

The CONTILANOD® process – continuous casting and cutting of copper anodes

Dr. Michael Schwarze
SMS Meer GmbH
Ohlerkirchweg 66
Postfach 10 06 45
41006 Mönchengladbach
Germany

Introduction

Since the introduction of the CONTILANOD® process some 10 years ago at Copper Range and IMI Refiners, significant changes and advances have been made to this pioneering anode production technique. To cut the 45 mm thick continuous by cast anode strip into shaped anodes at rates of 100 MTPH or more, a travelling hydraulic shear designed by SMS Meer GmbH – which is representing the Tube and Copper Plants Division of SMS Demag AG, Germany - replaces the formerly used plasma cutting torch. This plasma torch restricted the capacity of the CONTILANOD® process.

The new CONTILANOD® system with hydraulic shear represents a breakthrough into higher production capacities and improved geometrical dimensions of the anodes. Greater efficiency and a higher degree of utilization in the copper tank house is thus made possible.

Details of the caster and the new shear will be presented along with operating results from the new lines which have been successfully put in operation at the Gresik smelter/refinery in Indonesia and at the MKM (Mansfelder Kupfer und Messingwerke) in Germany in 1998.

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CONTILANOD® - Continuous Casting of Copper Anodes

Historical review

Early installations started with hanger bars and also a pattern cut by a stationary press which limits both anode thickness and line speed:

1966	BICC Metals Ltd., Prescott, England	40 - 50 t/h (hanger bar)
1972	Onahama Smelter & Refining, Onahama/Japan	40 - 50 t/h (pattern cut)
1978	Kidd Creek Mines, Timmins, Canada	55 t/h (pattern cut)

In a further step of the first generation of CONTILANOD® lines, cast anode lugs have been installed, while plasma cutter systems were used for separating full thickness anodes from anode slab but were still limited in casting capacity by plasma cutter.

1979	Metallurgie Hoboken-Overpelt, Olen/Belgium	50 t/h
1982	Copper Range Comp., White Pine, Michigan/USA	36 t/h
1985	IMI Refiners, Walsall/England	35 t/h

As a third step plants for CONTILANOD® system have been developed and installed, using traveling hydraulic shear system for cutting the anode slab. This is the technical breakthrough because the Hazelett caster with its tendency for higher capacity is not limited anymore by the cutting system. The plants started production in:

1998	PT Smelter Co., Gresik, Indonesia	100 t/h
1998	MKM Hettstedt, Germany	50 t/h

CONTILANOD® - Main Data

The typical actual thickness of produced anodes is in the range of 15/18 mm (Onahama, Kidd Creek) up to 38/50 mm (IMI, Gresik, MKM). In principle, the anode geometry depends on the technological requirements of the tank house. Typical ranges are shown below:

Anode thickness	15 - 70 mm
Anode width	up to 1,050 mm
Overall width (including lugs)	up to 1,300 mm
Anode length	approx. 1,000 mm

Figure 1 : **CONTILANOD®**Main Data

The CONTILANOD® technology of latest design using hydraulic shear system is suitable for production of copper anodes with hourly capacities in a range from 30 t up to 100 t.

CONTILANOD® - The New Design

The newly designed CONTILANOD® plant (*Figure 2*) includes all technologically necessary equipment, starting with the casting furnace (1), tundish (2), Hazelett casting machine (3), pinch roll (4), curved guide, hydraulic shear (5), cooling tunnel (6), stacking device (7), the transport equipment (8) as well as the hydraulic supply system and the electrical equipment including the control equipment, for automatic operation of the plant.

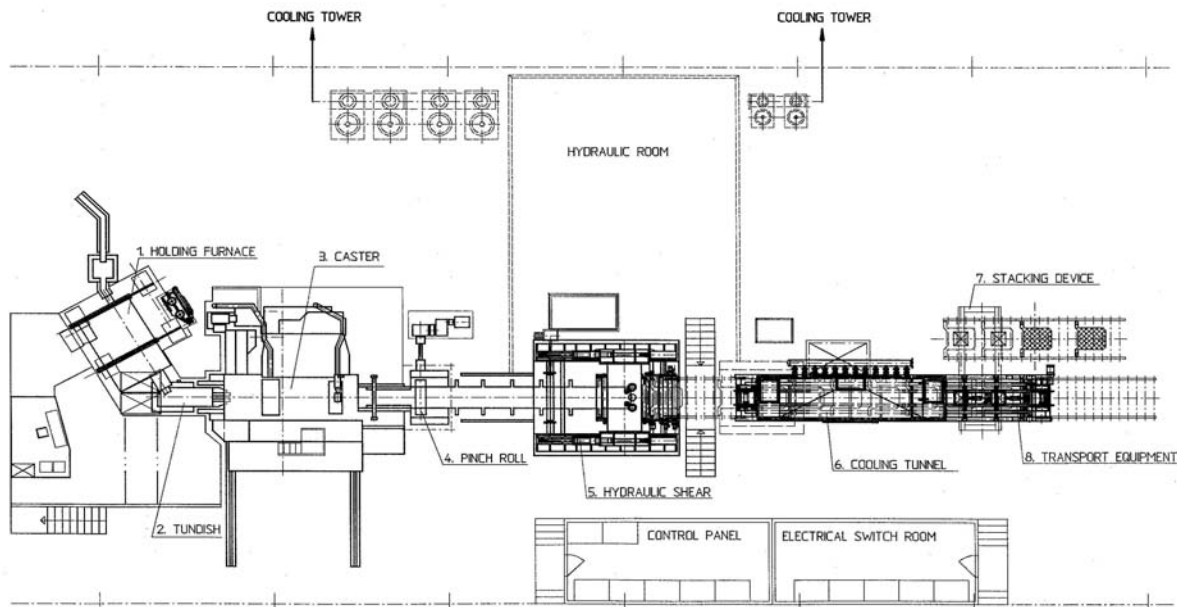


Figure 2 : **CONTILANOD®** Line with hydraulic shear-system

The CONTILANOD® plant commences with the casting furnace. The casting furnace is a continuous holding furnace. The liquid metal refined by anode furnaces is fed by a launder system to the front side of the holding furnace. The holding capacity of the furnace can be varied within the total capacity range as desired by adjusting the tilting angle (*Figure 3*).

