

Matte

This is one of the liquid phases obtained by melting the copper concentrate in the flash furnace.
It is a liquid that flows out of the furnace at a temperature of over 1,200ºC and contains 63-64% copper, the rest being sulfur, iron and other trace elements, including precious metals.
The matte is transferred by bridge cranes to the next phase of the process, conversion.

Converter. Removal of traces of sulfur, iron and other metals.

Converter

Matte conversion is the process by which copper is separated from the traces of sulfur, iron and other metals not removed during the smelting. It is a highly exothermal process, so secondary materials such as recycled copper can be added during conversion without the need for additional fuel. As in the flash furnace, the air used in the process is enriched with oxygen and is blown in using nozzles.

*Blíster, **99%** copper.*

Blister copper

Blister copper comes from the previous stage, the conversion of the matte.

Anode furnace and casting wheel. Oxygen and sulfur residues are removed; the metal is poured into molds and solidifies.

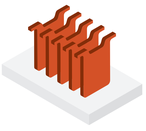
Anode Furnace

The objective of the *anode furnace* is to remove impurities present in *blister copper*, mainly oxygen (about 0.5 %) and sulfur (about 0.02%).
This is done in two stages:
- Oxidation of sulfur with pressurized air blown in through a nozzle that also generates copper oxide.
- Reduction of the copper oxide produced in the previous stage with natural gas through the same nozzle.

The furnace's operating temperature is about 1,250ºC.

Casting

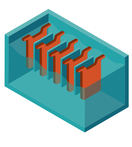
After the anode furnace stage, the copper is cast into molds measuring approximately one square meter called *anodes*, on two casting wheels.



*Anodes, **99,7%** copper.*

Anodes

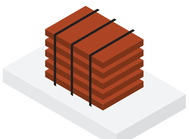
These are the end product of the smelting process. They contain 99.7% copper.
Production: about 300,000 t/year.



Electrolytic refining. Electrochemical dissolution of anode copper and deposit onto a stainless steel cathode.

Electrolytic refining

The object of the electrolytic process is to remove the impurities present with the copper in the anodes obtained in the smelting, in order to obtain high purity copper cathodes.
The *refinery* has 1,204 cells in which anode copper is electrochemically dissolved and, through a liquid substance called electrolyte, it gets deposited onto stainless steel cathodes. This refining process is what is known as *electrolysis*.



*Cathodes, **99,99%** copper.*

Cathodes

This is the main product of Atlantic Copper's metallurgical complex. They contain 99.99% copper.
Production: about 286,000 t/year.

www.atlantic-copper.es