From rebar to rounds on a 4 metre radius caster

Strong market pressures in the commercial billet sectors demanded radical solutions to improve profitability. Phased and prudent plant investments, process improvements and a dedicated workforce have changed OLIFER-ACP SpA from a rebar to a speciality steels producer.

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OLIFER-ACP SpA and STS SpA

Prior to 1997, OLIFER-ACP SpA, a steel melting shop located in Cividate al Piano on the outskirts of Milan (see Figure 1), produced approximately 40t/hr of commercial quality steel exclusively for hot rolling into reinforcing bars and commercial sections from 120mm square billets, produced on an unsophisticated 3-strand CONCAST caster of 4m radius with single casts only. The billet length from the caster was 4m maximum, delivered to a basic pusher-type collecting bed. Beyond 4m, the billets were bent to the point of being unacceptable for loading into the mill reheating furnace. Also, the mechanical shears produced a poor cut edge causing entry problems into pusher type furnaces, induction coil heaters and even the rolling mill stands.

Like many plants producing only commercial grade steel it faced an increasingly difficult market with growing competition from emerging economies in the developing world. Rather than shut down, as happened with some companies, OLIFER-ACP aimed to survive by modernising its plant to produce higher grade steels, but with careful and selective capital spending over a phased programme. This critical modernisation in order to survive was carefully budgeted and paid for mainly by savings on maintenance.

OLIFER-ACP SpA adopted a blend of new technology and economic solutions, coupled with a great deal of steelmaking experience to assure its market share against the most aggressive competition.

After the first extremely difficult years, the results have justified consistent investments in the EAF, ladle furnace and vacuum degassing (see Figure 2), bringing this company in line with the most modern manufacturers of special steels, but spending only a fraction of the investment normally required.

Later, with encouraging results on billet quality, the professionalism of dedicated staff, and a step-by-step upgrade of production facilities, the company was drawn naturally into the high quality steel market. The final step, considered impossible on a 4m radius caster by some, was the intention to further widen the range of high quality billet production by casting round billets. Initially the probability of success was considered very small and all major suppliers were reluctant to even consider such hazardous project. A comparable caster for special steel would have at least 6–7m radius.
In the end the caster was designed and supplied by STS but the final success in such a project comes from the dedicated staff operating the plant. STS is proud to be associated with this company, enthusiastically designing and supplying tailored solutions for its needs.

MELTING SHOP AFTER MODERNISATION
The plant comprises one 55t EAF with under door de-slag facilities, one LF equipped with alloy wire feeder and automatic alloy feeding plant, and one VD station equipped with alloy wire feeder and hydrogen monitoring. To help reduce costs the plant operates during periods of lower cost electricity and uses 100% scrap as raw material.

Ingot casting facilities are available for heavy forgings up to 55t.

CASTER AFTER MODERNISATION
The machine has been almost completely replaced with new mechanical equipment, electronics and regulation management. Of the original machine only the foundation and the steel supporting structure, partially reinforced to receive the new equipment, remains.

The main mechanical changes are:
- Ladle cars
- Tundish cars
- Oscillators
- Moulds
- Secondary cooling and guides
- Withdrawing straightening units
- Solid dummy bar system
- Automatic cutting torches

Casting floor In this area there is a twin ladle car with lifting facilities (see Figure 3), weight monitoring and ladle sliding gate (see Figure 4) and submerged nozzle manipulators. The tundish is of 10t nominal capacity with automated sliding gate actuation, tundish heaters,
and tundish cars with lifting facilities and weight monitoring. The steel streams are now protected against oxidation by submerged nozzles. The system comprises fully automatic start and casting speed settings using both the tundish gates and the withdrawal speed. Figure 5 shows a typical automatic start showing slide gate actuation in red and mould level in blue. Most steels are produced as sequence casts of up to six hours (limit set by refractory life) at a rate of 60t/hr with a casting speed of 1.5–3m/min according to steel grade and billet size.

