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Improving The Technology Of Continuous Casting Of Steel Castings

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ABSTRACT

This article describes the quality and cost-effectiveness of converting steels by melting them in electric arc furnaces. In addition, the technology of continuous casting of cast products in the furnace with the help of ferroalloys, followed by various equipment.

KEYWORDS

Steel, carbon, element, manganese, alloy, converter, stainless, acid-resistant, ferrochrome, electric arc furnace.

INTRODUCTION

Steels are mainly composed of carbon (up to 2%) and b. alloy with elements. The composition of ordinary technical steel is 0.05-1.5% carbon, up to 0.4% silicon, 0.1-1% manganese, up to 0.08% sulfur, up to 0.1%

phosphorus and 96.92-99, it consists of 27% iron. Industrial steels contain permanent compounds: silicon Si, manganese Mn, sulfur S and phosphorus P. The difference between steel and cast iron is that cast iron contains

more than 2% carbon and more permanent impurities. When steel is refined, its physical and mechanical properties change dramatically, hardness and strength increase, and it becomes malleable (see Steel refining). Depending on the amount of carbon and alloying elements in the chemical composition, steel is divided into carbon and alloy types. Carbon Steel (containing up to 0.7% manganese, up to 0.37% silicon, up to 0.04% sulfur and up to 0.035% phosphorus in addition to carbon steel) construction and mechanical steel; tool steel. Alloy steels include low (alloying elements up to 2.5%), medium (alloying elements 2.5-10%), high alloying (more than 10% alloying) steels (see alloy steel). Depending on their use, they are divided into construction (rolling) and machine-building (construction), instrumentation, and special types. Stainless Steel is stainless and acid-resistant, heat-resistant, corrosion-resistant, magnetic, etc. qualities [1,2].

Steel can be produced in liquid, plastic and solid state, but is mainly produced in liquid form. Liquid Steel Converter, open-hearth furnace, electric furnace, crucible, etc. in ovens. Plastic Steel is puddled (see puddling). Solid steel is recovered or electrolyzed in drum furnaces.

Blast furnace and scrap metal are used as raw materials. They are heated in the oven. As a result of a chemical reaction, C, Si, Mn, P and S oxides in cast iron and iron ore are reduced to form steel. If necessary (for example, in the production of alloy steel), the necessary chemical elements are added. Due to the negative effect of phosphorus and sulfur on the properties of steel, steel is refined. In this case, the basic characteristic flux is used.

Reductants (alloys containing Mn, Si, Al, Ca) are added to liquid steel to reduce the amount of oxygen in the steel. They combine with the oxygen contained in the iron oxide to purify it. Reduction can also be performed using diffusion. In this method, the refractories, which are crushed into powder and placed on the stone (slag), melt in the stone and return the iron in it. This, in accordance with the law of distribution, also leads to the return of iron in steel [3]. Steel production is completed by burning the finished steel into special metal molds using buckets.

MATERIAL AND METHODS

The main raw material for production of stainless steel is recycled steel scrap, mostly stainless steel scrap. At industry company, 85-90 % recycled scrap is used in the production. The rest is virgin material in the form of different alloying elements.

To handle such big volumes of steel scrap, rigorous purchase routines are needed [4]. At arrival, before entering the melt shop site, the steel scrap is tested to ensure that no radioactive components are present. The steel scrap is then tested, analyzed and sorted according to its alloying content to ensure that as little virgin material as possible is needed to get the right chemical composition of the stainless steel produced.

FERROCHROME

The ferrochrome plant is an integral part of the steel production at works. In ferrochrome production, the mined chromite ore is crushed and pelletized before it is further processed in a sintering plant. the sintered chromite pellets are brought to the ferrochrome plant where they are charged to a pre-heater, heated by the

off-gases from the actual smelting process. The ferrochrome smelting is done in a closed submerged arc furnace equipped with shafts to charge material from the pre-heater situated on-top of the SAF. To preheat the charged material up to 7000 C decreases the specific electric energy consumption in the smelting process and significantly improves the overall operation [5]. The finished ferrochrome (FeCr)

contains approximately 52 % chromium, 4 % silicon and 7 % carbon. The main of the part produced FeCr is cast and solidified in large castings, which then are crushed for sale, or further processed; see Figure 1. Part of the ferrochrome is transferred to the steel melting shop as a liquid, and is pre-processed in a ferrochrome converter to remove the silicon and part of the carbon content.



Figure 1. Liquid ferrochrome casting

The reaction energy from burning the silicon and carbon with oxygen is utilized to melt more material fed into the convertor [6]. As the charge weight increases, the chrome content decreases from 52 % to about 35 %. This liquid is then used as part of the raw material charged to the convertor for the next step in the stainless steel production.