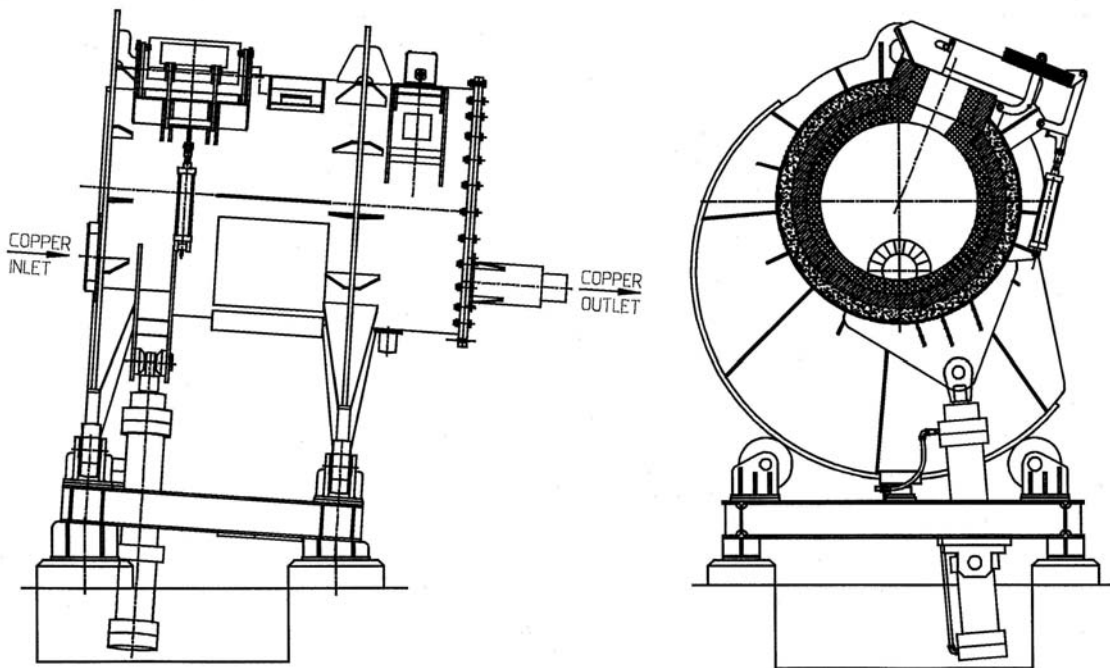


Figure 3: Casting furnace

The casting furnace is designed as a steel plate housing of horizontal drum type. It is equipped with two tilting cradles and a sectional steel frame. The drum is slightly inclined in casting direction and rotates eccentrically from the furnace axis. On both ends the metal inlet and outlet openings, are arranged on the tilting axis. On the circumference of the drum body 1 inspection door and 1 ventilation door are arranged. The casting furnace can be tilted into filling position by means of a hydraulic cylinder, which is supported on the frame and connected to the drum. The furnace is heated by a gas burner, which is fitted on the furnace. An independent combustion air supply system is provided for the furnace. The furnace is completely lined with required refractory material.

Liquid anode copper is fed from the casting furnace via the pipe-shaped outlet nozzle into the tundish before entering in the HAZELETT twin-belt caster.

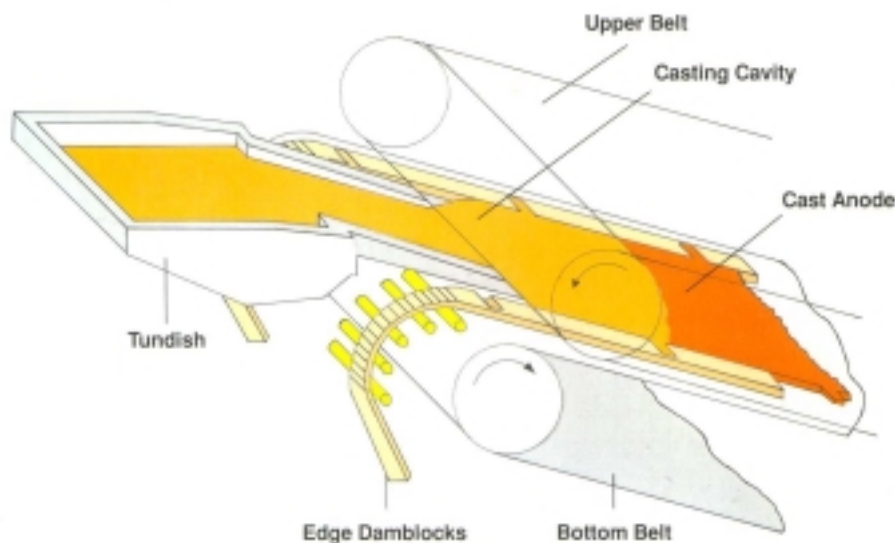


Figure 4: Metal flow into the casting machine

The fully retractable tundish evenly distributes the metal onto the moving lower belt and so into the moving mold of the caster. The wide casting spout provides for a calm and non-turbulent flow of the liquid metal into the mold area. The metal flow is regulated by automatic level control system - EMLI®.

