ALUMINIUM

Originally published in...
ALUMINIUM · 80 (2004) 7/8

# Construction and commissioning of a horizontal casting machine

O. Moos, R. Bauer, Tägerwilen and J. Sliwakowski, Klomnice

Gautschi maerz-gautschi Industrieanlagen GmbH
Geschäftsbereich Aluminium
Konstanzer Straße 37 · CH 8274 Tägerwilen
Tel +41 71 666 66 – 66 · Fax +41 71 666 66 – 77
info@maerz-gautschi.ch · www.maerz-gautschi.ch

# Construction and commissioning of a horizontal casting machine

O. Moos, R. Bauer, Tägerwilen and J. Sliwakowski, Klomnice

Fig. 1: Gautschi horizontal DC casting machine

*maerz-gautschi of Switzerland has recently successfully commissioned a horizontal DC casting machine at Eko-Swiat in Poland. The system, including the necessary peripheral equipment, is designed for a production capacity of 30.000 t/a in ingots and extrusion billets.*

PPH Eko-Swiat, Poland was established in 1990. The company is currently the main one in the Eko-Swiat Group, which consists of three companies including two production facilities. The Eko-Swiat Group produces 60'000 t/a aluminium alloys, which are supplied in the form of ingots, billets and liquid metal. As part of its long term investment program with focus on further growth and in order to serve its clientele better, Eko-Swiat decided to add a horizontal DC casting machine for the production of aluminium ingots and extrusion billets to one of its existing ingot casting facilities.

maerz-gautschi, responsible for the horizontal casting and stacking system for this project, covers the whole range of melting, casting and heat treatment equipment for the primary and secondary aluminium industry. The range of equipment, its reliability and its high efficiency are the reasons for the company's success on the international markets since 1922. maerz-gautschi equipment has been supplied around the globe to all major aluminium producers, including Alcan, Alcoa, Hydro Aluminium, and Pechiney.

## The plant

The new casting facility consist of four middle frequency induction furnaces (of which three have been installed in a first phase), a stationary 25 t, gas heated holding furnace, the horizontal DC casting machine, a flying saw, and a robotic stacking system. The plant was completely installed and ready for commissioning in December 2003. Production started at the beginning of 2004.

The equipment was installed in an existing production hall, which had been modified to accommodate the new casting facility. With respect to the materials processed and experience gained during many years of operation, Eko-Swiat decided to install induction furnaces to melt the aluminium. The liquid metal is then transferred into a stationary holding furnace by a launder system.

## The launder system

Liquid metal is transferred by a refractory lined launder to the tundish of the horizontal casting machine. The metal flow is controlled by a slide gate, which is incorporated into the holding furnace. A built in degasser and filter box assure that the required metal qualities are achieved. The equipment after the holding furnace (transfer launder, degasser and filter) has been supplied by maerz-gautschi. A jetcleaner has been chosen for this particular project. This type of degasser is designed as a in-line degasser using static nozzles to create bubbles of inert gas at high speed. A vertical filter box is installed in the launder system. This has the advantage, that the filter element can be changed during the operation. Furthermore, the electrical heating system of the filter box allows for the pre-heating of the box to avoid undesirable freezing and cooling of the liquid metal during start-up.

### *The horizontal casting machine*

Generally, a horizontal DC casting machine consists of four major parts. The tundish, including the attached moulds to distribute the liquid metal, a cooling water and a mould lubrication system to assure high quality standards of the produced product, the conveyor system to transport the strands towards the peripheral equipment and allow for a continuous casting process, and finally a sawing system to cut the finished product into pre-set length, allowing for easy handling.

### *The tundish*

A refractory lined steel trough, the so called tundish, distributes the liquid metal to the moulds. Prefired, lightweight liners are designed in such a way that the same liners can be used for different machine sizes. Micro-porous CaSi boards allow for an excellent back up insulation and the temperature difference of the liquid metal between the center to the outside strand is only 5°C for a 2 m wide tundish. The machine can be run with up to 20 strands, as required. All wearing parts are easily replaceable and not expensive. Activating the flow-regulating valve of the holding furnace controls the liquid metal level in the tundish.

*The cooling water and lubrication system*

The mold is the actual heart of every casting machine and influences not only the form and quality of the product, but also the production rate. The liquid metal solidifies by extracting energy in two stages. In the primary cooling process, the mould itself extracts enough energy from the liquid metal to create a solid boundary layer. In addition, a lubricant brought onto the metal acts as isolator and as lubricant. The core of the ingot is solidified during the secondary cooling process, which mainly takes place outside the mould. Cooling water is directly sprayed onto the strand exiting the mould.

The connections of the water and lubricant supplying system to the mold are done with quick – connectors to allow for easy maintenance. All connections are located on the top of the mold for easy accessibility.

*The mould system*

Eko-Swiat chose to produce ingots and extrusion billets on the horizontal casting machine to have more production flexibility. Liquid metal is supplied to the casting machine at the tundish. This allows for a distribution to the moulds with an even flow rate and temperature drop. The metal level in the tundish is kept within a narrow range. Cooling water and lubricant are continuously supplied to each mould in the exact amount depending on the individual casting recipe.