MELT SHOP

Processing steel scrap and alloys in the melt shop is the first step in the production of stainless steel. The configuration of the melt-

shop depends on the capabilities of the steel works, but consists of several combinations of equipment. Typically there four main steps, each in different units:

- 1) Melting of raw materials in an electric arc furnace (EAF);
- 2) Removal of carbon, sulphur and possibly also nitrogen in a steel convertor;
- 3) Tuning of the steel composition and temperature in ladle treatment;
- 4) Casting of slabs or ingots.

The most conventional method is to melt the raw materials, scrap (alloyed and unalloyed)

and ferro-alloys in an electric arc furnace, Figure 2.

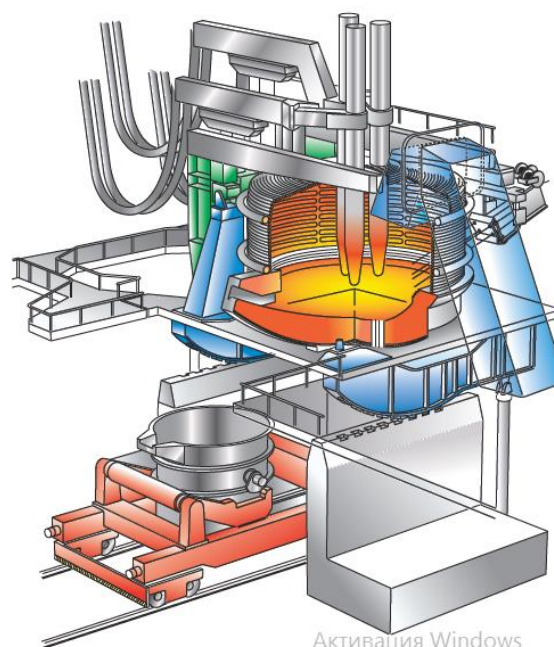


Figure 2. Schematic illustration of an electric arc furnace

The scrap is charged into the furnace using large baskets. The lid is closed and the electrodes are lowered, and powerful electric arcs start to melt the scrap and alloys. During the melting process, the arc reaches temperatures of up to 3500°C , and the molten steel can reach up to 1800°C . Additional injection of chemical energy in the form of carbon, ferrosilicon, oxygen or fuel gas mixtures speeds up the melting process [7,8].

After melting, the steel is further processed in an AOD (Argon Oxygen Decarburization) converter. The main objective of this step is to reduce the carbon content to a target amount by injecting an oxygen-argon mixture but also

to supply additional alloying elements. After the AOD treatment, the molten material is poured into a ladle.

In the case when liquid ferrochrome is used, an iron rich scrap mix with low alloy content is melted in the arc furnace. Nickel and molybdenum together with the liquid ferrochrome are then added in the AOD converter.

An alternative decarburization process is the VOD (Vacuum Oxygen Decarburization), which is especially suitable when very low carbon or nitrogen content is required, for instance in the case for some high chromium ferritic stainless steels.

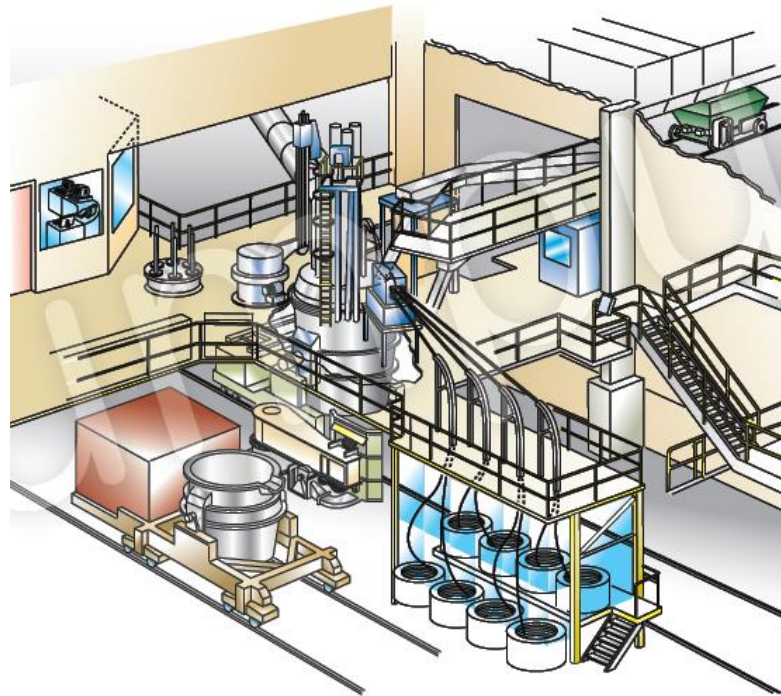


Figure 3. Schematic illustration of a ladle furnace

The quality requirements for most stainless steels make a secondary metallurgical treatment necessary. This is done in a ladle station, ladle furnace, or as a vacuum treatment of the liquid steel, Figure 3. The goal of this process step is to make the final adjustment to the chemical composition; the steel is calmly stirred to remove unwanted inclusions and to homogenize both temperature and chemistry of the molten material, maintaining a tight specified

composition within exact temperature limits [9,10].

