Improvements in refractory practices in reheating furnaces in Tisco

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The reheating furnaces are designed to reheat the semi-finished steel products such as ingots, blooms, billets, slabs, etc., to the desired temperature suitable for the metallurgical operation of mechanical working i. e., rolling, forging, etc.

Improved refractories practices in the construction and maintenance of reheating furnaces has resulted in better furnace availability, improved thermal efficiency and higher productivity with lower cost.

The paper deals with the various improvements made and the results achieved in authors' plant during the last few years.

Introduction

The rated capacity of the authors' plant is two million tonnes of ingot all of which are processed through the primary and finishing mills. Various products manufactured in these mills are—blooms, slabs, billets, rails, heavy and light structurals, wheels, tyres, axles, plates, sheets, merchant mill products, etc. In spite of the fact that the plant is more than 70 years old, the finished products produced are over 100% capacity for the past four years.

There are two primary mills where the ingots are processed into blooms. Soaking pits in both the mills are essentially of AMCO design with ceramic recuperators although in one of the mills a few pits of OFU design are in operation. The various finishing mills, include Merchant Mills, M. & L.S Mills, Strip Mill, Sheet Mills, Plate Mill and Wheel Tyre & Axle Plant. Table I gives the lining pattern, capacity and other details of various furnaces. Most of the furnaces in the finishing mills are of continuous pusher type although in some mills batch type furnaces are also in operation.

Some of the furnaces are as old as the plant itself whereas some were added in 1958 when the capacity of the steel plant was doubled to two million tonnes. All the ingot steel made is processed through the finishing mills and as such, it is imperative that maximum availability of furnaces are ensured for achieving the production targets.

TABLE—I Details of reheating furnaces

Location	Type of furnaces	No. of furnaces	Capacity of each	Quality of refractories Sidewalls	Quality of refractories Soaking zone	Operating temperature
Rail & Strl. Mills	Three zone Continuous pusher type	2	40T/hr, with cold charging	I. S. 8 quality	Chrome magnesite & high alumina	1280°C
M. & L. S. Mills	—do—	2	60T/hr.	—do—	Chrome Mag. & fusion cast	—do—
Merchant Mill No. 2	Two zone continuous pusher type	1	80T/hr.	—do—	Chrome Magnesite	—do—
Merchant Mill No. 1	Single zone continuous pusher type	1	30T/hr.	—do—	Chrome Magnesite	—do—
Strip Mills	—do—	1	45T/hr.	—do—	Chrome Magnesite	—do—
Sheet Mills	Continuous chain conveyor type	3	—	—do—	I. S. quality	—do—
Wheel tyre & axle plant	Batch type	3	—	—do—	Chrome Magnesite	—do—
—do—	Batch type rotary hearth	1	—	—do—	I. S. 8 quality	—do—
Plate Mills	Batch type Morgan	3	8T/hr.	—do—	Chrome Magnesite	1300°C
—do—	Batch type Amco	2	8T/hr.	—do—	—do—	

This needs that the furnace linings are made with reasonable predictability with minimum down time for repairs. With this in view various improvements were made in the design, construction, application and maintenance techniques. Further, various modifications to the lining were undertaken to combat the energy crisis and to improve the thermal efficiency of the furnaces. This paper deals with the various improvements in refractory practices carried out in the authors' plant.

Design modifications

In soaking pits the lintel tiles over the port openings used to sag and give way due to the weight of the brickwork of the short wall. A relieving arch was made just over the lintel tiles to reduce the load coming over the tiles. This, incidentally, also enabled to carry out repairs to tne port openings without disturbing the top brickwork

In the original design, the bridge wall of the soaking pits were given a curvature inside the pit which resulted in the movement of bridge wall towards recuperator side due to the pressure of slag build up at bottom. This resulted in the opening out of joints of brickwork and breakout of slag took place into the recuperator. The bridge walls have been modified now and are in straight line with bonded construction. $4\frac{1}{2}$ thick monolithic ramming mass is also provided in the bridge wall between the pit and recuperator to safeguard against slag penetration. The bottom slope of the port opening also has been made more steeper to prevent possible overflow of slag into the recuperator. Further, to give additional strength to the bridge wall, an inverted arch is provided in the recuperator side (Fig. 1).