Both, the quality of the product cast and the throughput of the caster depend on the performance of the mould system. The innovative mould design of the Gautschi horizontal DC casting machine is in use for many years and has recently undergone improvements. The moulds shine due to the good accessibility, low oil consumption and the top quality of the product cast. An other advantage of the Gautschi casting system is, that each strand can be manually shut – off in a safe manner using a specially designed valve. Mould maintenance is always an important issue with DC – casting, if first class material is to be produced.

The Gautschi mould system is completely pre-assembled on the mould plate. It is equipped with quick – connectors for the supply of cooling water and lubricant. Thus the complete unit is prepared in the mould shop. Only a short time prior to commencing a cast will it be taken to the casthouse and mounted onto the tundish.

**Ingot moulds and extrusion billet moulds**

A new mould design for ingots has been introduced during this project. The otherwise rectangular shaped ingot has a recess on one longitudinal side. This makes the necessity for a specially shaped mould for the foot layer of the stack obsolete. All strands can be handled the same way, which allows for an easier operation. Stacking and strapping is simplified by having only one ingot shape.

The moulds are installed in a group of four on the mounting plate allowing for easy handling. Only three connection for cooling water and two for the lubrication supply is necessary for this set of moulds (fig. 2).

Extrusion billet moulds are based on a design proven over many years in production. Lubricant is supplied through graphite pins integrated in the mould, to assure a good surface quality. Cooling and lubrication is done independently for each mould (fig. 3).

**The casting conveyor**

There is hardly any friction between the mould and the ingot/billet during the casting process. Thus no force is required to pull the casting product out of the mould. The purpose of the casting conveyor is to make sure that the casting product exits the moulds at a continuous speed and most importantly, straight. This guarantees for repeatable ingot/billet quality, long casting sequences and a secure cutting of the strands. The actual casting speed depends on the cross section, the shape and the metallurgical composition of the product and is individual for every casting recipe. Similar to the vertical DC casting process, a starter head is used to commence the casting sequence. The starter head set is linked to the conveyor for a secure start of the casting process. By the motion of the casting conveyor, the starter head set moves out of the mould with the required speed and at the exact moment when all the casting parameters are set. Once the cast has commenced, the starter head set can be removed.

A cooling water pit is located underneath the conveyor. Cooling water coming from the mould, i.e. ingot/billet surface is collected in the pit. Also, any remnants of the lubricant are collected with the cooling water. The depth of the cooling water pit is designed to

**Fig. 2: View on ingot moulds and strands (note that water and lubricant connections are accessible from the top)**

**Fig. 3: Billet mould**

Fig. 4: Gautschi flying saw

prevent a molten metal explosion in case molten aluminium drains into it during a casting anomaly. Metal debris collecting on the bottom of the pit must be removed on a regular basis. A independent emergency cooling water supply is installed, allowing for a safe and controlled emergency stop of the cast.

Adjustable rollers for each strand press the product onto the conveyor and assure a straight and continuous motion.

*The flying saw*

The advantage of a horizontal casting machine is the continuous production of ingots/billets for days without any interruption and thereby of an accumulated casting length of several hundred meters. A strand of this length cannot be handled anymore. Therefore, the billets are cut in pieces of 3 to 8 m and the ingots in pieces of 650 to 820 mm, according to production requirements.

A flying saw (fig. 4), located right after the casting conveyor, performs the cutting. The main components are installed below the casting conveyor level. A noise reduction cabin is placed around the unit to keep the noise level below the acceptable value. Hydraulically activated clamping cylinders are used to prevent any uncontrolled movement of the strands during the cutting process. The movements of the saw carriage and saw blade itself are controlled by electrical gear motors. The saw blade moves perpendicularly to the casting direction while the saw carriage travels on rails synchronized with the casting conveyor. Thus it follows the movement of the billet at any speed without influencing the casting process. Swarf is extracted by means of air suction and then separated from the air flow by a cyclone and gathered in a bin for further processing.

The cut-to-length pieces are moved away from the saw by an integrated roller conveyor.

**The peripheral equipment**

*Layer transport*

Due to the use of the new mould design for ingots, the production of a special foot layer ingot is obsolete. The design of the layer transport can hereby be simplified. After the foundry ingots are cut to the pre-set length, they are stopped and laterally moved off the exit roller table. After the ingots have reached the determined position, a hydraulically driven pusher moves the ingots along the skid rail to the accumulation station on the side of the casting machine.

While being pushed each ingot is marked by an ink jet spray system. The printing head of the ink jet is brought to the side face of an ingot at the edge of the layer transport and the alloy number, or any desired marking, will be sprayed on. Printing does not involve physical contact with the ingot, it is done with electronically controlled micro jets and characters produced are up to 30 mm in height. In the following production step, the stacking robot takes the ingots from the accumulation station and forms a stable stack on the storage conveyor.

**Robotic stacking device**

The supplied robotic stacking device can grab up to 6 ingots at the same time from the accumulation station and moves them to the stack conveyor (fig. 5). Cycle time is as short as 6 seconds per transfer. The robot is equipped with a multi purpose grab. When building the foot layer of a stack, the grab takes single ingots from the accumulation station and places them on the stack conveyor. Depending on ingot size, a double or single layer foot is produced.

