Revamping of a billet reheating furnace at TATA SSL

Changing the furnace recuperator, air blowers, burners and replacing the refractory in the heating and soaking zones has increased productivity and quality of reheated billets while reducing fuel consumption around 25% at Tata's special steel plant.

BY V B MAHENDRA*

TATA SSL Ltd is a specialised steel plant producing high to low carbon steel, stainless steel and special alloy wire rod. It is one of the plants of Tata Iron & Steel Co, the largest private steel company in India.

At Tata's Tarapore works, in Maharashtra state, the nominal 45t/h billet reheating furnace was modernised by Encon Thermal Engineers (P) Ltd (ENCON).

The work had a modest budget of US$150 000, but the result has been a saving of US$100 000 per month.

Prior to revamping, the furnace had a high fuel consumption and quality suffered from the development of very fine cracks on the final drawn bead wire.

Investigations lead to the conclusion that the billet reheating furnace required major modifications to improve:

- Productivity;
- Fuel consumption;
- Homogeneity in the temperature profile of heated billets;
- Soaking of billets;
- Decarburisation; and
- Break downs on the mill side due to poor heating quality of billets.

Productivity: Although the rated capacity of furnace was 45t/h, production had not exceeded 35-36t/h.

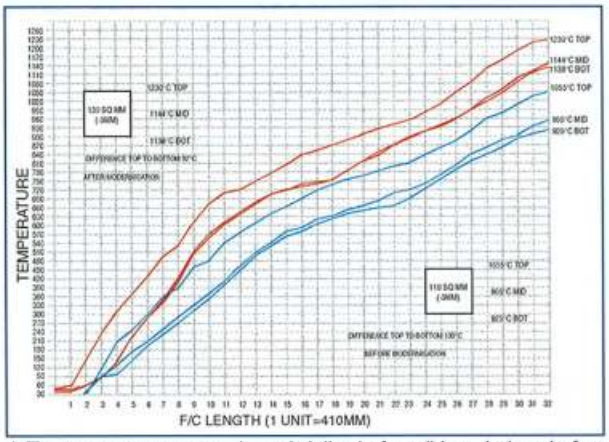
Fuel consumption: Fuel consumption averaged 47 litres per tonne of steel heated which was abnormally high by any standards.

Quality of heated billets: Heated Billets showed temperature variations from top to bottom and from tail to toe (**Fig 1**). This variation resulted in very fine cracks on the sections finally drawn when making bead wire – thus resulting in rejections and high losses at the final stage, when all the process cost had been incurred. In addition, the reliability of the passed products also becomes questionable.

Improper soaking: Improper soaking of the billets resulted in:

- Increase of frequency of break downs;
- More energy (power) to roll the same size of billet;
- Down time frequency percentage was high for maintenance purposes.

To combat these shortcomings, material was kept in the furnace for a longer time than required simply to heat to the rolling temperature, resulting in higher scale losses and in decarburisation.



1 Temperature variation through billet before (blue plot) and after (red plot) furnace modernisation

OPTIONS WITH TATA SSL

In the given circumstances, the options left for Tata SSL were:

- A new walking furnace;
- Major modernisation on the existing furnace.

Tata SSL opted for the major modernisation programme.

The total revamping was carried out in two phase of 3 days and 15 days respectively. The first phase of 3 days included changing the blower, recuperator and modification of air ducting. Work on the burner side walls – redesigning as well as relining of water cooled skids etc – was carried out by refractory experts under Encon's supervision.

BLOWER

Once the desired firing rate was ascertained and the total heat load had been calculated it was concluded that the existing air blowers were not sufficiently large. The required rate of connected load was 27 202m³/h and the running load was 22 914m³/h but the capacity of the blowers was only 18 060m³/h.

Apart from this, the pressure of the blower at the inlet of the recuperator was 730mm wc. Considering the pressure drop loss in:

– the recuperator =	180mm
– the pipe line =	140mm
– required at the burner tip =	600mm
Total pressure drop	**920mm**

The blower pressure fell short by 190mm. This was causing incomplete and inefficient combustion.

