1. Company description

Aurubis Beerse is located in Beerse, in the northern part of Belgium, close to the Dutch border. The company has been established in 1919 and employs currently 400 people.

Aurubis Beerse is a secondary treating complex scrap smelter, and developed an appropriate technology accepted as Best Available Technique under the IPPC regulation, based on

the use of a mini smelter
the use of TBRCs (Top Blown Rotary Converter),
use of iron as reducing agent,
application of vacuum and ladle metallurgy to separate minor elements (Sn, Pb, Zn, Ni) from the main production stream (copper).

Aurubis Beerse is certified according to ISO 9001:2015 and ISO 14001:2015.

Aurubis has another establisment in Spain : Aurubis Berango. Aurubis Berango produces "black copper" from low grade copper bearing materials (ashes, residues, slag, copper/irony scrap, …) in the same way as the "smelting process" of Aurubis Beerse (see below). The black copper produced in Spain can be sold to third parties, but will be normally further processed at Aurubis Beerse. Aurubis Berango consumes also lead- tin bearing materials for the production of solder shots, which will be further used by Aurubis Beerse.

2. Raw Materials

A broad range of raw materials is processed. All these products are wastes, residues and secondary materials containing at least one of the elements Cu, Sn, Pb or Ni. Other scrap or waste materials, mainly based on iron, silica or lime, are used as auxiliary products to enhance certain chemical processes. All input materials can be classified into the following different categories:

copper scrap (copper scrap, car radiators, copper cable scrap, …)
copper alloyed scrap (red and yellow brass, black copper, …)
low grade copper bearing scraps (non-ferrous shredder, copper/lead scrap, electronic scrap, …)
iron based scrap (copper irony scrap, copper or tin plated iron scrap, ….)
copper bearing ashes, residues, slag
tin and lead bearing scraps and residues (intermediates, solder drosses, lead scrap ….)
silica based products (foundry sand, crystal glass, CRTs, …)
other auxiliaries

Annex 1 gives an overview of some raw materials.

The ratios between those different products can vary within broad ranges. Material is purchased worldwide.

3. Reception of Raw Materials

All materials are delivered by trucks. Each truck is weighed and the accompanying documents are checked. In the storage area, the load is visually checked. Batches are (temporarily) stored individually.

All materials pass a quality evaluation process to determine chemical composition and other relevant quality aspects with respect to human health, safety, environment and economical or technical constraints. Materials not conform to the specified standards will not be accepted for processing, but will be returned to the supplier or transferred to specialized organizations able to handle or process the material in accordance to good environmental and social acceptable practice.

Quality evaluation is based on visual inspection, comparison with available data from previous experience and quantitative measurements with appropriate analytical instruments.

Quality control is carried out by a team of skilled personnel, extensively trained 'in-'house and advised or supervised by chemists and metallurgists. If necessary, assistance is given by specialized independent and authorized agencies.

When the supplier agrees with this quality evaluation, the material is released. Similar batches are then collected into larger homogeneous batches, often after an appropriate preliminary treatment. From these large batches material is taken for processing in the different production departments.

4. Preparation of Raw Materials

Some qualities of scrap are baled by means of hydraulic balers; other qualities are cut into manageable pieces by means of scrap shears. If necessary, slag is broken into smaller fragments.

Copper and tin ashes and residues are dried in a drying installation and separated into a fine (< 1 mm) and a coarse fraction. The fine fraction is stored in silos and pneumatically injected into the melting bath of the furnaces. The coarse fraction is mixed with other raw materials to prepare the furnace charges.

The furnace charges are prepared in advance. Each furnace charge is a mixture of different kinds of raw materials. A distinction is made between three kinds of furnace charges, depending on the point in the flow sheet where the material enters the process:

- a "poor" charge, i.e. a furnace charge containing only relatively low-quality and mainly cupriferous raw materials, usually of an oxidic nature (copper ashes and slag, Cu/Fe scrap, etc.)
- a "rich" charge, i.e. a furnace charge that only consists of high-quality cupriferous raw materials, usually of a metallic nature (copper scrap, gun metal, radiators, etc)

Individual lots of lead and tin containing materials will be accumulated and mixed to larger homogeneous batches. These will be shipped and treated in the Aurubis Berango smelter.