The top and bottom of the mold are formed by two endless steel casting belts (*Figure 5*), which are tension controlled and supported accurately throughout the mold region. The belts are supported by accurate roller shafts, which ensure a perfectly flat anode. The backsides of the belts are continuously cooled by high-speed water flow.

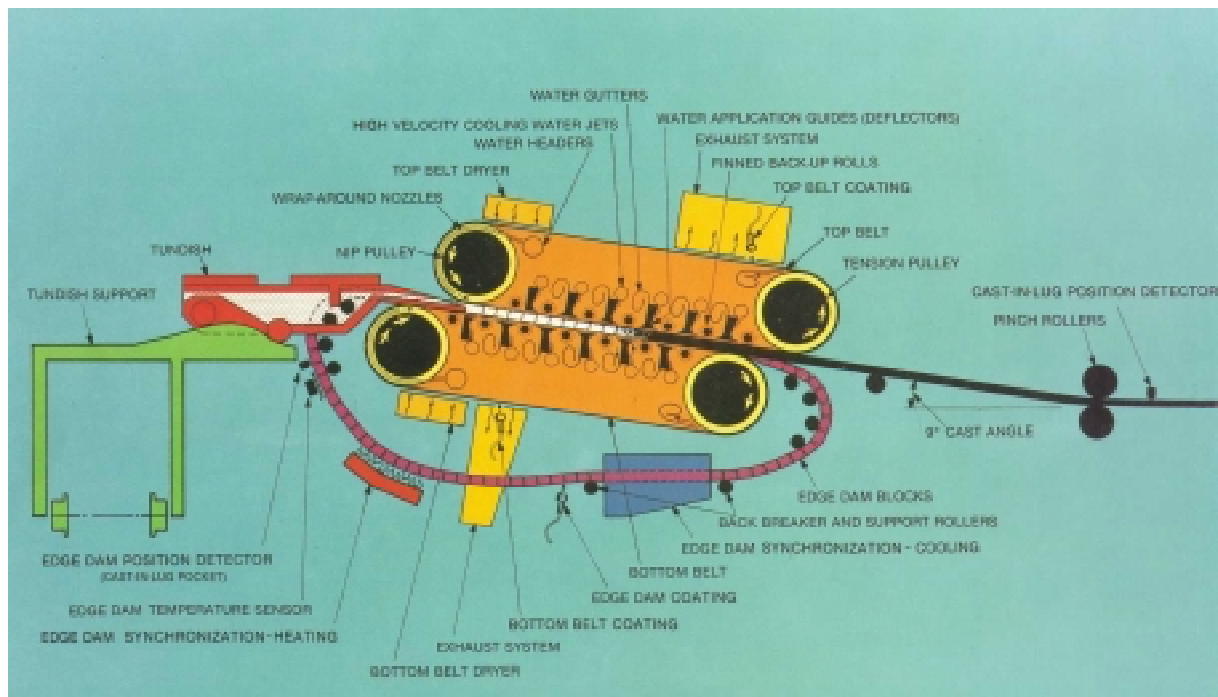


Figure 5: Anode caster scheme

Two endless chains of metallic dam blocks, which are sized according to the anode dimensions, form the sides of the mold. The location of the anode lugs on the emerging casting slab and the position of the lug pockets are continuously controlled and monitored. The opposing lug pocket blocks on both sides of the caster are synchronized by heating or cooling the dam blocks to thermally contract or expand the distance between succeeding pocket blocks.

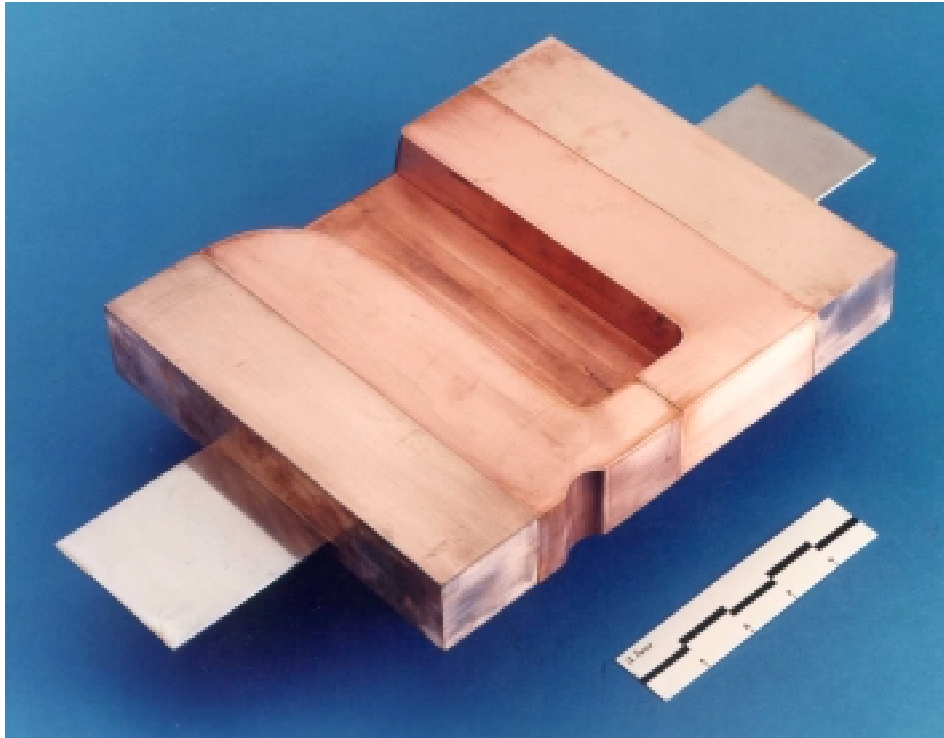


Figure 6: Edge dam block for anode lug casting

Specially formed edge dam blocks (*Figure 6*) with machined pockets for the anode lugs are spaced periodically in the chain to allow casting of integral half thickness lugs on the continuous anode slab.

