Design & Construction of a Copper Plant based on modern & environmental-friendly Processes

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Abstract

In 2007-2011 Engineering Dobersek GmbH was involved in a project to build a new copper smelter and copper refinery for Kazzinc Ltd. in Kazakhstan with an annual production of approx. 90,000 tons of refined copper cathodes. This project was a fully integrated project, in which most by-products from each operation step are treated to form saleable metal products.

Engineering Dobersek GmbH as an EPCM contractor was responsible for the general coordination of the project, for whole plant design, equipment delivery, erection management, commissioning and personnel training.

The copper technology by Kazzinc Ltd. includes following steps:

- Feed preparation and smelting in TSL furnace
- Slag/matte treatment in the rectangular electric furnace
- Copper matte converting in the PS-converters
- Blister copper fire refining in the anode furnaces
- Anodes casting on the wheel machine
- Copper electrolytic refining with permanent cathode technology
- Anode slime treatment to Doré metal

This classic technology is completed with modern dust, gas and water treatment systems which accord to world and European standards. The new copper plant was successfully put into operation in the summer 2011.

Objective: Improved full-scale Extraction of valuable Components from own raw Material

Introduction

Kazzinc is a major fully integrated zinc producer with considerable lead, gold and silver credits located in Kazakhstan. Along with increased base of raw materials currently developed by the Company the percentage and importance of copper in the entire polymetallic raw material structure increases, too. As opposed to these metals, which are metallurgically processed and sold to the consumers in their pure form, copper was extracted from the ore into saleable copper concentrate shipped to the consumers as semi-finished product.

The New Metallurgy Project

The New Metallurgy Project implemented by Kazzinc was intended to do away with raw material-oriented copper production through construction of two metallurgical plants: a copper smelter and a copper refinery to produce copper cathodes, a high value-added product which meets the highest international standards.

Figure 1: View on Plant under Construction in Ust Kamenogorsk

The most advanced environmental-friendly autogenous processing of sulfidic copper concentrates with complete sulfur utilization was applied.

The given advantages are:

- The metallurgical processes applied at the Copper, Lead and Zinc plants were tied in with the integrated processing of middlings, e.g. Pb dusts from the copper smelter and Pb sulfate from the Zinc plant are processed at the Lead plant. Slag fumes from the Lead plant are processed at the Zinc plant and the Cu-bearing middlings from the Lead plant are processed at the copper plant;
- Flexibility in terms of raw materials composition, fuel and reductant types as well as operation conditions control;
- Extraction of Copper, Gold and Silver from copper concentrates and production of pure saleable high value-added metals;
- Improved complex utilization of raw materials due to production of a new commercial product, i.e. refined copper cathodes;
- Minimization of SO_2 emissions from processing of sulfidic copper concentrate and sulfuric acid production.

Plant Description

Process-wise the new plant which is shown in figure 1 in front of the overview about the production site in Ust Kamenogorsk, can be described as follows:

Quite simple feed preparation system designed for processing of concentrates with up to 14 % moisture and consisting of bins, conveyors, feeders and a mixing drum. The feed gallery to the ISA-smelter is shown in figure 2.

ISAsmelt furnace for autogenous oxidizing smelting of Gold-bearing copper concentrates and copper-bearing reverts to produce molten slag and matte. Process gas is cooled in the waste heat boiler to 340 - 400 °C with coarse dust precipitation. Cooling is followed by "dry" purification in the electrostatic precipitator where fine dust is removed; the purified gas is supplied to the acid plant through the gas duct.

Discharged molten slag and matte are supplied through the water-cooled copper launder to the rectangular 11 MVA electric furnace with three Soederberg electrodes. The tapping procedure is shown in figure 3 and figure 4 gives an overview on the electric furnace. The ladles with precious metals containing copper matte are delivered to the converting section. Slow cooling of low-grade (0.7 % Cu and less) slag ensures optimal coalescence conditions for copper-bearing slag components. The slowly cooled slag is crushed and delivered to one of Kazzinc-owned concentrators for reprocessing. Re-extracted copper is sent back for pyro-metallurgical processing. Figure 5 gives a view inside the copper smelt building.