**Moulds** This is one of the most important areas in which to maximise quality and minimise costs, and STS has supplied additional equipment to produce a wider range of square billets and a range of round billets. The full range is 100, 115, 120 and 140mm squares and 100, 117 and 135mm rounds. Multi-tapered and parabolic pattern copper tubes are used which are tailored for the specific steels produced. To maximise mould utilisation and avoid premature scrapping of usable equipment, the mould tubes are continuously monitored for wear and deformation. Then, according to their evolving geometry due to normal wear, they are utilised for different steel grades. The alternative and more costly procedures would involve buying a variety of copper moulds with different tapers, each dedicated to a defined range of steel qualities. Powder lubrication is via the ladle shroud. The mould oscillation mechanism is hydraulically powered and can operate at high frequency (350) and small stroke (3–5mm) without vibration. Finally, use of specially designed foot rollers and guides allows easy and accurate setting of the foot rolls and rapid mould replacement with easy, low cost maintenance.

**Billet cooling and withdrawal** Primary and secondary water is automatically controlled, with provision for automatic spray holders in the future (see Figure 6). The guide apron assures a perfect guide and secure hold against oscillation movements. There is a double radius straightener with variable pneumatic pressure, and a solid dummy bar for easy size change. The mechanical shears have been replaced with high speed torches, followed by a walking beam turnover cooling bed for 12m long billets (which utilises some pre-existing machinery; see Figures 7 and 8). The torch cut end and excellent straightness are suitable for any type of heating process (induction or gas furnaces).

**PROCESS CONTROL**
OLIFER-ACP has adopted the most modern automation and melting shop plant management with computer programs able to collect process and reproduce efficiently all casting parameters. STS supplied the computer system supervising the caster operation. The
alloyed special steels, 90% of which go for hot forging. These include ASTM A 350 LF2, carbon steel, case hardening and tempering qualities, Cr – Ni – Mo alloyed grades, boron steels, resulphurised steels (0.025%/0.050%S), and grades with Al higher than 0.025% treated with Ca and Ti. There are no problems

STEEL QUALITIES PRODUCED
The range of grades has increased from six simple rebar and commercial structural grades to over 400 low

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Settings</th>
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<tbody>
<tr>
<td>Ladle super heat °C</td>
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<tr>
<td>Booster pump bar</td>
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<tr>
<td>Casting speed m/min</td>
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<tr>
<td>Casting super heat °C</td>
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<td>Primary water m³/hr</td>
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<tr>
<td>Lower zone m³/hr</td>
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<tr>
<td>1st straightener °C</td>
<td>1,000–1,080</td>
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<tr>
<td>Top spray nozzles</td>
<td>Full cone spraying nozzles</td>
</tr>
<tr>
<td>Lower zone nozzles</td>
<td>Full cone spraying nozzles</td>
</tr>
<tr>
<td>Mould powder type</td>
<td>Polvereling SPH 411</td>
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</table>

Table 1 Typical casting parameters
also in producing peritectic and microalloyed grades with Nb and V.

SOME EXAMPLES OF PRODUCT QUALITY CARDS

Product 1: Boron resulphurised steel
- Metallurgical route: EAF, LF for first refining, analysis calibration and aluminium and calcium treatment, vacuum degassing station, LF alloy additions by cored wire for sulphur and boron, continuous casting machine.
- Results at quality control: good equiaxed zone, no internal or external cracks, low dendrite zone, no central porosity, positive temperability test (see example in Figure 9).

Product 2: Mo Cr and Ni Cr Mo alloyed steels
- Metallurgical route: EAF, LF for first refining and analysis calibration and aluminium and calcium treatment, vacuum degassing station, alloy additions by cored wire for calcium, continuous casting machine.
- Results at quality control: good equiaxed zone, no internal or external cracks, low dendrite zone, no central porosity. Easy machining of billet having controlled sulphur (see example in Figure 10).

Product 3: High strength V Nb microalloyed steel
- Metallurgical route: EAF, LF for first refining and analysis calibration and aluminium and calcium treatment, vacuum degassing station, alloy additions by cored wire for calcium, continuous casting machine.
- Results at quality control: good equiaxed zone, no internal or external cracks, low dendrite zone, no central porosity. Good yield strength and impact test.

CONCLUSIONS
The high quality of the products in the caster is far beyond any expected performance for a plant equipped with a 4m radius machine, and has been achieved at a cost considerably below the norm. MS

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