The continuous anode slab emerges from the caster and passes through a pinch roll unit, which isolates the casting process from the shearing process (*Figure 7*). Following the pinch roll, the slab is supported on a curved guide table with pinch roll into the traveling hydraulic shear.

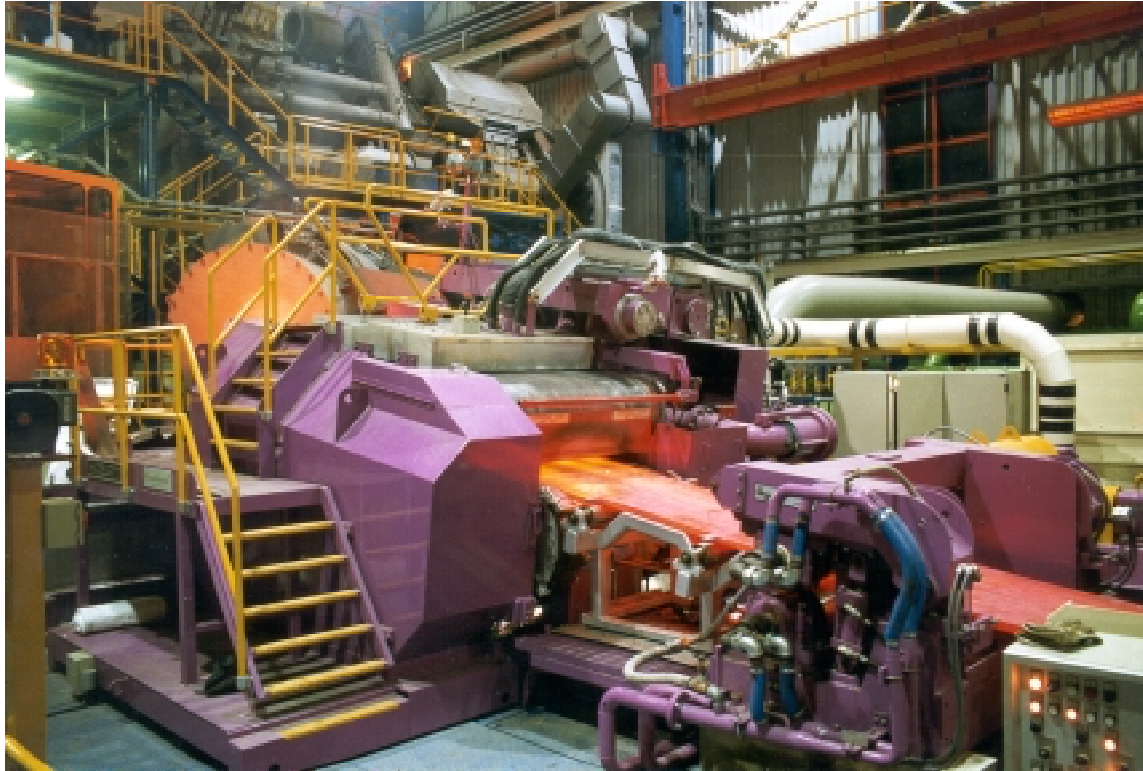


Figure 7: Anode caster exit with pinch roll

The hydraulic shear (*Figure 8*) is arranged to move together with the anode slab to carry out the cut without any difference in speed between anode slab and shear knives. After getting signal from both anode lugs the shear starts moving, increasing its speed by two hydraulic cylinders. When the slab speed is reached the holders and the lower cutter will move into the position, where they cover the complete width of the anode. Special attention is made to the lug area to avoid any buckling during cutting.