Figure 2: Feed gallery to the ISAsmelt furnace

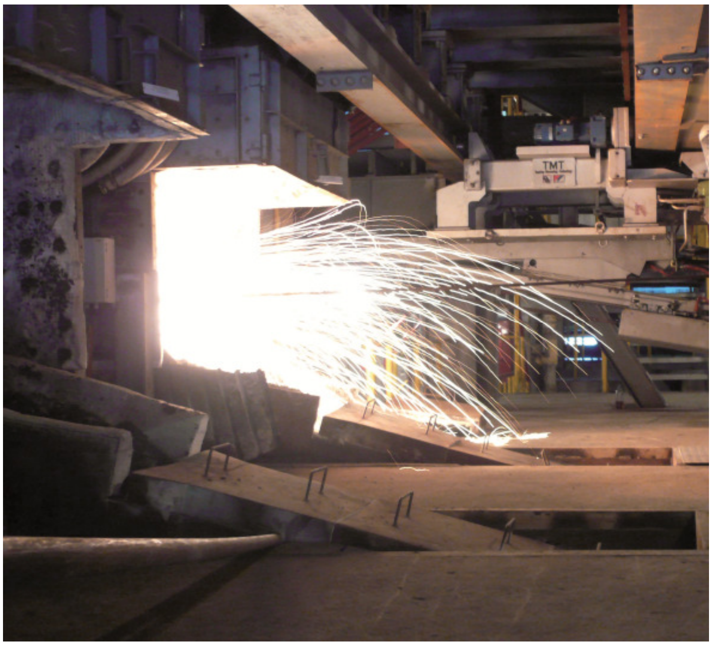

Figure 3: Tapping procedure on the electric furnace

Figure 4: View on electric furnace

Copper matter is processed to copper blister in two 80 ton Peirce-Smith converters - one in operation and the other under rebricking. Figure 6 shows the charging procedure. The entire process contributes to considerable resource savings as opposed to the process of similar capacity with three converters. Semtech system ensures through control of converters operation, including timely discharge of matte and slag of different converting periods.

Figure 5: View inside the copper smelt building

Figure 6: Charging of the Peirce-Smith converter

Converter gases cooled in the vacuum evaporators which are shown in figure 7 and purified in the dry ESP are supplied to the gas duct to join rich gas from Isasmelt furnace and follow to the new acid plant, which is an integral part of the New Metallurgy Project, for SO_2 utilization and double contact acid production.

Copper blister is pyrometallurgically refined in two 200-ton anode furnaces with further casting in 16-mould casting wheel. Figure 8 gives an overview about the two anode furnaces while figure 9 shows the 3-D modelling. The mentioned mould casting machine is shown in figure 10 from top view.