At the correct time, and placed in such a way that the next heat will be ready for casting when needed, the liquid steel ladle is transported to the continuous casting machine or, in some special cases, to the ingot casting area. Continuous casting is a process in

which molten steel is converted into slabs of manageable size, Figure 4 and 5.



Figure 4. Continuous casting. Turred with ladle and tundish, from which the molten steel is led down into the mould by the submerged entry nozzle (SEN).

The ladle with molten steel is placed in a holder or on a turret. From the ladle, the steel is tapped through a nozzle into the tundish. The tundish is an intermediate vessel designed to

maintain a constant weight and allows for flying ladle changes during the course of casting in a continuous process. From the tundish the steel flows through a submerged entry nozzle (SEN) into the water cooled copper mould [11].

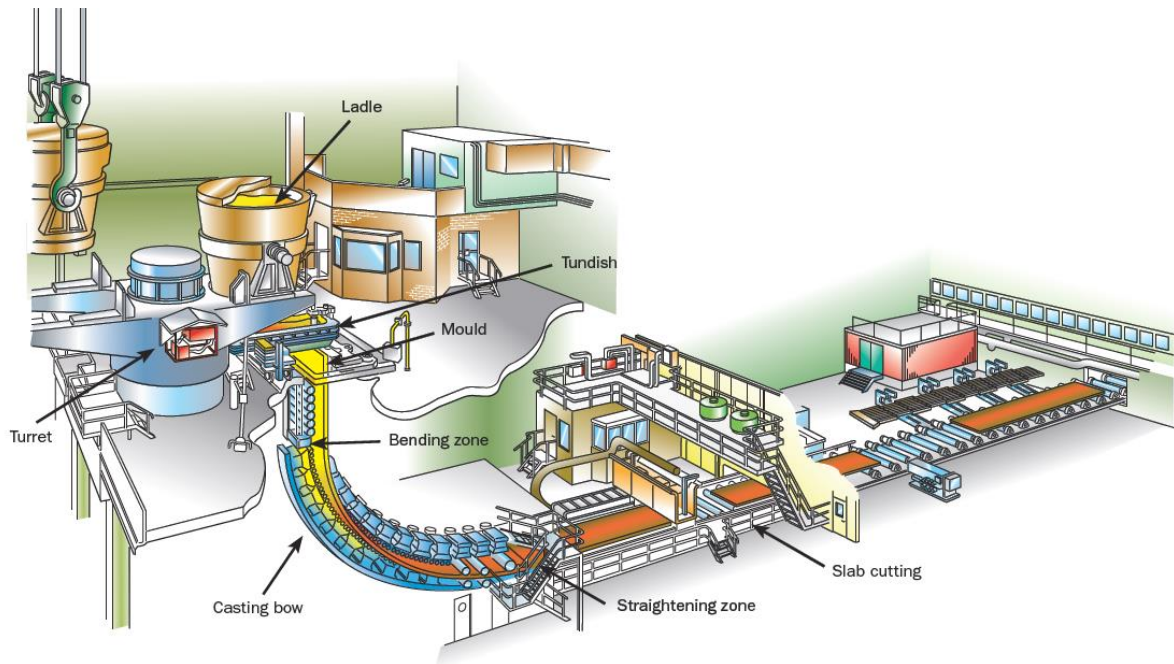


Figure 5. Schematic illustration of a continuous casting machine.

The steel flow is often auto-matically controlled to maintain a constant steel-level in the mould as the bottom of the mould is slowly retracted and follows an arc shaped set of top and bottom rollers which support the solidified strand shell. Molten casting powder is used to reduce friction and ensure good contact between the mould and solidified shell. Intensive water spray cooling of the strand starts immediately below the mould and in-between the supporting rollers, to solidify the hot melt inside the solidified shell to form a

solid strand of steel. The strand is continuously cooled and shrinks in volume as it is withdrawn on its arc-shaped path down to the cutting station. At this stage, the steel is still hot and glowing, but is sufficiently solid to enable the strand to be cut with movable oxygen lances into manageable pieces called slabs. Slabs serve as the feedstock for the flat hot rolling mills. The process is similar for the

semi-finished casting products like blooms and billets which are starting material for the long product production.

