

Micro mills for niche locations and niche applications

For some locations, building a 'traditional' 1Mt/yr EAF-based mini-mill may not be the right answer to supply a local market. Reasons could include availability of raw materials, skilled workforce or power, distribution problems or a specialised market. STS has 30 years' experience in supplying bespoke, flexible solutions to the steel industry, including the supply of micro mills. Two examples are described.

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EXAMPLE 1: ICELAND'S FIRST STEEL PLANT

Iceland's first steel plant was designed and built by STS and commissioned in August 2013. Prior to 2013, Iceland imported all its steel and exported all its scrap, incurring additional freight tariffs both ways compared to, say, mainland Europe or the USA.

Iceland has produced aluminium for many years, courtesy of its abundant and cheap renewable hydro and thermal electricity. It is quite logical, therefore, to consider using local steel scrap to produce steel anodes and cathodes badly needed by the local aluminium industry and other steel products for other industries, especially when steelmaking could make use of this cheap, locally available electricity – one of the main costs in steelmaking.

Following a difficult period to arrange financing by the owner, Geothermal Metal Recycling (GMR) – given both worldwide and local financial crises – the project was approved. STS enthusiastically embraced the idea from the start, helping design, with the customer, a very viable tailored project to produce 30kt/yr of steel initially, gradually rising to 100kt/yr, with the possibility of increasing production to 200kt/yr in a second stage of investment.

The plant, equipped with the most modern machinery, is squeezed into the smallest imaginable, yet well-organised space, to minimise initial investment. Good industrial land is extremely expensive in Iceland, so the total building area is only 81 x 46m with just two cranes running at approximately 10m in height.

Other technical challenges were to produce initially only 30kt/yr with acceptable yield and at a competitive production cost, while allowing a gradual expansion up to a more viable output of approximately 200kt/yr.

The main plant items are as follows:

Electric Arc Furnace (EAF)

An initial 15t EAF, due to crane and transformer capacity (see *Figure 1*), will be increased later to 30t. The AC ▶



Fig 1 15t EAF



ⓐ Fig 2 Single strand bloom caster

furnace has a transformer power of 12MVA+20%, which will produce a tap to tap time of 60-70 minutes. Scrap is top charged via two buckets.

We designed a most reliable, heavy-duty unit, but with rapid controls able to withstand ultra-high power electrical input supplemented by chemical energy input for rapid scrap melting, and without the need for scrap preheating. STS worked together with electronic and hydraulic specialists to assure extra-fast electrode movements and controls to reduce power and electrode consumptions without high maintenance.

It is provided with highly efficient process and electronic control, completely inhouse designed, and using market hardware components instead of expensive branded label equipment.

STS is known for including safety considerations, gathered in its years of experience, with the demands of high efficiency and reliability.

Continuous caster

The key details of the caster are as follows:

- Machine radius 8m
- Number of strands 1, with the possibility of adding another in the future (see Figure 2)
- Steel to be cast Anode and cathode steel, medium and low carbon steels
- Ladle capacity 20-25t with sliding gate system and porous plugs
- Sequencing Ladle car for two ladles

- Tundish
- Tundish car
- Machine range
- Casting equipment

3t capacity with open nozzles and provision for future nozzle changer
Semi-cantilevered, motor powered
Rounds:130-180mm, Squares/rectangular: 90-180mm
Rounds:160mm, 180mm Squares:120mm, 140mm, 150mm
Rectangular: 100x150mm, 107x122mm
Such a range is needed to cover all requested anodes and cathodes, plus billets for re-rolling
Curved, tubular, multi-tapered, 800mm long
With minimum radioactive emission, and automatic start
1-3m/min according to size
Oil by alternative proportioning pump with variable flow (future possibility of submerged casting and powder lubrication)
Hydraulically controlled

- Mould type
- Speed control
- Casting speed
- Mould lubrication
- Mould oscillator



Fig 3 Cast blooms on cooling bed

- Withdrawal straightener with various patterns optimised for each steel shape and quality
- Dummy bar system Double radius 8/15m, four pneumatically pressurised withdrawal powered rolls, for high quality product with minimum deformation
- Cutting length Solid type with overhead tilting/parking
- Cutting system 2.5-6.0m
- Cooling system Automatic oxygen/LPG, cutting torch with minimum flame flaring
- Plant supervision Hydraulic notch type elevator coupled with turnover walking beam cooling bed (see Figure 3) HMI level 1 and 2.

Auxiliaries

- One crane Charging/Melting/ Services with three hooks 35t/15t/5t
- One crane Scrap/Blooms with one hook; 10t with grab and magnet
- Heaters Vertical/horizontal for ladles; swinging for tundishes
- Water plant Supplied turnkey

- Furnace auxiliaries Oxygen/carbon lancing with door manipulator
- Instruments Steel temp, carbon, oxygen monitoring by steel samples
- Laboratory Spectrometer
- Product The product mix for electrodes and cathodes is according to sizes required by the aluminium smelters and will be supplied without further processing.