Appendix 2 gives an overview of the production flow sheets of Aurubis Beerse and Aurubis Berango. The process is further described here in the chapters 5, 6 and 7.

5. Foundry Process

The smelting furnace processes all cupriferous raw materials with a relatively low copper content. The feed material is continuously charged to a molten bath of slag, while oxygen is blown into the bath. The necessary heat of fusion is generated by the exothermic reaction between oxygen and iron. At high temperatures metallic iron reduces the oxides of copper, tin and lead and nickel. This reaction produces iron oxide which ends up in the slag phase. Some other elements will oxidize as well, such as aluminum, silicon, and partly zinc. Those oxides will react with silica, to form an iron silicate slag.

The major amount of the non-ferrous metals are collected in a copper bath underneath the slag, and some will be evaporated and recovered in dust collected in the filter installations. The metal phase is an impure copper metal ("black copper", containing + 80 % Cu and impurities such as Sn, Pb, Ni, Fe, Zn, etc).

At the end of the batch process, metal is transported to the refining furnace for further processing. The iron silicate slag from the smelting furnace contains Zn and minor amounts of Cu, Ni, Pb and Sn. It is transported in liquid state to the Slag Cleaning furnace. In this installation, Zn and Pb are fumed out of the slag. Cu, Ni and Sn collect in a metal phase. The resulting slag is a very clean mineral product, leach-stable in its pure form. It's marketed under a different name than the original smelting furnace slag: Koranel®. The flue dust consists of mainly zinc oxide, with a few percents of lead oxide. It has a low halide content, and is considered a very pure

concentrate for treatment in the zinc industry. The bullion, containing Cu, Ni and Sn, is tapped off and transported back to the refinery.

In the refining furnace (TBRC converter 70T1) copper scrap is melted by means of natural gas and oxygen. The black copper from the smelting furnace is also added into this furnace. By injecting oxygen into the liquid metal, less precious impurities than copper (in practice about all other elements such as tin, lead, nickel, iron, aluminum, zinc, etc) are transformed into their oxide form. Sand is added as a slag builder. The obtained slag (= mixture of molten metal oxides, including sand) is transferred to one of the two slag furnaces (TBRC converters 70T2 and 70T3) for further processing. Finally, only liquid copper metal of about 98% Cu content remains in the refining furnace.

This refined copper is transferred to the anode furnace, where it is deoxidized by injection of natural gas into the bath. The liquid copper, with a copper content of above 99%, is finally cast into anode moulds. Copper anodes are sold to other refineries.

The slag from the refining furnace is treated in the TBRC slag furnaces. This slag contains metals such as Cu, Sn, Pb and Ni. In the slag furnaces, all these elements will be recovered step by step. In a first stage, as much copper as possible is recovered, by adding an appropriate quantity of Cu/Fe scrap into the slag phase. Fe will preferentially first reduce the copper oxide in the slag, producing an impure copper alloy. This metal is tapped and returned to the refining furnace, and converted into "impure" copper anodes. These "impure" anodes will be consumed in the tankhouse of Aurubis Beerse.

The remaining slag contains mainly Sn and Pb, and minor amounts of Cu and Ni. In this second stage of the process, more tin and lead bearing raw materials can be added. Next, any existing Sn and Pb oxides are reduced with iron scrap, producing a complex multi constituent alloy containing mainly Pb and Sn, but also Cu and Ni.

The remaining slag is granulated in water.

The complex alloy, containing Pb, Sn, Cu, Ni and some Fe, is processed in a small TBRC furnace. By adding silicon metal to the liquid alloy, a Ni containing phase and a crude Pb/Sn alloy will be generated. The Pb/Sn alloy will be further processed in the Pb/Sn department. Ni is concentrated in an intermediate product.

In a small TBRC converter (10T1) will be processed only cupriferous raw materials.

