

Recent developments on the graphite electrode market in the EU

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INTRODUCTION

In addition to the blast furnace converter route, electric steel production in the electric arc furnace is one of the two main production routes for crude steel. In 2016, the share of the world via the electric steel route was around the world 34 % of crude steel, equivalent to approx. 407 million tonnes of crude steel. [1] For the crude steel production in the electric arc furnace, electrical energy is used to melt mostly steel scrap. Graphite electrodes are used to transfer the required energy. Graphite is pure carbon. On the one hand, it can be made from carbonaceous raw materials; on the other hand, it is also present as a natural resource. Its good electrical conductivity and high temperature resistance characterize graphite. Therefore, graphite is used in many areas.

In addition as electrode in the electric arc furnace, graphite is used, for example as anode in lithium ion accumulators or in the fused-salt electrolysis of alumina. The demand for graphite increases on the one hand by the electrification of road traffic, on the other by the increasing production of alumina. Inter alia, these two factors lead to a shortage of graphite electrodes in steelmaking and increasing prices.

Raw materials and production of graphite electrodes

For all types of graphite, naturally occurring natural graphite and anthracites are suitable as raw material, whereas cokes and carbon blacks are artificially produced starting materials. The main component of graphite electrodes are highly anisotropic needle cokes. These are ideally suited because of their needle-like structure, since it depends on the electrode on a very high electrical, mechanical and thermal capacity. The delayed coking process produces needle coke industrially. Here, residual residues of crude oil or coal tar pitch, a by-product of coke production, are delayed in refineries and gently coked.

However, all needle cokes still contain a considerable proportion of volatile constituents and hydrogen of about 5 to 12% by mass. This leads to mass losses in the event of subsequent heating and ultimately to pore and crack formation. [2]

Needle coke is not sinterable under normal conditions, which is why it must be connected to each other via binder bridges by means of binders. Suitable binders are usually coal tar pitch and phenolic resins.

The manufacturing process of graphite electrodes is divided into the processing of raw materials, the shaping process, baking and graphitizing as well as the final processing of the products.

In the first step, the needle coke is milled and sieved to the necessary grain size and then mixed with binders. Due to the anisotropy of the needle coke, the shaping process, in graphite electrode production, must ensure intentional alignment of the particles. The subsequent electrical conductivity of the electrode is the most important prerequisite for the functionality and is defined by the shape. For this reason, all graphite electrodes are extruded, whereby the needles are longitudinally aligned and arranged in a circle. Therefore, single- or twin-screw extruders are used. The thermal treatment is divided into two processes, the baking and the final graphitizing. During the baking the material is heated up 1300 °C in several steps. For the final graphitizing of the electrodes temperatures up to 3000 °C are necessary. In the last step of the electrode, production is machined to its final dimensions as well as the sockets for connection between the sections of each electrode. [2]

Needle coke market

As mentioned in the previous section needle coke is the main raw material for the electrode production. The price for a ton of needle coke in 2017 is 2600 €. Compared to the previous year, when a price of 370 €/t was requested, a price increase of 600% can be seen [3]. Not only supply and demand play a greater-term role in this significant price increase. Rather, a combination of supply and demand, political decisions and natural disasters are determining factors in the world market of needle coke.

In Summation, these are the main factors for the increasing prices:

- Oligopolistic market structure [4]
- Energy intensive production, only profitable at production sites with low energy costs
- Rising demand because of the increasing production of aluminium and lithium-ion-batteries [5]
- Damage of production sites in Houston (31,9% of worldwide needle coke production) caused by hurricane Harvey in 08/17 [6]

- Closing of production sites in China due to new environmental regulations [7]
- Increasing steel-production on the EAF-route in China [1]

Graphite electrode market

For the past decade, the graphite electrode manufacturers have been struggling with falling prices and fierce competition from China and Japan. There was a continuous oversupply of electrodes and the capacities of the manufacturers were never fully utilized.

At the beginning of 2017, the price of graphite electrodes rose from 1,700 €/t within months to over 29,200 €/t in September 2017 to € 37,570 €/t [4, 7, 8]. The main reason is the increasing needle coke price. Graphite electrodes mainly consist of petroleum coke-based needle cokes, whereby the cost of the starting material, depending on the source [4, 7, 8], is 40% to 70% of the total geothermal costs. But the increase of the needle coke price would only let to a price of 11,000 €/t [4]. Besides the factors which also let to an increased needle coke price are the following factors:

- Oligopolistic market structure [4]
- Reduction of worldwide production capacity, especially in China (30% in 2017) [9]
- Timely purchase of steel plants at the end of 2017 and panic buying in fear of more increasing prices
- Increasing steel production in the EU due to reduction of steel exports from China [4]
- Continuous decreasing exports of graphite electrodes from China [9]

Conclusion and outlook

The raw material needle coke causes approximately 40% to 70% of the electrode costs and has risen rapidly in 2017 due to a natural disaster, increasing demand from other industries and political decisions in China. At the same time, in addition to years of hard price competition and continuous capacity reductions, these decisions are leading to a shortage of graphite electrode production. These factors, combined with an oligopolistic market situation and no alternatives as substitutes, exacerbate the market around the graphite electrode.

A constant price level is likely of needle coke such as graphite electrodes for the next two years. It has to be seen which new capacities will come onto the market after these two years and what effects an increased availability of needle coke will have on the price. The increased and sustained demand for needle coke and the increasing number of EAFs in China are unlikely to bring the price back down to its 2016 price of 1,700 €/t even after two years. Graphite electrode prices of an estimated 10,000 €/t to 20,000 €/t are

quite likely. Currently, in May 2018, a German electrode manufacturer reports that the situation has eased compared to 2017. Prices are not rising any further, although they are still consistently high. Also of interest is the development of the lithium-ion battery sector.

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