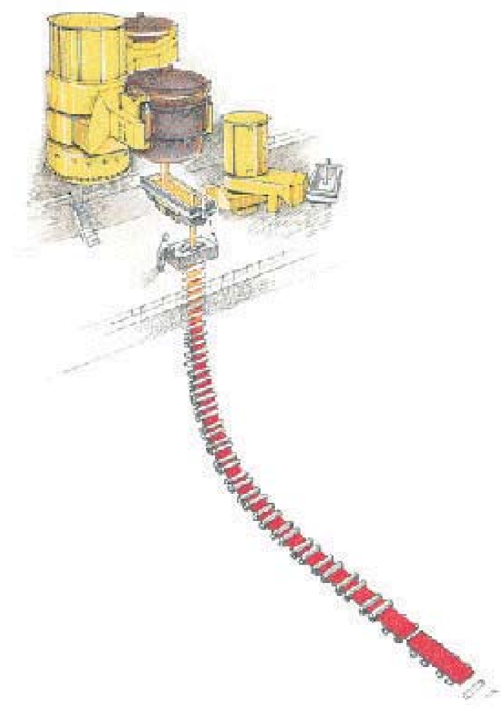
Submerged-arc strip cladding of continuous casting rollers using OK Band 11.82 and OK Flux 10.07

by Dipl.-Ing. Rolf Paschold, ESAB GmbH Solingen

Continuous die casting systems are very much used in modern steel plants. The continuous die casting technique achieves for a steel plant and the attached rolling mill considerably higher productivity when compared with former standard gravity die casting technique.

Due to gravity, the continuous casting process takes place in a vertical direction, followed by redirection of the red-hot billet into horizontal position in order to be able to carry out the subsequent working operations like cutting to length in the latter position.

Billet guide rollers, so-called continuous die casting rollers, are used for redirection of the red-hot billet (Fig. 1). These are exposed to considerable strain in service:



Thermal load and thermal shock

The surface gets very hot (approx. 950°C) through the contact with the red-hot billet. The roller is subjected to heat, scaling and because of fast local temperature changes to thermal shock. As the temperature fluctuates locally, the rollers circumference and cross-section is exposed to thermal stress. As a result of such thermal load, material loss through scaling and tearing may develop.

Corrosion

The red-hot billet already carries a scale film on its surface. Together with the cooling water sprayed onto the billet, it produces an acidy medium (pH 4–5) which causes roller corrosion.

Wear by friction

There is a mixture of rolling and sliding friction at the contact point with the billet. These frictions cause roller abrasion. Mill scale which contains very hard oxides, causes grinding wear (abrasion).

Metal fatigue

To guide the steel billet, the rollers are exposed partly to very high forces. The present reverse bending stress can cause fatigue cracks and, at the worst, roller breakage.

The sum of these strains results in a limited service life of the continuous casting rollers. The system operators usually have at least two sets of rollers of which one is in use and the other is being re-surfaced. The repair of the rollers is either carried out by an individual unit of the steel plant or by a dedicated external company. Soft martensitic weld metals are commonly used as an alloy for surface welding. They consist of approx. 13% chrome, 4% nickel and about 1% molybdenum. These alloys have been a great success because of their combination of resistance to heat, thermal shock, corrosion and wear.

Different welding processes are applied for surface welding of continuous casting rollers. In some cases, the regeneration is carried out by MAG welding where cored wire electrodes are preferred. Because of its higher deposition rate, submerged arc welding is often used. Wire electrodes used are also cored wires, a typical one is OK Tubrodur 15.73. Suitable fluxes are OK Flux 10.61 and the specially developed OK Flux

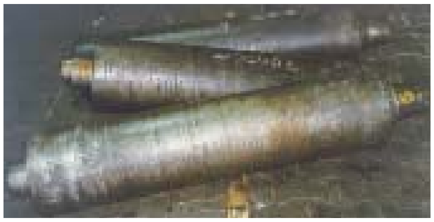


Fig. 2. Worn concast rollers before repair and maintenance

fig 3.