The top layer of soaking pit bottoms were made of chrome magnesite bricks in the past which used to get crushed during operation. This has now been replaced by special quality fireclay tiles of 18″ x 9″ x $4\frac{1}{2}$″ with 3″ thick chrome plastic on the top. The modified arrangement has given encouraging results.

In the soaking pits the long walls used to bulge out on top and required premature shut down of pits. To overcome this suitable anchoring arrangements have been designed and tried on some pits (Fig. 2). This is giving good results and it is proposed to extend the same to all the pits as and when they are taken down for major repairs. Suitable anchoring arrangements have also been provided in the walls of various other reheating furnaces.

In medium & light structural mills the apron plate at the charging end of the roof used to get buckled due to overheating and the leakages through the gaps so formed caused further damage. The roof was extended beyond the charging side, thus eliminating the apron plate. In order to improve the thermal efficiency of recuperators in soaking pits the number of

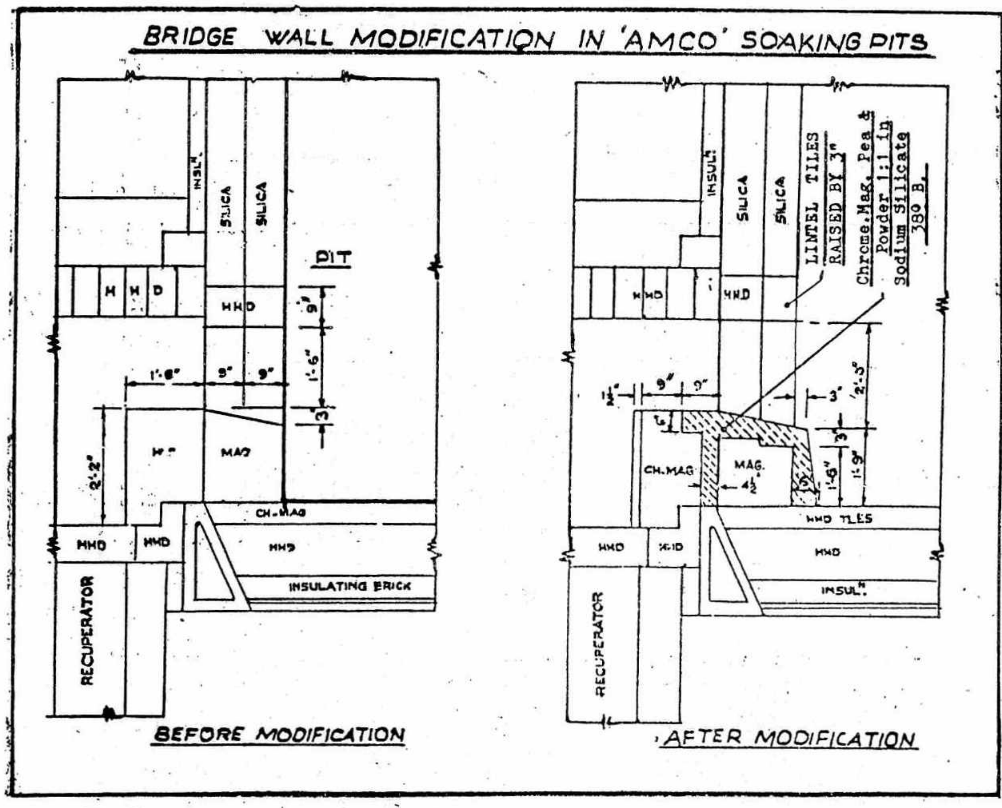
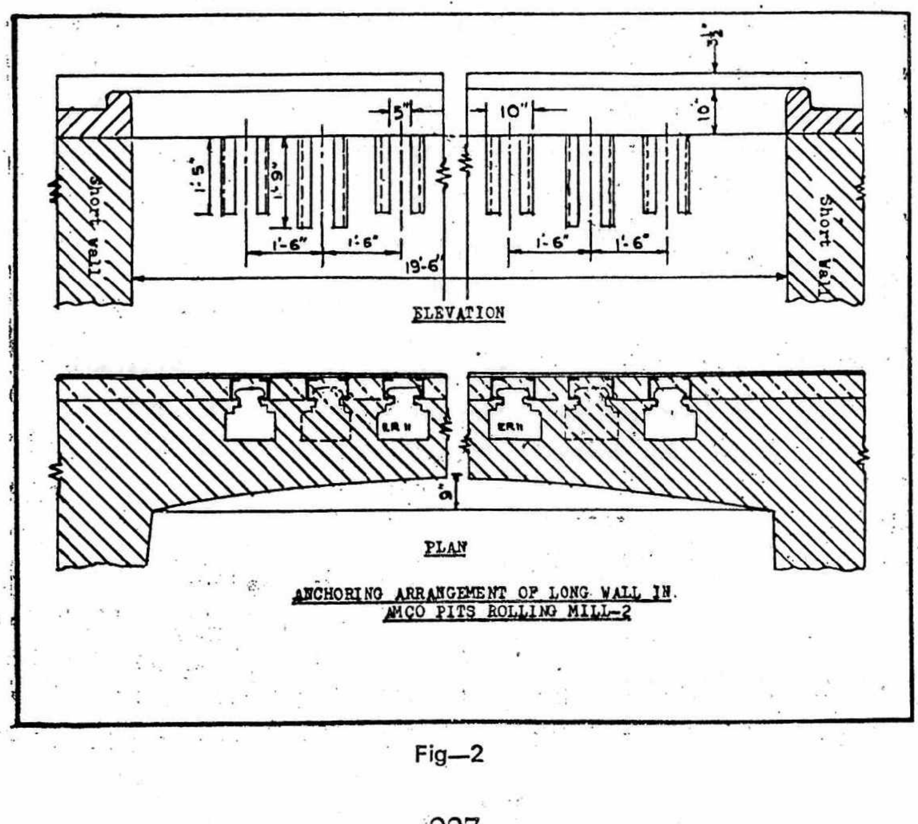