Pb/Sn bearing batches are processed in the Aurubis Berango smelter to recover the Sn and Pb as a crude Pb/Sn alloy. This crude alloy will return to Aurubis Beerse to be treated in the Pb/Sn plant.

All furnaces are equipped with highly efficient off-gas cleaning systems to prevent dust emissions and to adsorb dioxins and other volatile organ chemicals.. Depending on the composition, the collected dust is either once again introduced into the production process (low zinc content), or sold to zinc producers (high zinc content).

6. Pb/Sn Production

In the foundry a crude Pb/Sn alloy is produced, which is the most important raw material for the Pb/Sn plant. However, certain types of Pb/Sn bearing scraps can directly enter the Pb/Sn department without passing through the foundry first. In the Pb/Sn department, Sn and Pb will be separated from each other by distillation in a number of stages.

Previous to the distillation process, some chemical products which preferentially combine with the impurities (Cu, Fe, Zn) are added to the molten crude Pb/Sn alloy. The chemical compounds formed by this reaction will float on top of the liquid metal, and they will be removed and returned to the foundry.

In the vacuum distillation plant the lead-tin alloy (solder) is treated under vacuum and at high temperature in three steps. The products of the installation are tin, lead and a lead/antimony alloy.

During the first stage of this process, mainly Pb will evaporate. This lead vapor condenses to form nearly pure lead. The remaining metal after the first distillation step is still an alloy, but contains mainly Sn. This alloy contains also minor amounts of Ag (mainly coming from solder residues).

After the first distillation step, the remaining alloy is submitted into a fractional crystallizer. The crystallizer is continuously fed with the liquid alloy. Over a temperature range slightly above the solidification point pure tin crystals are deposited on the spiral arms and are removed as a crystallizing mass. The alloy at the drain side is relatively high in silver but represents only a very small fraction of the input material. This silver-containing alloy is returned to the foundry or sold to interested companies. The crystals are returned into the liquid state and will be submitted to the next distillation step.

During a second distillation stage all the Pb will evaporate. The remaining metal is pure tin. The vapor phase will be condensed to produce the "second condensate" which contains Pb, Sb, and some Sn. Depending on the Sb content, it can be recycled to the first distillation step (low Sb content) or it can be stored temporarily as an intermediate product (Pb/Sn/Sb alloy).

The Pb/Sn/Sb alloy is treated batch-wise in a third distillation step, to produce hard lead (lead-antimony alloy). The condensation product is recycled to a previous distillation step.

The final products of the Pb/Sn department are tin, lead and a lead/antimony alloy.

7. Chemical department

In the tank house, impure anodes (3-10 % Ni) are transformed further into copper cathodes, anode slime, and a nickel sulphate solution.

Impure anodes are therefore suspended in a bath consisting of water, sulphuric acid, copper- and nickel sulphate.

By electrolysis, the copper of the anodes will be dissolved and deposited onto stainless steel sheets to produce copper cathodes. Nickel dissolves in the solution but will not be deposited on the cathode.

A part of the tankhouse electrolyte, enriched in nickel, is regularly withdrawn ("bleed off") and decopperized. A part of the enriched nickel containing is the starting solution to produce nickel at Aurubis Beerse. The rest is sold to specialized companies to recover nickel as metal or as nickel sulphate.

In the foundry process precious metals (Ag, Au, Pt, Pd) are concentrated in the anodes. During electro-refining these elements do not dissolve, but sink to the bottom of the electrolysis cells as a kind of slurry. This anode slurry ("anode slime") from the copper/nickel electro refining is collected and sold to companies specialized in the recycling of precious metals.

What remains at the end of the electro refining of the copper/nickel anode ("spent anode") is removed from the tank. The spent anodes are returned to the foundry for re-melting.

Ni is recovered from the "Ni enriched solution" of the Cu/Ni electrolysis, by precipitating. The Ni precipitate is decomposed at high temperature to make Ni powder. The Ni powder is pressed into briquettes.

8. Output

Aurubis Beerse is a "zero waste" processor. All input materials will be transferred by pyro- and hydrometallurgical processes into a limited number of output products, all with a certain commercial value and specific applications. All of those products are registered under the European REACH Regulation.