A new blower capable of providing 24 000m³/h of air at 1000mm wc was provided which resulted in a significant improvement in the combustion quality.

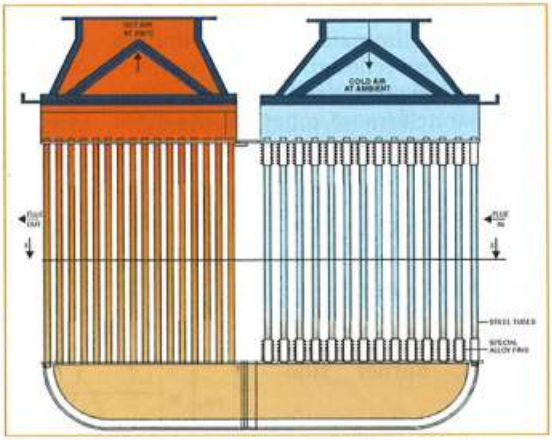
RECUPERATOR

The following observations were made on the existing recuperator:

- Temperature of flue gas at inlet 699°C
- Temperature of flue gas at outlet 293°C
- Temperature of air from blower entering the recuperator 30°C
- Temperature of preheated combustion air 187°C.

This was a very low recovery by any standard. For the efficient running of the furnace, it becomes very important to have a good and efficient recuperator

2 Metal fin recuperator offers a longer life and greater heat transfer



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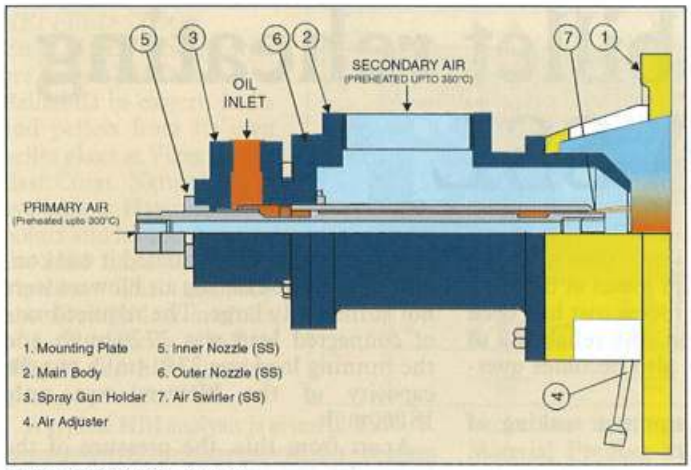


3 The ENCON film burner

CHARACTERISTICS OF MODIFIED FURNACE

Furnace type	Pusher type Billet Reheating Furnace
Capacity	45t/h (70% for Stainless Steel Rolling)
Charge Material	High Carbon Steel up to 0.85%C, Low Carbon and Stainless Steel
Billet Size	130 x 130 x 9000mm
Billet discharge temp	1150°C
Furnace temp	1250°C
Charging	End Charging
Discharging	Side discharging through ejector
Fuel	Furnace Oil/LSHS/HPS/Light Industrial Oil
Air preheat temp	Combustion air - 300°C
No. of furnace zones	3 with bottom firing in Heating & Preheating zone
No. of burners	9 Soaking zone end wall top 2 Nos. Soaking zone side wall top 9 Nos. Heating zone end wall top 5 Nos. Bottom firing zone Total heat load 2030 litre/h
Blower	24 000Nm³/h at 1000mm wc x 110KW motor Rated capacity : 24 000Nm³/h Pressure : 1000mm wc Motor : 150HP
Recuperator	Metallic with special alloy fins to withstand flue gases at 950°C Surface area : 220m² Temperature of preheated air : 300°C

to give hot air at 250-300°C with minimum pressure drop on the combustion air and the flue gases side.

The life of the recuperator at such an operating temperature of 700°C becomes significant.