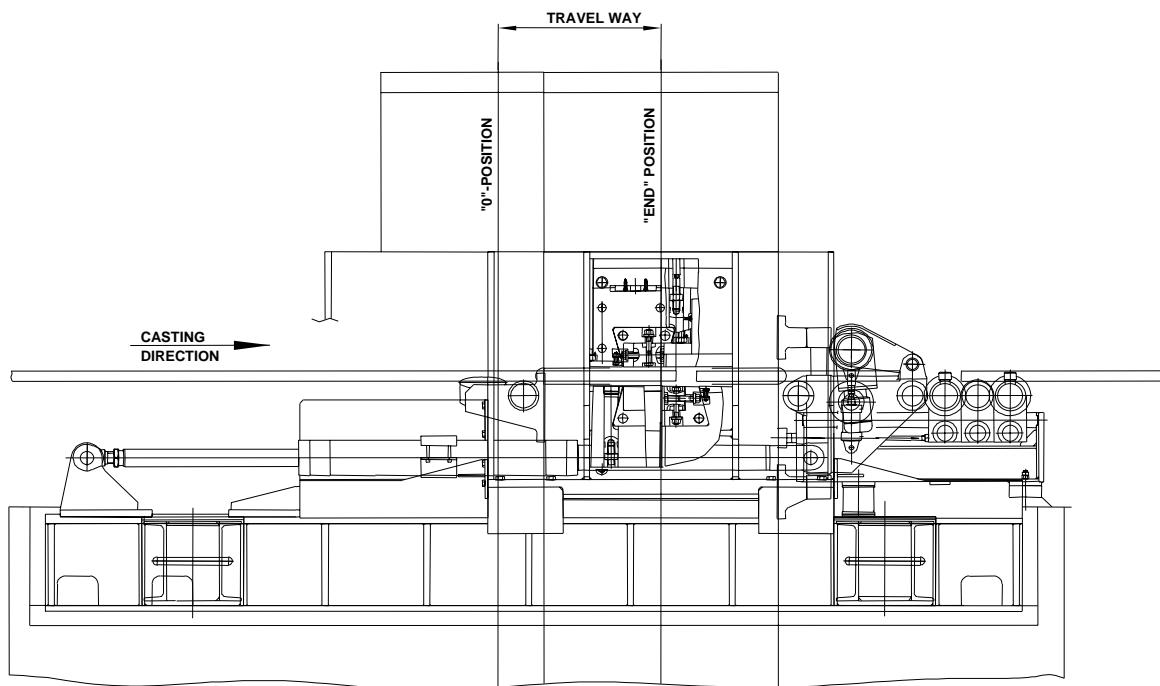


Figure 8: Traveling hydraulic shear with expandable roller table

The lower cutter carries out the cut and at the same time the cutted anode is hold parallel by means of the knife holder and clamping device. After cutting the knife holder and clamping devices are moved down and release the cutted anode to run out by pinchroll located downstream of the shear. In the same time the shear is moved back to "0" position to start the cutting cycle again. To bridge the moving gap of approx. 600 mm during cutting a special expandable roller table is located behind the shear. This deposits the anodes to a stationary roller table (*Figure 9*).

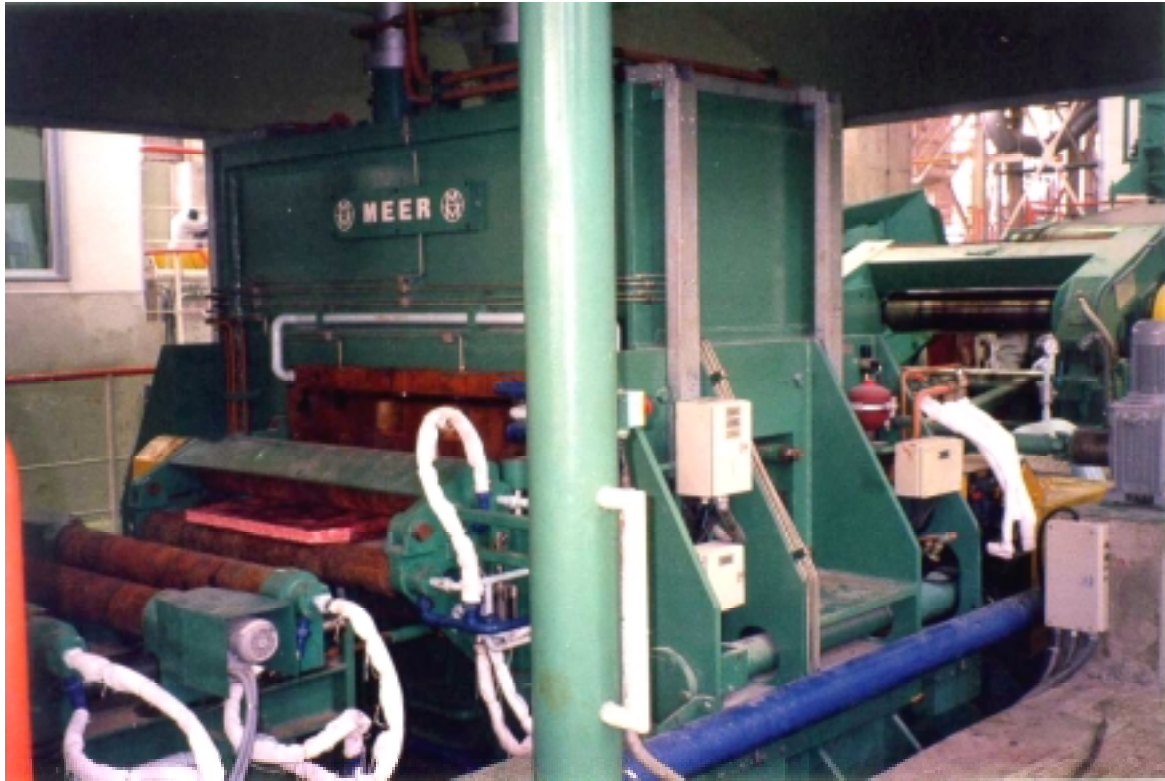


Figure 9: Traveling hydraulic shear with exit pinch roll

A driven conveyor chain transfers the anodes through the cooling tunnel. All movements of the shear are controlled by PLC-System based on the speed signal of the caster pinch roll and laser beams for lug detection. In this way a precise cut without any destruction of anode geometry is carried out (*Figure 10*).



Figure 10: Precise cut of anode shape

Due to the geometry of the dam block pockets, the half thickness lugs are cast with a 5° rake on the bottom surface. This provides a knife-edge contact on the anode centerline ensuring maximum and equal current flow for all anodes and a plumb hanging conditions.

