Examining the copper value chain

This article, whose full title is “The Value Chain of Copper – from Mining to Application” is mainly based upon the book Understanding Copper – Technologies, Business, Markets. Author Dr. Bernd E. Langner gave a similar Webinar presentation in December 2014 in association with the European Copper Institute.

Before one can use copper as the most important conductor in a car, or in the generation, transformation or transportation of electrical energy, it has to be produced in several steps – the value chain. In Fig. 1 the processes and the values are illustrated. The first process is mining the ore and concentrating the copper in the ore to copper concentrates, which is the first value, as it can be sold. The second step is producing cathodes - the second value. Cathodes are produced in three ways: from sulfidic concentrates by smelting or refining (about 64%), by leaching and electrowinning of oxidic ores at the mine site (19%) or by processing scrap (17%) (2). The third value are the semis like wires or strips which are used, e.g. for cables or connectors.

In contrast to aluminium or steel the value chain of copper is strongly fragmented. There are no companies which are active in mining and producing semis. So the copper companies have specialised on either mining, smelting and refining, or producing semis. One reason for that is the cathode. In contrast to aluminium or steel, where you have a liquid metal melt as the final product of refining which can be cast into billets and cakes directly, cathodes can be transported and traded and have to be melted for further processing. The big aluminium companies like Alcoa are active on producing aluminium and processing aluminium, e.g. to foils.

This makes it understandable that copper is the most traded metal, as it has to be traded from one company to the next. Therefore fixing the copper prices by hedging between the steps of the value chain plays an important role.

Registered cathodes

The LME registered cathode is also the base of all calculations of prices, cost and revenues in the value chain. Although registering a cathode is a strictly regulated process and there are only 80 registered brands of cathodes, the value of the registered cathode is the base of all calculations in the value chain of copper, not only for registered cathodes.

So the prices of raw materials are calculated by: LME cathode price for the copper content - minus processing charges - minus losses during processing - minus penalties for impurities + plus value of other metals like gold and silver.

The prices of copper products are calculated by: LME cathode price of the copper content + plus premiums (e.g. for financing, assurance, transportation) + plus value of alloying elements.

From the different price components, only the LME part can be hedged for future deliveries.

Mining sulfidic ores

The first step in the value is mining the ore. As the copper content of the ore has only 0.3-1.0 % copper, it is enriched by flotation to a copper concentrate with about 25-35 % copper to avoid processing of a high amount of gangue material. So copper concentrate is the first traded product with a value. There are mining companies with their own smelting and refining capacities producing cathodes. For those companies the value is:

LME cathode price + plus cathode premium for financing - minus costs for smelting and refining + plus sales of by products.

For companies not producing cathodes the calculation is:

LME cathode price - minus TC/RC to be paid to the smelter - minus penalties for impurities - minus losses to be paid + plus paid value of other metals like gold and silver.

To compare different mining companies normally the so-called C1 costs are considered. An example for a cost calculation is given in Table 1. It can be seen that the credits for valuable by products are incorporated into the costs. That means that sometimes C1 costs can be negative, if the credits are bigger than the real costs. Also, comparing costs from year to year may be caused by fluctuations, e.g. by a change in the prices of by products.

Solvent extraction and electrowinning

In former times many oxidic copper ores could not processed economically as they could not be enriched by flotation. Since the 1970s this has changed by the new technology of leaching and SX/EW producing directly cathodes from a leached ore. So the gained value is the cathode: LME cathode price + cathode premium but no valuable by products are recovered. The processing costs are normally lower than for the sulfidic route.

Smelting and refining

Most of the cathodes are produced by smelting, converting and electrowinning in a tankhouse. The main revenues for a smelter and refining are the so-called treatment and refining charges (TC/RC). Often expressed as, e.g. 60/60 or 100/100. That means that the mining company has to pay 60 USD/ton of concentrate to be processed and 60 ct/lb for the copper content to be refined to the cathode. So the revenues for the concentrate depend also on the copper content in the ore.

There may be other effects on the economy of a smelter:

Sulphuric acid: One ton of concentrate generates one ton of sulphuric acid. The prices are normally lower than the costs for producing sulphuric acid with a high purity.

Slag/silicate stone: This may be used, e.g. for river embankment if it has a low level of impurities – otherwise it has to be given for waste disposal.

Metal gains or losses: If the yield of copper or other valuable metals is higher than contracted, the smelter earns money, but if the concentrate has a high level of impurities this may be also negative.

Other by products: e.g. the costs for arsenic to be given for waste disposal.
Scrap processing
Recycling is a big contributor to the worldwide demand of copper. There are three big groups of recycling material:
• New Scrap (production scrap) – often directly melted and not processed via the cathode route – so is often not in the scrap statistics
• Old Scrap (copper >90%) – often refined in special secondary smelters producing cathodes.
• Complex Scrap – residues or electronic scrap.

The copper content of new scrap and old scrap are normally determined by estimation of both parties, whereas complex scrap has to sampled and analysed.

The value is determined by:
Copper content – minus losses priced by LME according to “the lowest of the four” of Settlement Buyers and Sellers, and 3 Month Buyers and Sellers. – minus the price for processing and refining (if refining scrap)

The processing and refining charges are very volatile and depend on the offer and demand. In history they have been between 100 to 1,000 euros per tonne. So the offer is higher if there is a high copper price. It also depends on the arbitrage between the LME and Shanghai Futures Exchange. If the quotations in China are higher, the Chinese buy a lot of scrap in the market.

Copper products
The main first use of copper cathodes is the production of wire rod. About 60-70 % of the cathodes produced are converted into standardised wire rod with a diameter of 8 mm and an oxygen content of 150-250 ppm from which are produced copper cables by drawing and insulation. The second first use of cathodes and new scrap are billets and cakes for the production of strips and tubes by rolling and drawing. These are not standardised but have a high variety in dimensions and chemical composition in different alloys.

The value of a copper product has two or three components:
- LME Copper Price
- plus cathode premium
- plus surcharge.

or it can be:
Copper Price including financing and purchasing costs
+ plus surcharge for converting cathodes into the product.

For the Copper Price including financing and purchasing costs, in different companies and countries there are different quotations. The prices for copper semis are often based on 100 kg.

For wire rod the surcharges have been in history less than 300 euros/ton. For strips in commodity quality they have been less than 1,000 euros/ton. For specialties they can be substantial higher.

Operational Costs + Financing Costs + Costs for Scrap
Financing Costs are big for strips and tubes: Processing time: 3-8 weeks, and stocks because of a big variety of products Payment terms have to finance also the metal value Scrap rate of about 30-60 %

So there is a high burden for financing working capital, especially because of the high copper price since 2002.

Conclusion
In Figure 2 the revenues of the whole value chain of copper are illustrated. It can be seen that most of the revenues are obtained by the mines. The revenues for processing concentrates to cathodes, and further on to products, are a magnitude lower.

Bibliography
(2) ICSG World Copper Factbook 2013, www.icsg.org

Author: Bernd E. Langner has been almost 30 years in the copper industry dealing with nearly all aspects and businesses in the value chain of copper. The last years of his career he was a member of the executive board of Aurubis AG. After his retirement he wrote a book about copper and a lexicon on metals and offers seminars and workshops on copper.