ENCON have pioneered Metallic Recuperators made of special alloy fins for such applications (**Fig 2**).

Due to increased wall thickness and material, there is no distortion in the recuperator. Such recuperators are still in use even after 7-8 years with minimum maintenance and are operating at the same level of efficiency. Proper design ensures that the pressure drop is in the range of 100mm on the air side and 10-15mm on the flue side. The preheat temperature of the combustion air is around 300°C.

AIR PIPE

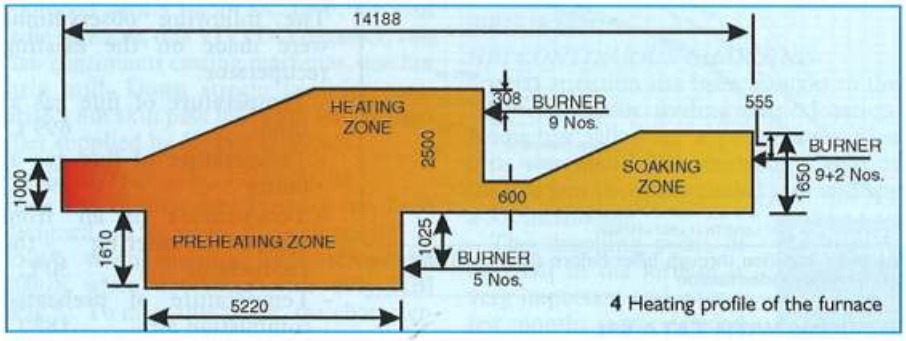
All unnecessary bends in the air feed pipes were eliminated. The distribution headers were redesigned to be compatible with the air delivery requirement of the separate furnace zones. All the down line distribution Headers were rematched to avoid air starvation to individual burners.

SECOND PHASE

The second phase included changing the burners, burner side walls, refractory lining in the soaking zone, lining of water cooled skids etc. The work was completed during a 15 day shut down.

IIP-ENCON BURNERS

In IIP-ENCON (film) burners, oil is sprayed through the middle of the spray gun nozzle in the shape of a thin cylindrical film. Atomising air is passed through the centre of the burner through a swirler. Secondary air is passed from the outer tube. Thus the oil film is sandwiched with air from the inner and outer side. Due to the swirling action of the air, the oil spray is atomised giving highly effective combustion. With this process, excess air requirements are reduced to 5%-10% to complete combustion. The atomising air as well as the primary air are fed with just one blower at the same pressure thus eliminating the need for a separate atomising blower (**Fig 3**).



4 Heating profile of the furnace

5 Fuel consumption fell 26% and power 8% on average following furnace modernisation

The furnace had been using conventional burners divided into three zones with a connected heat load of 1785l/h.

The heat load was increased to 2030l. The burner firing configuring was unchanged with firing in the soaking zone 25% less than in the heating zone. Firing in the preheating zone was reduced, and the hot gas travel was divided such that billets in the preheating zone were heated by hot gases travelling from the Soaking and Heating zones (**Fig 4**).

REFRACTORY

The refractory lining of the burner was re-designed to enable easy removal of Burner Blocks without disturbing the burner walls. This was accomplished by providing arches on each burner block. Refractory selection took into consideration the temperature levels in each zone. The furnace roof in the heating and soaking zones were replaced with new refractory lining.

WATER COOLED SKIDS

The water cooled skids in the furnace were relined with high density refractory lining backed up with ceramic fibre. This work employed refractory mixers, proper moulds and packing materials.

ACHIEVEMENTS

The final results were:

- Increase in production of 16-25% from 36t/h to 42-45t/h;
- Fuel consumption reduced 23-30% from 47l/t to 33-36l/t (**Fig 5**);
- Electrical power consumptions reduced by about 8% (**Fig 5**);
- Temperature difference from top to bottom of billets reduced from 130°C to 90°C;
- Temperature difference from tail end to front end of the billets reduced from 90°C to 60°C;
- Reduced break downs due to better quality of heated billets. □