Energy Saving and Environmentally Sound Melting and Casting Furnace Technology for Copper Tube Casting

Introduction

Copper tube casting plants for small to medium scale production are predominantly marketed under the trade names CAST AND ROLL® and DIRECTUBE®. In this process a hollow tube shell of about 100mm outer diameter and a wall thickness of typically 25mm is cast on a horizontal continuous casting plant and further deformed by a planetary rolling mill into a mother tube which is then drawn to finished dimensions.
This process features less production steps and needs lower investment costs than conventional copper tube production lines.

The cast shop itself is composed of a horizontal continuous casting machine with typically four strands. The liquid metal is supplied to the furnace-related moulds by a pressurized induction casting furnace, which on the other hand is refilled, batch-wise by one or two induction melting furnaces. Cathodes and return scrap are used as charging material for the melting furnaces.

As usual for copper tubing, the metal quality is phosphor-deoxidized copper.

Fig. 1: Overview of a DirecTube®-plant with charging systems, two melting furnaces, a pressurized horizontal casting furnace, withdrawal unit, saw and milling machine.

Charging System

The first component of the cathode charging system is a cathode package storage conveyor, which is loaded by a forklift. From here the cathodes are isolated by a vacuum lifter, which puts the cathodes one by one on a tilting table. As soon as the tilting table has received one cathode, it tilts it into the vertical direction from where it is picked up by a clamping unit and lifted upwards.

Thereafter the cathode is alternatively charged into one of the two melting furnaces. To do this in a systematic way and under clean environment, the furnace hood has a slit at one side as well as on the top through which the cathode is moved into the furnace, lowered down into the melt and released.
A precise exhaust system insures that no dust comes out and that as little air as possible is sucked into the furnace.

It is clear that the cathodes have to be kept under roof for some time because only dry cathodes are allowed to be charged. The charging cycle depends on the castrate and is typically in the range of 90 sec.

The whole charging system is fully automatically controlled without any personnel being involved. Appropriate interlocking automatically stops the system for instance during furnace tilting or if the furnace is full. This function is controlled by load cells, which are installed under the furnace tilting chair.

If return scrap has to be charged, it can easily be done by a vibratory conveyor. For this the furnace hood is equipped with front doors. This process is manually operated.

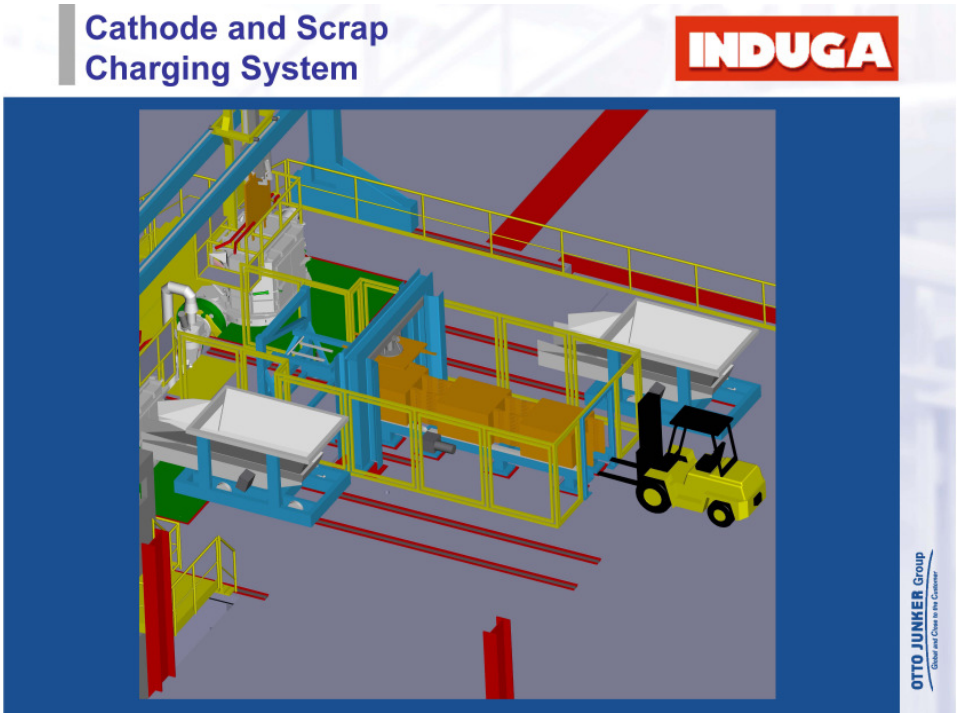

Fig. 2: Charging System.