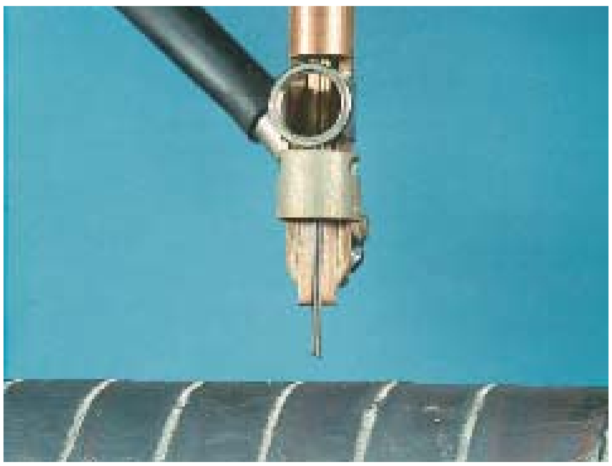


Fig. 4. Sub-arc cored wire surface welding with OK Tubrodur 15.73 and OK Flux 10.37

10.37, which is suitable for sub-arc surface welding of continuous casting rollers. Its application secures outstanding weld surface and slag removal at very high working temperatures.

All previously mentioned methods work with alloyed cored wires in combination with shielding gases or neutral, non-alloying fluxes. Since the production of equivalent solid wire electrodes is quite difficult because of their hardness, cored wire electrodes have been successfully produced for a long time. For sub-arc strip cladding suitable strip electrodes using sinter technique have been made available. However, production of sintered strips is relatively complicated and costly. The more cost effective alternative is a solid strip containing the alloying element chrome along with an alloyed flux which mixes the elements of nickel and molybdenum with the weld metal:

Strip electrode:	**OK Band 11.82**
EN 12072:	S 17
DIN 8556:	UP X 8 Cr 17
Werkstoff-Nr:	1.4015
Flux:	**OK Flux 10.07**
EN 760:	SA CS 2 NiMo DC

This is a special flux with excellent welding and self-releasing slag properties also at high working temperatures. It produces even and notch-free plating surfaces.

Alloy mechanism

Metallurgical reactions set-in during sub-arc welding, when material transfers from the wire or strip electrode to the molten pool and when it comes into contact with the slag, or when the molten pool is in contact with slag. These processes depend also on the welding parameters. For example, an increased arc voltage results in a more intensive contact of a droplet with the slag and consequently a stronger reaction. The metallurgical processes during production of a multi-run soft martensitic weld metal with OK Band 11.82 and OK Flux 10.07 are briefly described here. A three-run coating onto mild steel was carried out to show the alloy distribution. OK Band 11.82 was used, dimensions were 60 x 0,5 mm, the weld metal parameters were is = 900 A, Us = 26 V, vs = 13 cm/mm, stick-out length of the strip: 30 mm

Chromium

Chrome is the main alloy element in a soft martensitic weld metal with approx. 13% Cr content. The chromium is added to the weld metal via the strip electrode, which contains approx. 17% Cr. With mixing with the base material or previous runs together with flashburning through oxydic flux components, the chromium content of the weld metal levels out at desired 12–14%.

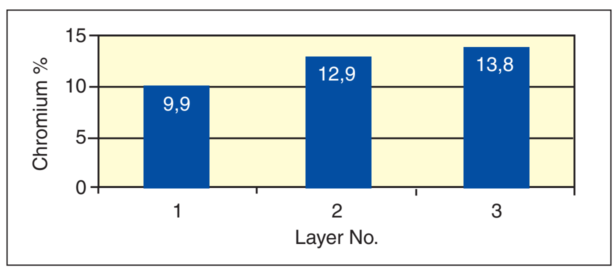


Table 1. Chromium content in weld metal

Nickel

Nickel is exclusively added via flux to the weld pool. With reference to equilibrium reactions, the increase of nickel content becomes smaller with each run. Finally the nickel content levels out at desired 4–5%.

Molybdenum

Adding molybdenum via the flux is similar with that of nickel. With increasing number of runs, the alloy difference becomes smaller, until the equilibrium is reached at about 0,8–1,2%.

Surface cladding of continuous casting rollers is carried out in three runs. As a result, the requested target analysis is achieved and a soft martensitic weld metal is produced. Before machining, the rollers are