In the cooling tunnel (*Figure 16*) the anodes are cooled equally on both sides using spray nozzles. The used cooling water flows into the scale-collecting tank and then into a pit and will be pumped back to the cooling tower via strainer.

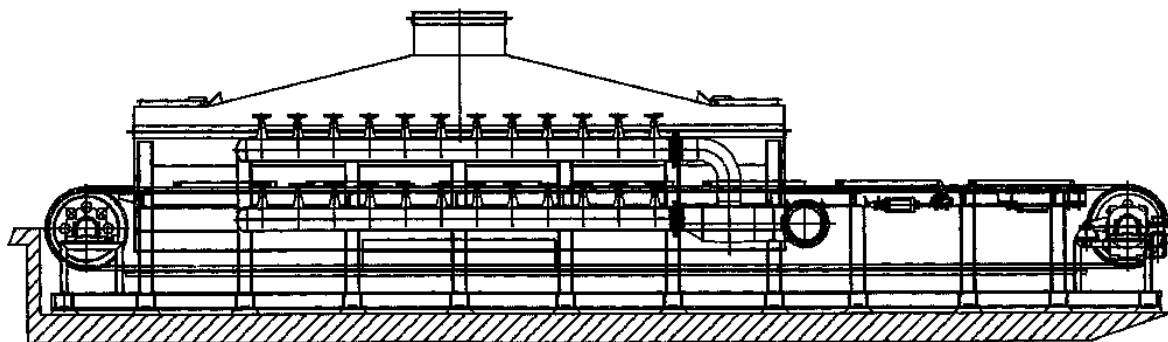


Figure 11: Cooling tunnel with transport conveyor chain

The cooled anodes emerge from the cooling tunnel and move to the stacking device (*Figure 12*). For high capacity lines two anodes are lifted simultaneously from the transfer chain system and moved to the stacking roller table. The two anodes are deposited here again. In this way two anode stacks are formed of 10 - 15 anodes each.



Figure 12: Cooling tunnel, transport conveyor chain and stacking device

The roller table then transfers these anode stacks to their collecting position from where they can be removed by local transfer equipment (fork lift truck).

AUTOMATIC CONTROL SYSTEM

It is of benefit for the casting process if the casting speed, and thus the speed of the cast anode slab, is held constant. That means that any changes in the metal supply from the anode furnace must be compensated by the operator of the casting machine by adjusting the position of casting furnace. At the same time, the casting level in the casting machine should be kept as constant as possible in order to avoid significant changes in the effective mould length (Figure 13).

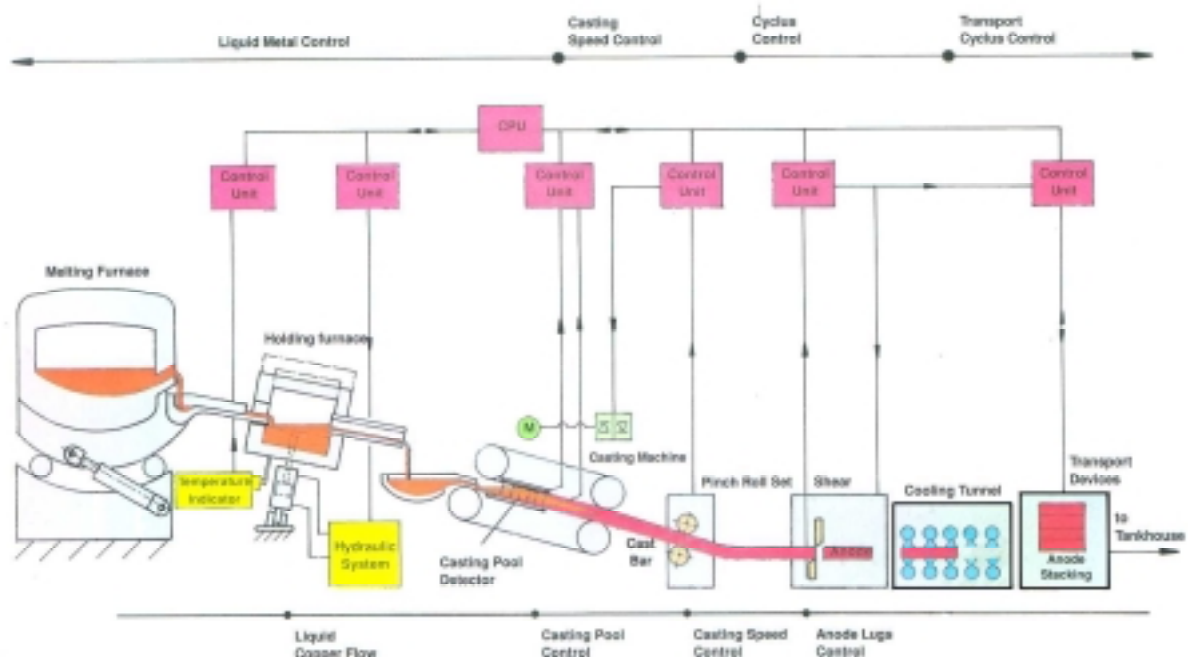


Figure 13: Automated process control-system

In "Manual" mode, the operator monitors the casting level from his control desk and adjusts the metal flow of the casting furnace by tilting the furnace via a very sensitive hydraulic system.

The automatic control by Electro Magnetic Levelindicator - EMLI[®] -of the metal level in the casting machine takes over this function during continuous operation of the plant.