BRIDGE WALL MODIFICATION IN 'AMCO' SOAKING PITS
INSL"
SILICA
SILICA
PIT
H H D
HHD
9"
1'-6"
3"
1'-6"
9"
9"
2'-2"
MAG
CH-MAG
HHD
HHD
HHD
INSULATING BRICK
RECUPERATOR
BEFORE MODIFICATION
INSUL"
SILICA
SILICA
LINTEL TILES
RAISED BY 3"
Chrome.Mag. Pea &
Powder 1:1 in
Sodium Silicate
380 B.
HHD
HHD
9"
9"
3"
2'-3"
1'-6"
1'-9"
CH.MAG
MAG.
HHD TILES
HHD
HHD
INSUL"
RECUPERATOR
AFTER MODIFICATION

Fig.—1


3½"
5"
10"
10"
1'-5"
1'-9"
Short wall
Short wall
1'-6"
1'-6"
1'-6"
1'-6"
19'-6"
ELEVATION
ERH
ERH
9"
PLAN
ANCHORING ARRANGEMENT OF LONG WALL IN
AMCO PITS ROLLING MILL-2

Fig—2

shelves is being increased from 6 to 7. This modification has been carried out in 4 soaking pits and these changes will be done on other recuperators as and when they are due for rebuild.

Ludwig annealing furnace cover in Sheet Mills was originally of suspended design with tiles. The tiles were supported only at four corners. These tiles were cracking and falling down during operation. To overcome this problem, the lining was changed to hot face insulation suspended from the top (Fig. 3). In the same furnace, stainless steel buffle holders were getting burnt. These were replaced with specially grooved bricks (Fig. 4).

Application and maintenance technique

High alumina refractory plastics developed and manufactured in the plant were applied to the spalled refractory linings especially in the roof and side walls. This has reduced the extent of replacement of costly refractory bricks and the down time required for furnaces repairs.

Gunniting, another versatile maintenance technique, is done in hot and cold conditions to extend the life of reheating furnaces. This is also done in soaking pit walls where damages occur in localised areas. This technique helps to carry out the repairs to the furnaces from outside when it is in hot condition.

Improved quality of heat setting mortar has been developed for brick laying. This improves the strength and stability of construction and has also reduced the leakages through the brickwork. Special mortar has also been developed for recuperator laying.

Salvaged old bricks are extensively used in less vulnerable areas to reduce the cost of maintenance.

Improved insulation

In the recent past, special efforts have been made to reduce the heat losses through the walls of reheating furnaces and soaking pits. Better insulation was provided which has resulted in a drop of cold face temperature from about 170°C to 60 / 70°C. A typical sketch of such modification is shown in Fig. 5. This has greatly helped to reduce the fuel rate of various reheating furnaces in the primary and finishing mills as is evident in Table II given below :

TABLE—II : Fuel rate from ingot to finished steel.