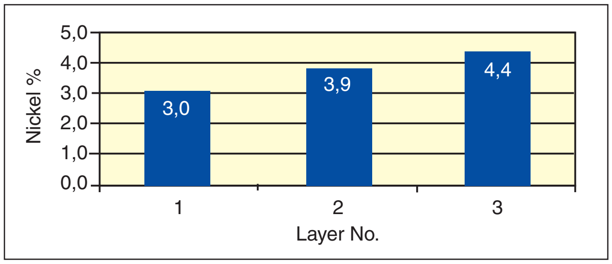


Table 2. Nickel content in weld metal

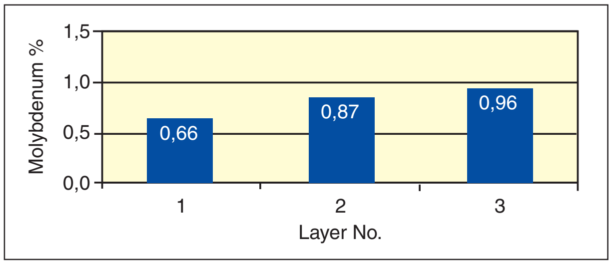


Table 3. Molybdenum content in welding pool

annealed (e.g. 520°C/4h). The weld metal hardness after annealing is 40±2 HRC. However – are there further advantages using sub-arc strip cladding with OK Band 11.82 and OK Flux 10.07 apart from cost-effectiveness? OK Band 11.82 is mostly used as a strip of 60 x 0,5 mm. A welding current of 700–900 Amps is usually used for that strip dimension, which results in a deposition rate of 12–14 kg/h – a very good rate of profitability with surface cladding. In addition it must be considered that the weakest point of cladded rollers is the transition between the weld beads. Due to the heat spread from the next run, annealing affects the overlap line. Here the hardness and wear resistance are a bit lower. Using wide strip electrodes, the number of weld bead overlaps is reduced and abrasive resistance is in total better.

Fig. 5. Strip cladding of smaller rollers with OK Flux 10.07 and OK Band 11.82 dimension 30 x 0.5 mm.

About the author

Rolf Paschold, product manager at ESAB GmbH Solingen (Germany), graduated in 1990 as a mechanical and welding engineer. He joined ESAB in 1991 and is the sales support manager for welding consumables. Mr Paschold has always shown a special interest in tailor-made process applications developed together with the costumer.

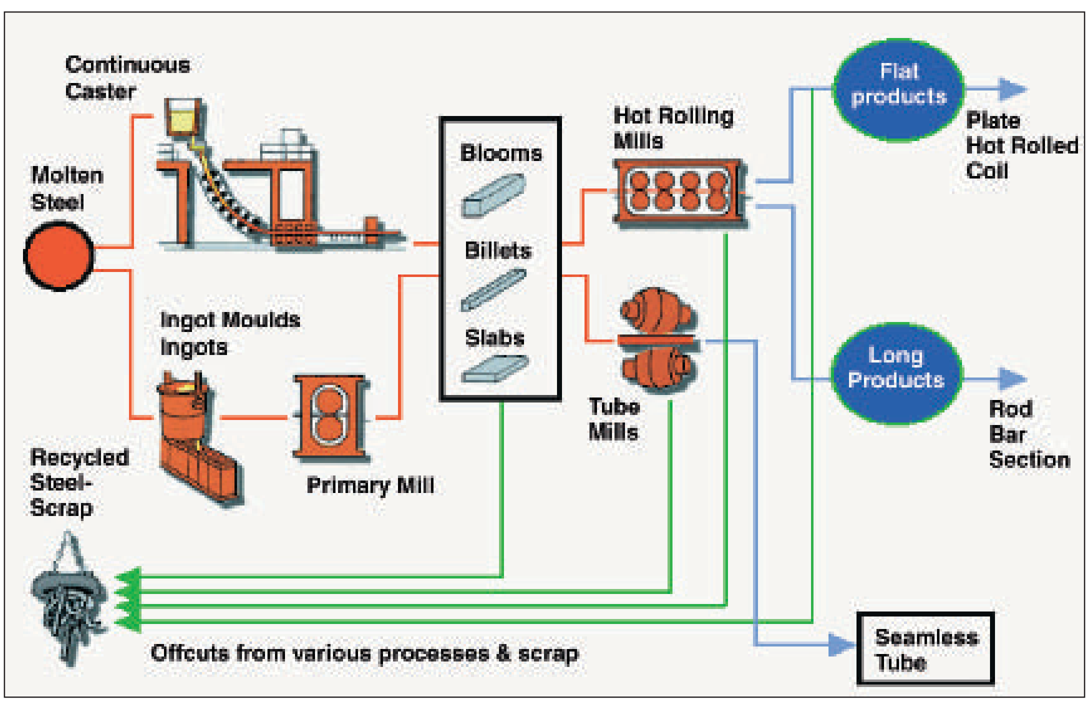


Fig. 6. The principle of continuous casting and hot rolling.