To be able to maintain this policy, processes and techniques need to be developed with this principle in mind and input materials have to be carefully selected and controlled.

Annex 3 gives an overview of all output products with their applications.

9. Environmental Care

Aurubis Beerse N.V. respects in its transport, purchase and sales of materials the relevant legislation of all involved countries (origin, destination and transit) and international agreements.

All raw materials are stored on impermeable soil (concrete). Sprinklers constantly humidify the storage yard to keep dust emission in the environment to a minimum. Indoor storage and handling facilities will be available in the near future.

The waste water of the company (a mixture of sanitary water, process water, and rainwater) is centralized. In the "wastewater treatment plant" all the water is submitted to a physico-chemical purification process before it is re-used or drained.

In the foundry all furnaces are totally encapsulated to capture dust emissions from charging and discharging activities. Dust and fume emissions in the work place are therefore limited. In the Pb/Sn plant all melting pots are also encapsulated and equipped with an accompanying exhaust system.

All pyrometallurgical smelting and refining facilities are equipped with highly efficient "off-gas cleaning systems", using dry bag filters. The collected dust of all filters is pneumatically transported and stored into silos. From there the dust can either be pneumatically injected into the furnaces for internal recycling (low zinc content), or can be transferred to silo trucks for shipment (high zinc content), depending on the composition. All dust manipulations take place in a completely closed system.

After dedusting, the gas stream is treated in an adsorption filter, to capture dioxins and other volatile organochemicals.

The vacuum furnaces in the Pb/Sn plant are completely closed installations, which means that they cannot cause any kind of dust and fume emissions.

For all kind of emissions the company is submitted to periodic controls by the competent authorities.

It is the general policy of Aurubis Beerse N.V. to limit the impact of its operations and products on the environment beyond legal requirements.

10. Energy consumption

Aurubis Beerse N.V. made a commitment to the regional authorities to use energy for its activities in the most efficient way. The performance of the plant is reported to and verified by the authorities on a yearly basis. Procedures to ensure sustainable use of energy are integrated in the Quality Management System of the plant.

Aurubis Beerse N.V. takes part in the European greenhouse gas emission trading system since January 2008. As an implication of this, greenhouse gas emissions of the plant are limited by the authorities. A monitoring protocol for registration and reporting of CO2 emissions has been set up. Procedures to ensure that the actual emission will not exceed target levels are incorporated in the Quality Management System.

Glossary of Terms

TBRC Top Blown Rotary Converter

CRT Cathode Ray Tube

IPPC Integrated Pollution Prevention and Control

REACH	Registration, Evaluation and Authorization of Chemicals
Cu	copper
Sn	tin
Pb	lead
Sb	antimony
Ni	nickel
Fe	iron
Zn	zinc
Ag	silver
Au	gold
Pt	platinum
Pd	palladium

Annex 1

Overview of some input materials

RAW MATERIALS – COPPER AND COPPER ALLOYED SCRAP

RAW MATERIALS – LOW GRADE COPPER BEARING SCRAPS

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MATERIALS – COPPER BASED RESIDUES AND SLAG