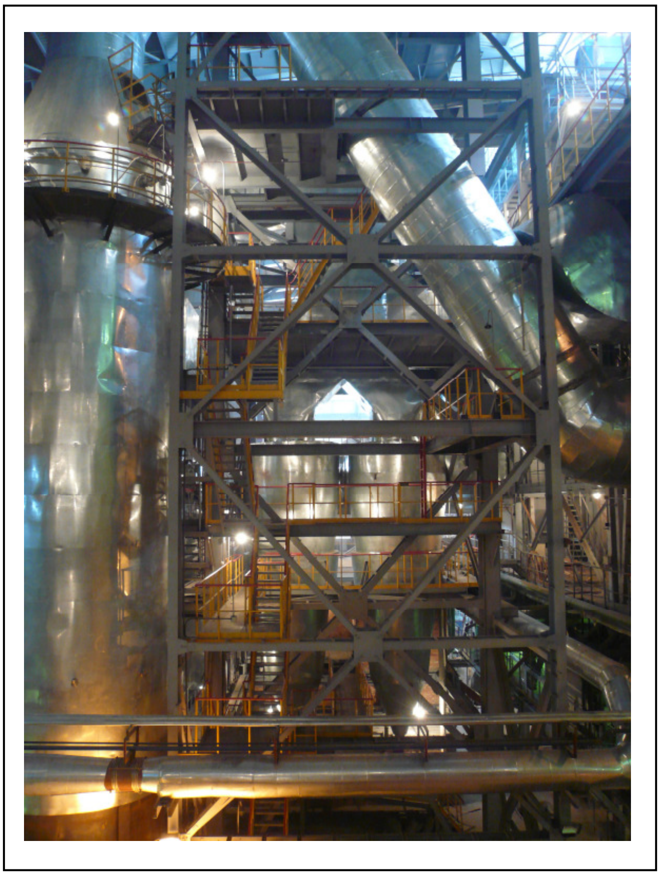

Figure 7: Vacuum evaporaters

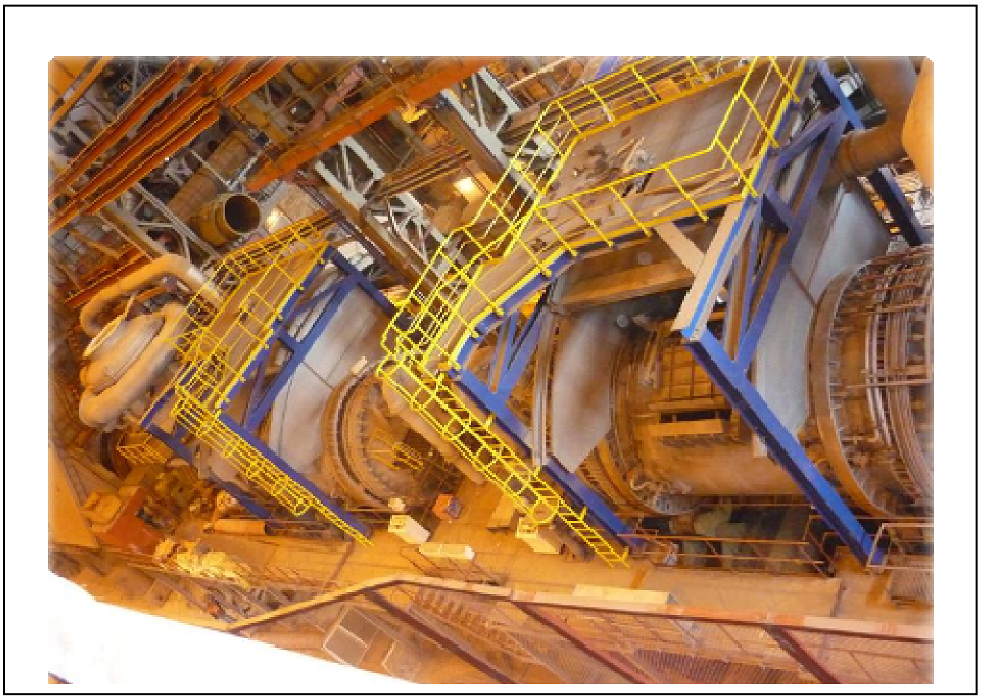

Figure 8: View on two anode furnaces

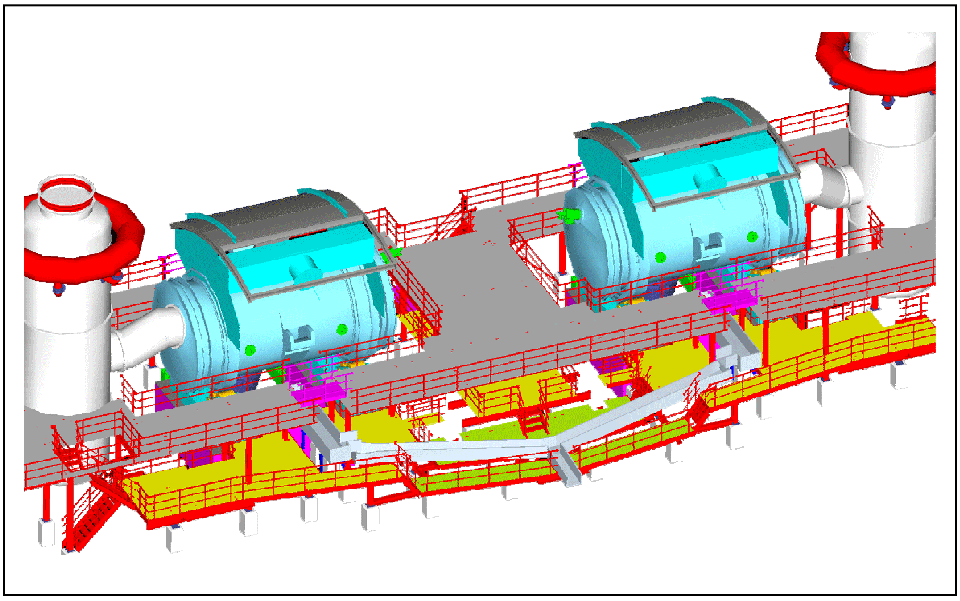

Figure 9: 3D - design of two anode furnaces

Figure 10: Top view of the 16-mould casting wheel

Dust generated in various production sections of Isasmelt system and other pyrometallurgical processes is collected in an integrated dust collection system (1,000,000 m^3 design capacity) and processed at the lead plant with lead metal production.

Copper anodes are transported by crane to the anode storage area, sorted and delivered to the tankhouse for electrolitic refining. The tankhouse, shown in figure 11, is equipped with the machines for automated preparation, washing and stripping of anodes and the fully automates crane used for anodes and cathode plates transportation and installation into the cells. The final product is copper cathodes, MOK and MOOK grades (99.97 and 99.99% Cu respectively).

Figure 11: Copper refinery tankhouse with the fully automates crane in the back

During electrolysis gold and silver pass into slime to be further recovered at the precious metal refinery with production of 99.95% gold and silver. Copper is removed from anode slime in the atmospheric leaching section. Figure 12 gives an idea about the leaching section in the refinery hall.