Melting Furnaces
The two melting furnaces are designed as channel-type induction furnaces comprising a vessel-like body under which a W-type channel inductor is flanged. Discharging is done through a siphon-like spout into a launder from where the molten metal flows into the casting furnace.

The furnace capacity is about 7 tons with a useful capacity of about 3 tons. Each furnace is heated by a 900 kW channel-type inductor.

The residence time inside the furnaces is relatively high due to the alternative melt transfer. This is important for good phosphorous reaction and low residual oxygen level. Of course, this may also be achieved by only one melting furnace if its design is accordingly.

As already mentioned, the furnaces are positioned on load cells to control the filling weight. This information is used to automatize the charging process.

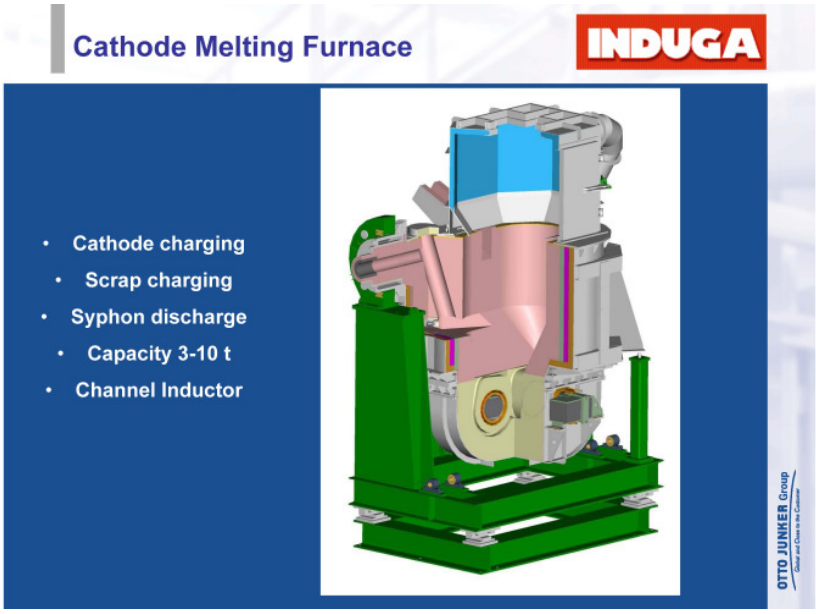

Fig. 3: Melting Furnace for Copper Cathodes and Return Scrap.

The quality of the DHP copper melt produced is determined in this line on the one hand by the choice of the raw material. On the other hand, further passive measures are taken to prevent an unnecessary oxygen enrichment of the melt. This starts with the individual charging of the cathodes into the channel-type melting furnaces that are designed to minimize oxygen absorption. The cathode is charged into the furnace by a claw in such a way that it is completely immersed into the copper melt, and hence melts below the surface of the liquid copper without contacting the furnace atmosphere.
The melted copper is then transferred by the shortest route via the hollow tilting bearing of the melting furnace and a short launder to the inlet siphon of the casting furnace.
Of course, the copper melt is protected by dry charcoal all the time.

Casting Furnace

A pressurized multi-chamber induction furnace is used as casting furnace. It consists of a charging chamber, a pressure and a casting chamber that are heated by a channel-type inductor which is integrated into the furnace itself in a sandwich-like manner between the chambers.

The casting furnace has typically a total capacity of 10 tons, a useful capacity of 6 tons and a heating capacity of 350 kW.