MATERIALS – IRON BASED SCRAP

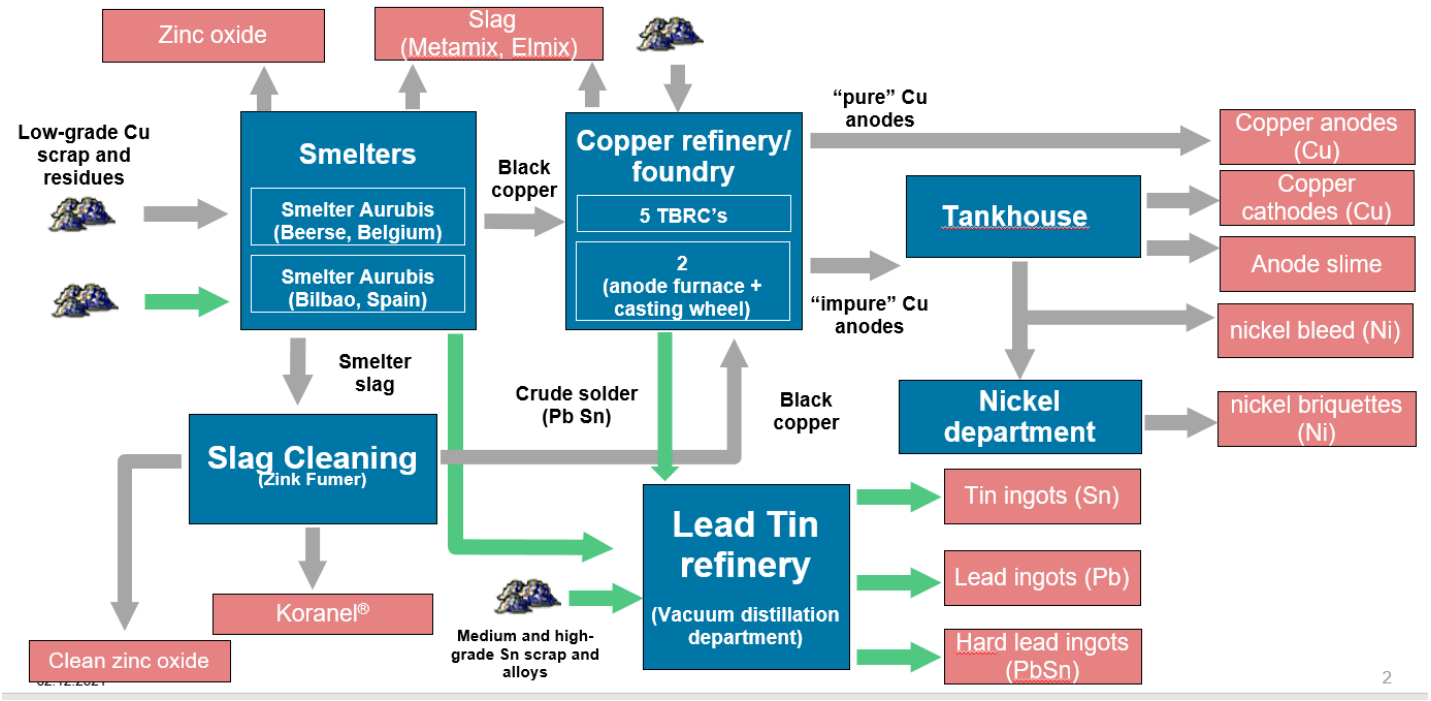
RAW MATERIALS – TIN AND LEAD SCRAP AND RESIDUES

RAW MATERIALS – TIN AND LEAD SCRAP AND RESIDUES

Annex 2

Flow sheet production process

Aurubis Beerse & Berango – General Process Flow Sheet



Annex 3

Output products and applications

OUTPUT PRODUCTS AND APPLICATIONS

Cu cathodes → Production of copper tubes/sheet
Cu cathodes → Production of copper alloys
Cu cathodes → Production of copper wire
Cu cathodes → Production of copper powder

Cu anodes → Production of copper cathodes by electro-refining

Anode slime → Recovery of precious metals and other elements

Bleed off → Recovery of copper and nickel as metal or sulphates

OUTPUT PRODUCTS AND APPLICATIONS

Cu granules → Recovery copper, nickel, and other elements for further refining

Nickel → Production of ferro-alloys

Tin → Production of lead free solder
Tin → Plating steel an non-ferrous metals
Tin → Consumption in chemical industry

OUTPUT PRODUCTS AND APPLICATIONS

Lead → Production of sheet lead; Use as balance lead; Production of chemicals; Production of brass alloys

Pb/Sb alloy → Production of hard lead alloys, type metal, bearing alloys, balance lead, keels

Flue dust → Recovery of zinc and other elements

Metamix → Secondary material to be used in the building industry; Abrasives

3

OUTPUT PRODUCTS AND APPLICATIONS

Koranel → Pitch black granulate, excellent environmental performance, excellent strength properties

Clean Zinc oxyde → > 70% Zn, high-grade concentrate for zinc industry