The automatic control of the casting level monitors, on the one hand, the metal level in the casting machine using an electromagnetic measuring device and automatically corrects the casting furnace position. The whole casting and cutting process can be fully automated by using the casting speed from caster pinch roll and anode lug signals for all following equipment downstream of the caster.

The benefits of the use of the "Automatic" mode lie in the greater constancy of the supply and thus in a greater reliability of casting at high casting speeds and in relief for the operator. When the start-up phase has been completed and the "Automatic" mode has been activated, the operator can concentrate more on general monitoring duties.

CONTILANOD® Advantages

The advantages of using the CONTILANOD® process compared to the conventional wheel casting method are seen throughout the smelting and refining process. Many of the money-saving and quality advantages become apparent later on in the tankhouse operation. Some of the advantages are :

1. Because of the geometrical accuracy of the twin-belt caster mold and the superior knife-edge contact of the lugs, there is no need for additional equipment and labor to condition the as-cast anode by machining the electrode contact of the lugs and flattening and straightening the anodes.
2. The CONTILANOD® is a truly continuous casting process. As such, the casting scrap rate is significantly lower than that of a batch casting process.
3. A reduced tank house anode scrap rate is achieved primarily due to the reliability of the CONTILANOD® process and uniformity of anode cross section and weight control. The average anode weight variation has been shown to be less than $\pm 1\%$ and anode thickness variation anode-to-anode and within each anode is within 2 mm. Subsequently, drops in the tank house cells all but eliminated. The tank house scrap rate reachable under optimal conditions is 10 %. The geometrically accurate anodes hang very straight and vertical in the tank house cells, creating several advantages:
 - 3.1 The new type of anode offers more possibilities for mechanical handling in the tank house operation. Anodes, which are hanging very accurate, allow i. e. the use of automatic cathode sheet settling.
 - 3.2 A reduced spacing (pitch) allows additional capacity in the tank house per unit area, reducing investment costs.
 - 3.3 This close spacing, together with the superior knife-edge contact, causes benefits in increased current density and current efficiency.
 - 3.4 The superior anodes allow reduced manpower for inspection and adjustment of misaligned anodes, which typically cause short circuits.
4. Cathode Quality is improved due to:
 - 4.1 More uniform current distribution per cell.
 - 4.2 The elimination of the mold coating, which contaminates anode slimes, results in reduced slime handling and treatment costs and faster, more effective precious metals winning.
 - 4.3 Due to the even and symmetrical cooling of both sides of the CONTILANOD® anodes during casting, the casting structure is much more fine-grained and homogenous compared to conventional open mold cast anodes. This more homogenous structure of the CONTILANOD® anodes results in a higher quality of the cathodes. Due to the more even distribution of the impurities of copper, the formation of contaminated areas on the surface of the anodes in the tank house is considerably confined. The contaminated areas often dissolve and lead to short circuits and rough impurities in the cathodes.

The economical benefit out of these advantages of a CONTILANOD® plant versus a conventional plant is shown in the process flow sheet (Figure 14) for a plant with a capacity of 250,000 t/y.

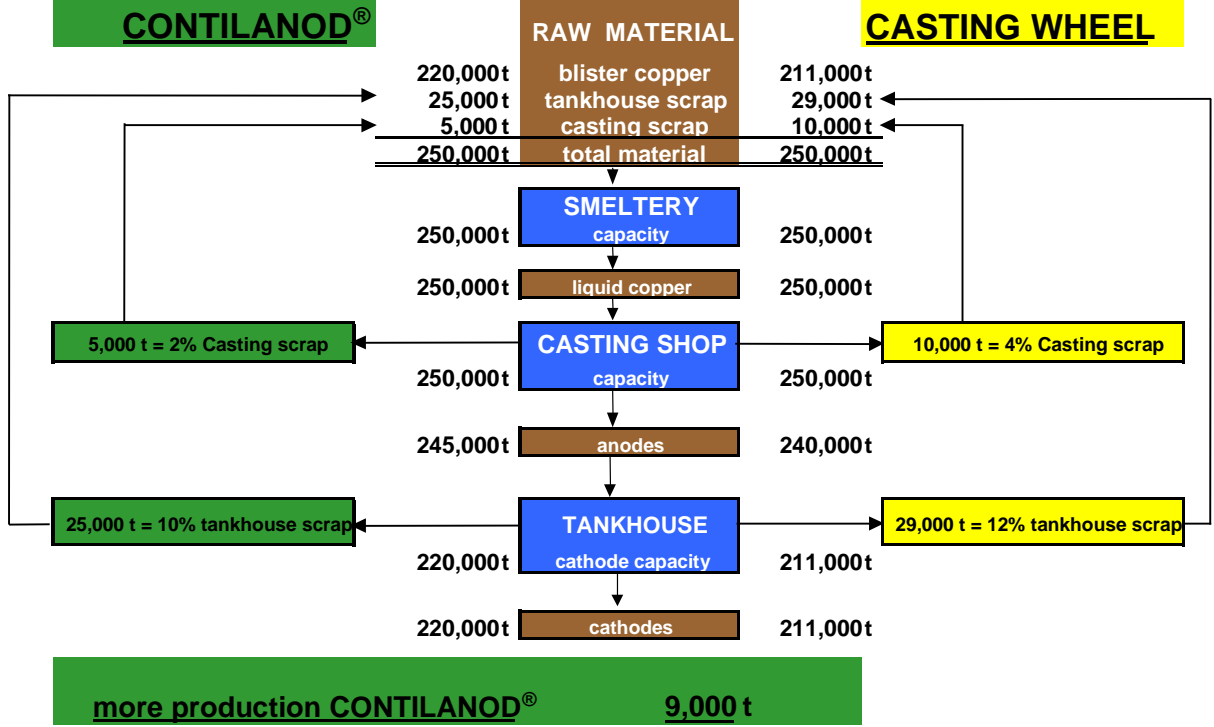


Figure 14: Process flow sheet

Based on the same casting capacity this process flow sheet shows that due to the higher level of technology and quality of cast anodes for the CONTILANOD® – system the scrap rate in casting shop and in the tank house operation are decreased. The uniformity of the anode cross section, the geometry and the anode weight cast by CONTILANOD® system makes it possible to decrease these figures from 4 % to 2 % and from 12 % to 10 % respectively. This decrease of anode scrap rate will result in annual additional copper production of approx. 9,000 t .