A view into the anode slime treatment section is shown in figure 13.

Copper chips are used to extract tellurium, which is a by-product of electrolytic copper refining, from the electrolyte in the form of cuprous telluride.

Spent electrolyte is supplied to 3-stage regeneration for copper cathodes production while some sulfuric acid is recovered from the electrolyte to reduce gypsum formation and recycled in the process.

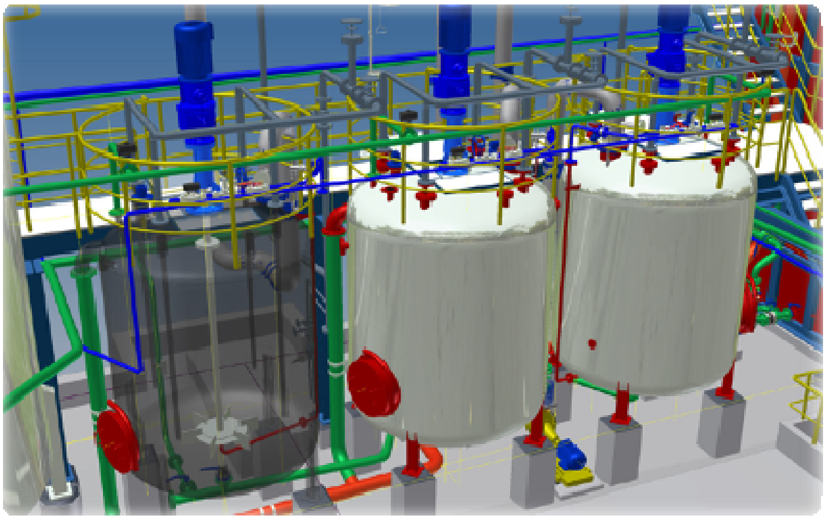

Figure 12: Design of atmospheric leaching tanks

Figure 13: Anode slime treatment section

Conclusions

Implementation of three segments of the New Metallurgy Project, i.e. construction of the new copper and acid plants and reconstruction of the existing lead plant contributed to reduction of air pollution by the Metallurgical Complex in Ust-Kamenogorsk. Minor emissions from the new copper smelter were more than offset by almost complete utilization of gases from the state-of-the art lead smelter in sulfuric acid production. Previously these diluted gases were released into the atmosphere.

In addition, Kazzinc enjoys a broader product line and higher production output, which along with complex utilization of raw materials and more flexible production processes contributed to higher net profits.

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