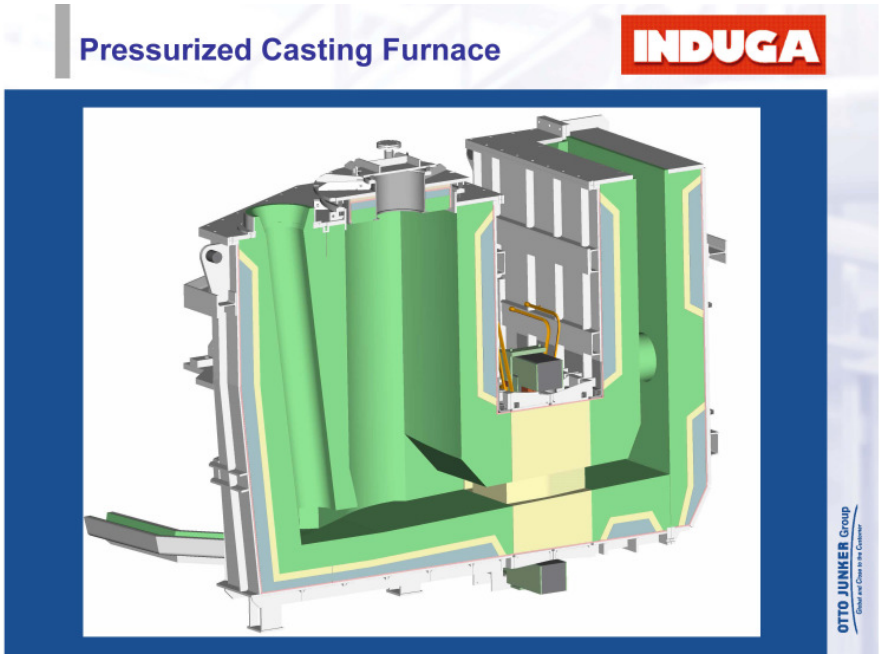

Fig. 4: The multi-chamber pressurized casting furnace.

Thanks to its special design, this casting furnace offers the following benefits:

- Quick mould changing
- Constant metallo-static bath level above the mould
- Extremely low inclusion rate thanks to the separation of casting and recharging
- Negligible metal burn-off thanks to the nitrogen pressurization
- Constant casting temperature due to optimized inductor positioning

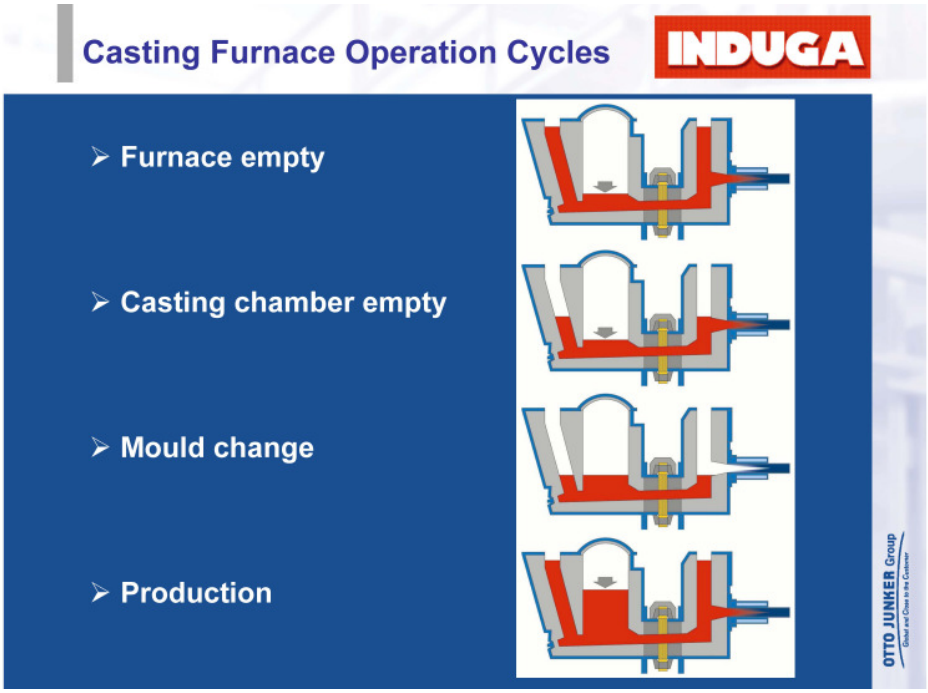

Fig. 5: The multi-chamber pressurized casting furnace.

Fig. 5 shows the mould changing process without complete emptying of the casting furnace. The metal is cast down to the minimum bath level first in the pressure chamber, then in the casting chamber. The furnace is then depressurized so that the mould is drained and can be changed easily and quickly.

Nitrogen is generally used as pressurizing gas to prevent any slag formation inside the closed and sealed pressure chamber. This allows the furnace to be operated for 6 months or longer without having to clean the pressure chamber.

The use of Nitrogen also offers big advantages from an environmental point of view, because it saves metal, avoids slag formation and is therefore one step further towards a cleaner cast shop.