Handling the same total quantity of 250.000 t of anode-copper the value added of copper cathode more production is approx. 1.8 Mio US \$ per year. This figure is based on a refining margin of 200 US \$ per t refined copper cathodes and tank house power costs of 20 US \$ per t.

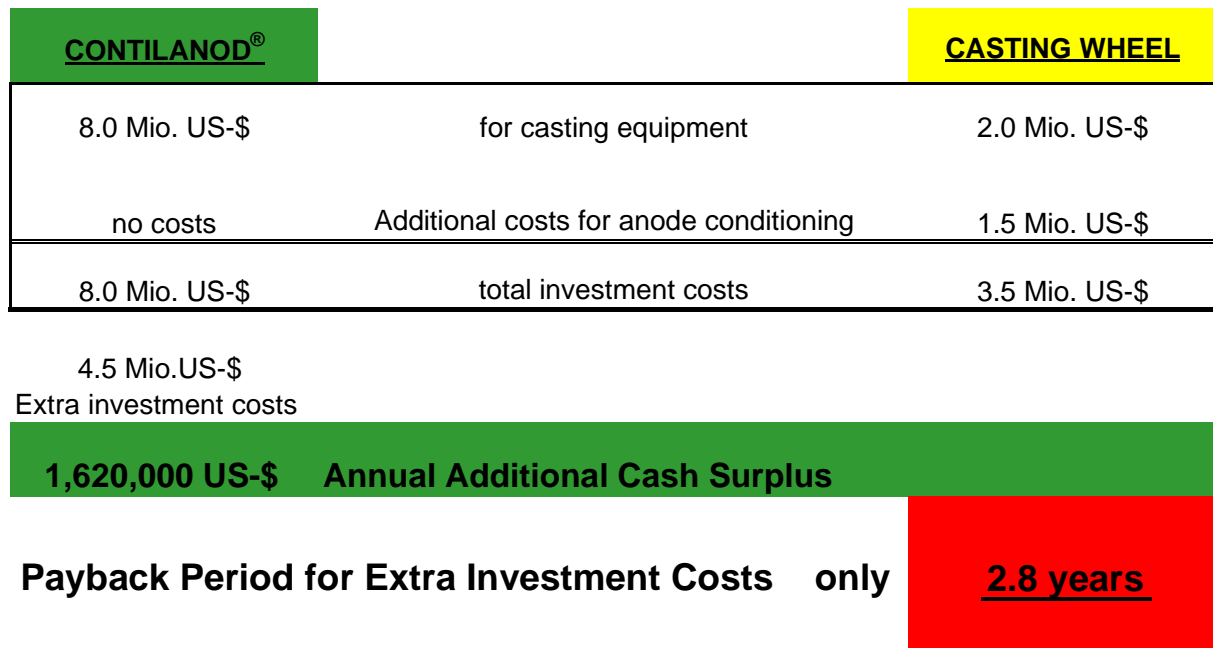


Figure 15: COMPARISON of investment costs

Based on comparison of investment costs (*Figure 15*) for both systems and the additional annual cash surplus for CONTILANOD® system of 1.62 Mio. US \$ it's shown that required extra investment cost of 4.5 Mio. US \$ will be compensated within less then 3 years. After that the surplus of 1.62 Mio. US \$ is cash at customer's free disposal for any other purpose in each of the following years.

Performance:

The largest of the new CONTILANOD® lines in commercial production is located at the new Mitsubishi/Freeport smelter (P.T. Smelting) in Gresik, Indonesia. The smelter was fired in early 1999, and anode production rates have met and/or exceeded design parameters, using a casting crew of five people, consisting of a lead man and four Indonesien operators.

Tank house performance has accelerated rapidly in the few months of operation. The latest figures available are shown in Table

Table - CONTILANOD® Performance at P.T. Smelting
March 2000

Casting Rate	100 Metric Tons per Hour
anode weight	370 kg
Tank house Scrap Rate	11 %
Tank house current density	295 A/m ²
Tank house Current Efficiency	99 %
cathode quality meet with CME grade A from aspect of both physical and chemical analysis (registration expected to obtain early 2001)	

Resume:

The design and use of hydraulic shear system solves the problems of the CONTILANOD® plants of first generation such as:

- No limitation to capacities above 50 t/h due to required number of plasma torches.
- Reduction of copper losses of plasma torch cutting
- Reduction of process costs (energy consumption, no expensive wear parts for torch system, maintenance work)
- Reduction of environmental impacts as fumes and noise

So, the newly designed CONTILANOD® system using a traveling hydraulic shear represents a breakthrough into higher production capacities and improved geometrical dimensions of anode production as a basis for greater efficiency and a higher degree of utilization in the tank house operation and copper production at all.