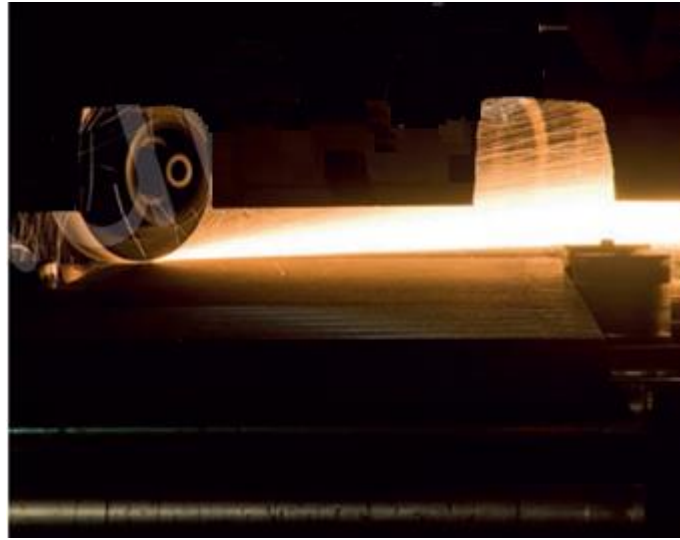


Figure 6. Hot grinding of slab

Every slab has a unique identity number and is carefully tracked. This identity (slab/coil number) follows the material through the whole production line and is written in the material certificate. This makes it possible to back-track the material all the way back to the melt shop [12]. Recorded production parameters are linked to the identity number to ensure that the individual and product fulfills the requirements given by the customer. All slabs are inspected to ensure a high quality. Slabs for more demanding stainless steel grades are ground to ensure a high quality surface finish on the final product, Figure 6.

RESULT

Hot rolling is a metalworking process that occurs at a temperature above the recrystallization temperature of the material.

The starting material is usually semi-finished casting products such as slabs, blooms, or billets. The cast microstructure is broken

down and deformed during processing and the deformed grains recrystallize, which maintains an equiaxed microstructure (a structure in which the grains have approximately the same dimensions in all directions) and prevents the steel from work hardening. While the finished product is of good quality, the surface is covered in mill scale, which is an iron and chromium rich oxide that forms at high-temperatures. It is usually removed in the annealing and pickling line, which restores the smooth metallic surface.

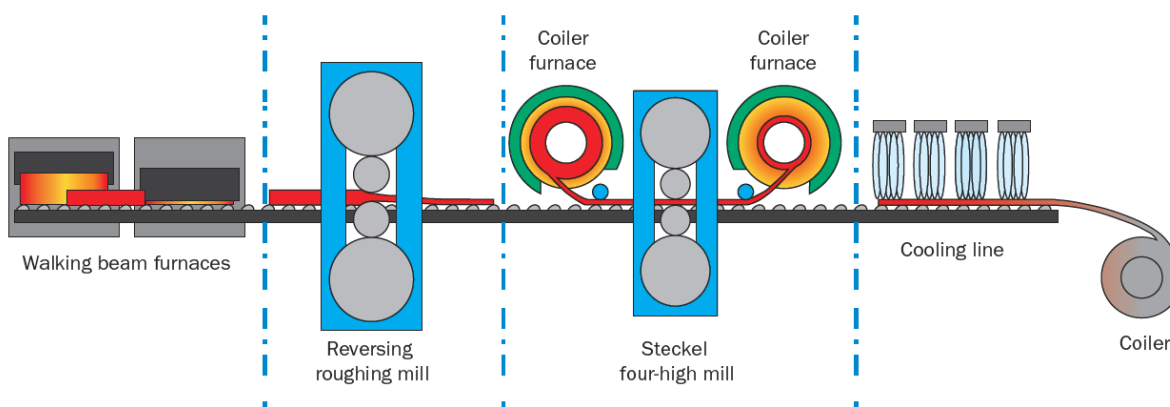


Figure 7. Schematic illustration of the complete Steckel rolling mill line

CONCLUSION

Various products are made from steels by casting or rolling. The article describes the technology of converter steel production and continuous steel production. The quality of steels obtained by the converter method, the content of minor additives and the amount of harmful gases O_2 , H_2 , N_2 can produce a higher quality steel product than other electric arc and induction furnaces. Continuous casting technology uses the technology of obtaining cast products from liquefied steel by various equipment. The advantage of this technology is that the product can be obtained by continuously pouring liquefied steel in the furnace using various equipment. Compared to other methods, this technology increases productivity, but in a certain amount of continuous injection technology, the equipment is expensive.

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