(in 10^6 K. Cal/t)

1973—74	...	2.77
1974—75	...	2.40
1975—76	...	2.31
1976—72	...	2.22

Better quality refractories

Fusion cast high alumina blocks have been used to replace conventional refractories in the soaking zone hearth of strip mill and medium & light struc-

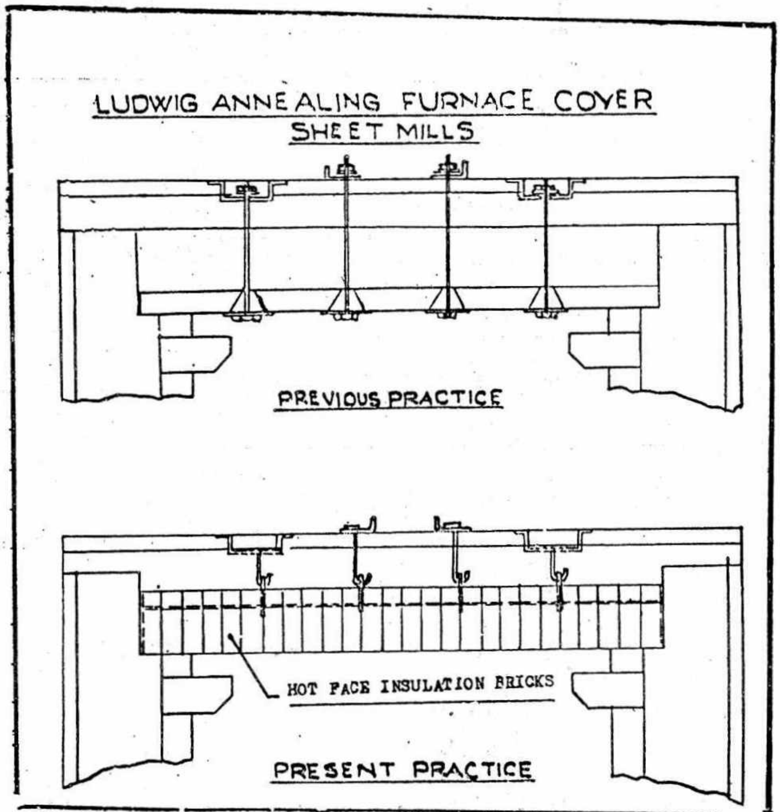


Fig. 3 Modification of furnanace cover by replacing refractory tiles with hot face insulation.

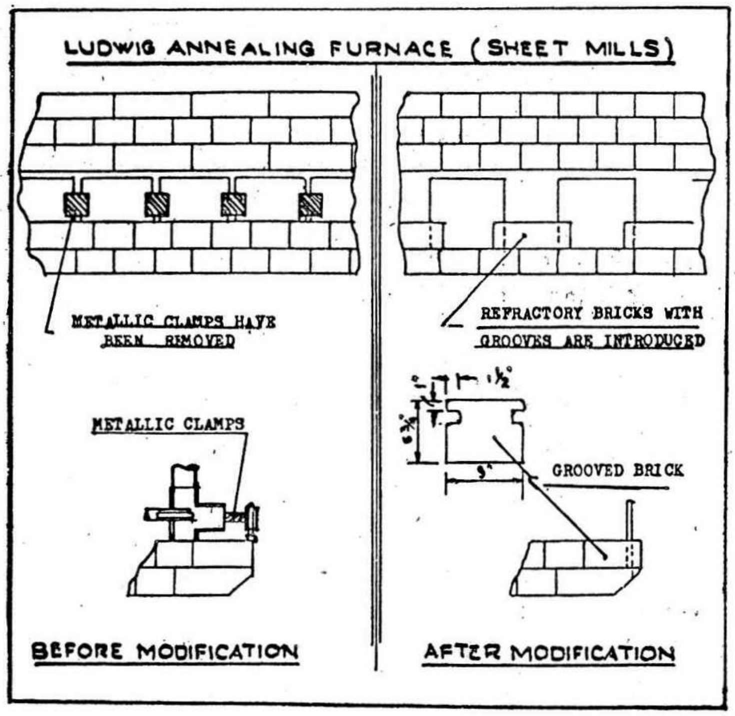


Fig. 4 Replacement of stainless steel holder by grooved brick.