The square billets will be produced for further hot rolling and exported as, at this stage in Iceland, there is no rolling mill. A rolling mill will be installed in a future, second stage of investment.

EXAMPLE 2: 400KT/YR CRUCIBLE FURNACE STEELMAKING AND BLOOM CASTING

June 2012 saw the start-up of the first European melting shop using three induction furnaces to melt scrap and linked to a bloom caster for the production of up to 400kt/yr of high grade steels. This Spanish greenfield meltshop started production in 2012, despite the world economic crisis, when even large and modern plants have been badly affected or have even closed down. This is an encouraging example of how a small melting shop can be economically viable even in Europe by using modern technologies coupled with low pollution, low maintenance equipment.

Each furnace produces 30t with a 120-minute tap-to-tap ▶



Fig 4 35t ladle furnace



Fig 5 Cut to length blooms on cooling bed

time, so with one furnace on maintenance, two produce 30t/hr. Given European energy costs and the small furnace for this application, induction furnaces were more convenient than EAF. Other advantages are less electrical flickering, lower pollution and a smaller fume dedusting system.

The owners pioneering this unique project have more than 30 years' experience in steel melt shops and rolling mills in more than four plants using traditional EAFs with capacity of 100t and over.

STS was the first plant builder to combine induction melting in continuous casting with plants, initially of small size, in Pakistan than 20 years ago, followed by the USA and South Africa, where the combination of economics with efficiency in order to produce commercial steel quality, led to this process route.

This peculiar project is a great success, combining the owner's traditional experience in high capacity melt shops with STS's long experience in small size plant and induction melting. Key to the success of this project is the optimisation of knowhow and experience in laying out and selecting the high performance equipment best suited to continuous production, with only planned shutdown periods and minimum, mainly preventative, maintenance.

User-friendly equipment, in line with STS's company philosophy, was the ideal companion for this venture.

The main plant equipment can be summarised as follows:

Induction furnaces

- Three crucibles 30t each with 14MVA power supply
- Shredded selected scrap feeding by high efficiency automatic feeders.

Ladle refining

- Ladle furnace 35t with 6MVA transformer with on-load tap changer (see Figure 4)
- Wire feeding machine with two wires (Al, CaSi)
- Ladle car equipped with automatic connection for Ar /N₂
- Automatic storage, weighing and supply of alloys to LF.

Caster

- Machine radius: 8m
- Number of strands: Two with possibility to add another strand
- Casting speeds: 2.5-3.2m/min depending on grade and size
- Steel grades: Low, medium and high carbon for strip rolling
- Ladle capacity: 30t with sliding gate system and porous plugs
- Sequencing facility: Ladle car for two ladles with hydraulic lifting system for sequences of 5-10 30t ladles

- Weighing management: Tundish and ladle monitoring by load cells
- Tundish type: 9t capacity with open and submerged type nozzles, sliding gates, protected nozzle and rapid automatic mould level control to assure a smooth gradual cast starting fully automated and a level control assuring almost zero level fluctuation resulting in the best condition of steel for uniform powder lubrication and solid skin formation
- Tundish car: Fully cantilevered, equipped with hydraulic lifting system
- Machine range: 120-180mm square
- Current sizes: 140mm and 165mm square; 150 x 285mm and 165 x 230mm rectangular
- Mould type: Curved, tubular, multi-tapered 1,000mm long, mould stirrers
- Speed control: With minimum radioactive emission and automatic start and tundish slide gates
- Mould lubrication: By optional proportioning pump for oil with variable flow or automatic powder system
- Mould oscillator: Mechanical controlled with adjustable stroke and inverter controlled frequency
- Withdrawal straightener: Double radius 8/15m with two pneumatically pressurised withdrawal powered rolls
- Dummy bar system: Solid type with overhead tilting/parking
- Cutting length: 4-12m
- Cutting system: Automatic oxygen/LPG cutting torch with minimum flame flaring
- Cooling system: Hydraulic turnover walking beam cooling bed
- Plant Supervision: The billets/blooms production parameters are accurately monitored through STS HMI with billet quality control package where we collect and tune up the recopies for consistent product quality resulting for a perfect machine setting for each steel grade.

Figure 5 shows cut to length cast blooms on cooling bed.

Auxiliaries

An automatic water treatment plant is included with all interconnecting pipes prefabricated for fast erection, and equipped with air-to-water heat exchangers and automatic filters to recycle the water according to the highest European standards. **MS**

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