Afterwards, the same grab picks up a number of ingots to build the upper layers on the stack. Layers are placed crosswise on each other to build a stable stack. The weight of each stack can be adjusted to production requirements by adding more or less layers to it. Usually the weight of a stack is set in the range of 500 to 1000 kg.

Fig. 5: Robotic stacking device

One other advantage using such a system is the flexibility for different product length. In this case, ingots with a length of 650 to 820 mm are processed.

## Stack storage conveyor

A storage conveyor for up to 7 complete stacks is installed at the end of the casting line. This allows for certain operator flexibility. In addition, one weighing station and one station for the semi-automatic strapping of the stacks are incorporated in the storage conveyor.

The conveyor is built as a double chain conveyor with two cross connection support beams per stack point. At the same time, the support beams are designed as guides for the strap during the strapping process. Each stack is automatically weighted at the weighing station, which provides the necessary information to the associated control equipment. The complete weighing station is fitted into the stack storage conveyor frame. Four load cell assemblies are bolted to the top of the weighing platform. To weigh the stack, the weighing/lifting platform is pneumatically raised to clear the stack off the storage conveyor. The weighing system registers the stack weight and processes the data as requested by the control system. The stack is then lowered onto the storage conveyor chain to complete the weighing cycle.

The stack weighing system is PLC controlled, in conjunction with the weighing system digital indicator/controller. Operator interface is via the PLC operator terminal or the weighing system digital indicator. Both units are located in the stacker operator control desk.

The stack strapping station is designed to semi - automatically apply three steel bands to each completed stack (fig. 6). The strapping station support frame incorporates an operator platform to provide easy access to the strapping head/strap dispenser. A strap guide assembly is attached to the strapping device support frame. The strap guide assembly is extended across the stack storage conveyor during the strapping cycle, connecting the fixed strap guides on the support frame with the strap guides incorporated into the transfer carriage. The continuous strap guide system ensures a trouble-free feeding of the strap during the strapping cycle.

The automatic strapping head assembly is a compact and pneumatically operated unit. It incorporates all necessary electric sensors and safety devices. This allows also for the possibility of cross – strapping with individual orientation of ingots due to the robotic stacking device and the ingot size of 40 mm x 80 mm.

## The electrical and control system

The electrical system for the equipment is divided into a power and a control section. With the exception of the hydraulic and swarf extraction drives, all drives are frequency controlled.

Remote I/O's are used at strategic locations to reduce the cable requirements. Those remote I/O's are via Profibus directly connected to the PLC. Furthermore, all frequency converters are connected to the PLC. The drives of the casting conveyor and the flying saw carriage are equipped with impulse transmitters, which are directly connected to the frequency converters in order to have a optimum synchronisation between the two movements. Casting recipes can be chosen and modified at the operator panel. Furthermore, all alarms are indicated to allow for an easy and quick problem rectification.

## Summary

The complexity of the horizontal DC casting process of aluminium is comparable to the vertical one. One advantage of this process is the low investments cost (for example: no expensive foundation work is required and a overhead crane to remove the billets out a casting pit is not required). Furthermore, a high production flexibility can be achieved by producing ingots, billets and forging stock. Especially the production of ingots has shown that a high output with small ingot cross sections can be achieved. The experience in casthouses around the world has shown, that well trained and experienced operators can easily keep control over the casting process.

The plant was completed and commissioned successfully. Good co-operation of all parties involved made this success possible. The above described casting and stacking equipment represents a milestone in the development of HDC plants worldwide and represents the state of the art continuous casting equipment supplied by maerz-gautschi. As with every product, maerz-gautschi is constantly improving the technology and will supply equipment suiting each customer's unique requirements to meet market demands.

Fig. 6: Semi-automatic strapping system

## Authors

Oliver Moos (1968), Dipl. Ing. (FH), MEng. After an apprenticeship as Mechanical Draftsmen with maerz-gautschi in Tägerwilen (Switzerland), he studied Chemical Engineering and worked subsequently for maerz-gautschi as Project Engineer and Project Manager on several projects in Europe and South Africa. He rejoined maerz-gautschi in 2001 as Sales Engineer after working 5 years in North America as Project Manager on several large aluminium foundry projects.
(oliver.moos@maerz-gautschi.ch)

Roman Bauer (1965), Dipl. Ing. (FH), studied Mechanical Engineering after the completion of an apprenticeship as Car Technician. During his studies, he had the opportunity to spend 6 months in the United States as an intern. Mr. Bauer joined maerz-gautschi in 1998 as Project Engineer and Project Manager for aluminium casting systems.
(roman.bauer@maerz-gautschi.ch)

Jaroslaw Sliwakowski (1965), technical university education, shortly after graduation – in 1990 has established company PPH Eko-Swiat. Recycling activities were soon replaced by aluminium alloys production. New companies: Eurometal SA (est. 2000) and Eko-Swiat Poland Sp. z o.o. (est. 2001) started operating, forming the current Eko-Swiat Group.
(ekoswiat@eko-swiat.pl)