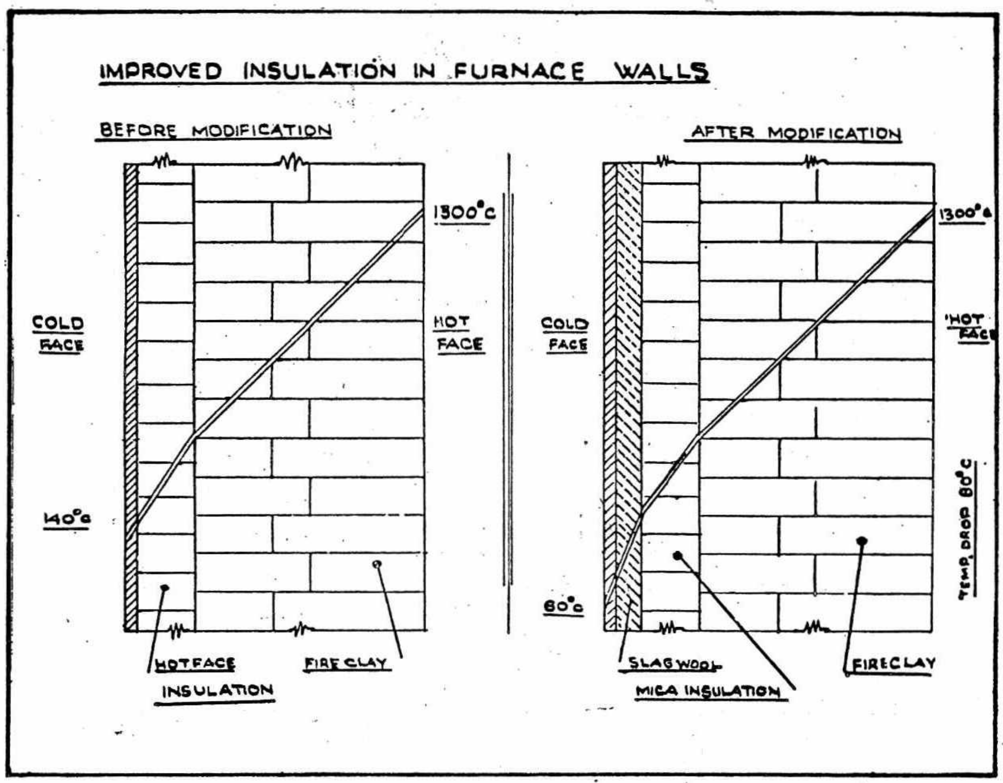


Fig. 5 Modified wall insulation.

tural mill furnaces. This has resulted in the elimination of bottom build up and has also increased the campaign life.

88% alumina bricks have been used in the hearth of rail and structural mill furnace and the performance is satisfactory.

In AMCO pit covers, 45% alumina bricks have replaced conventional high heat duty bricks which is giving about 2 to 3 years life. In one of the primary mills, the covers were originally of hot face insulating bricks. As the life obtained was very poor, the covers have been modified by using high alumina bricks.

54% alumina bricks used as skew-back bricks of Merchant Mill No. I were not giving satisfactory service as a result of spalling. In its place 45% alumina bricks with proper expansion allowance are giving satisfactory service.

Rationalisation of shapes

Since the furnaces in Tisco have come up at different times from suppliers quite a number of special refractory shapes were involved. It became very difficult to keep stock of each and every item. With a view to reduce the number of shapes, a comprehensive study was undertaken which has resulted in an elimination of 397 shapes out of a total of 559 shapes studied. Some of the bigger shapes like burner blocks, etc., are either precast or cast in situ. For precasting a small plant has been set up with all facilities required.

Conclusion

Improvement in refractory practices has been achieved by design modifications in selected areas, by adopting better and faster maintenance techniques, by better insulation and judicious selection of quality refractories to suit the service conditions. Campaign life of furnaces was extended with less down time for scheduled repairs and maintenance thereby giving better furnace availability to enable the plant to produce more than the rated capacity. The total refractory maintenance cost also has come down as a result of selective repairs and by adoption of better maintenance techniques during the past three years. Thermal efficiency of the furnace has also gone up by use of improved insulation of furnace sidewalls and roof.

Acknowledgement

The authors are thankful to the management of Tata Iron & Steel Company for giving permission to present this paper at the seminar on 'Reheating and Heat Treatment Furnaces'.