BURN DOWN, EXCAVATION AND RELINING ENS12 2013/2014

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ABSTRACT

This report describes the condition of the ErametSauda High Carbon furnace 12 immediately prior to relining, observations during the excavation of the furnace and the relining of the furnace in 2013. This furnace was last relined in 2002 with 50 cms high carbon blocks / freeze lining concept. Shortly after start-up lifting of the lining was observed and continued in the following years until relining in 2013. During this period the lining condition was continuously monitored using thermocouples in the lining and periodic heat flux measurement by measuring the shell cooling water flow and temperature rise. Periodic injection of grouting paste was made in an attempt to keep good contact between the hot face and the cooled shell. During the dig out the penetration of slag between the blocks which resulted in the lifting and tilting of lining was confirmed. In additionб samples from the burden and banks around the sidewalls were taken in order to increase process knowledge. The new lining is based on the large block / freeze lining concept to avoid penetration of liquids in the joints. Experience to date shows that this concept has been successful.

1 INTRODUCTION

Furnace 12 has operated from 1972 until 2004 with two tapholes levels. The reason for this design was to reduce metal losses to slag, reduce specific energy consumption, reduce coke consumption, increase pre-reduction and better control the liquid supply to refining operation. Other large HCFeMn furnaces also operate / have operated successfully with two taphole levels, in particular Beauharnois and Samancor M12. Furnace S12 was relined in 2002 using the new (for Eramet) freeze lining concept. The freeze lining concept is based on a high conductive lining with water cooling on the shell in order to freeze a protective layer of slag/mix on the inner face of the lining to protect it from corrosion. The sidewall lining was constructed of small blocks from by European supplier to avoid cracking of large blocks, furnace shell was water-spray-cooled and the metal and slag tapholes were cooled with water-cooled copper blocks inserted into the lining. Difficult furnace operation, many stops to fix water leaks, an unstable freeze lining, lining lifting problems and high lining temperatures began soon after the reline in 2002. A large water leak occurred in the lining between the slag hole copper cooling block and slag hole 1 in March 2003 and lifting began shortly afterwards. High lining temperatures and slag tapping difficulties from March to July resulted in single level front tapping which was implemented only on 15.07.2004 in an attempt to lower the liquid levels in the furnace to reduce the thermal stress and buoyancy effect on the sidewalls. A decrease in the lining temperature was achieved after one tap-hole level was implemented.

An advantage of bi-level practice is the lower metallic losses to the slag, because metal is only tapped through the lower taphole. Little if any slag skimming is required. This saves time and reduces the metallic losses to the slag, particularly during the slag raking operation. In the present work, metallic loss is defined as the difference between theoretical daily production based on Mn balance and the actual daily production of casted metal. For the studied slag pool operation period, the metallic losses were of about 2 wt.%, whereas those found for the single level operation period are around 7 wt.%, which confirms the above-mentioned advantage.

Figure 1 below shows side wall temperatures before and after introducing one tap-hole level.

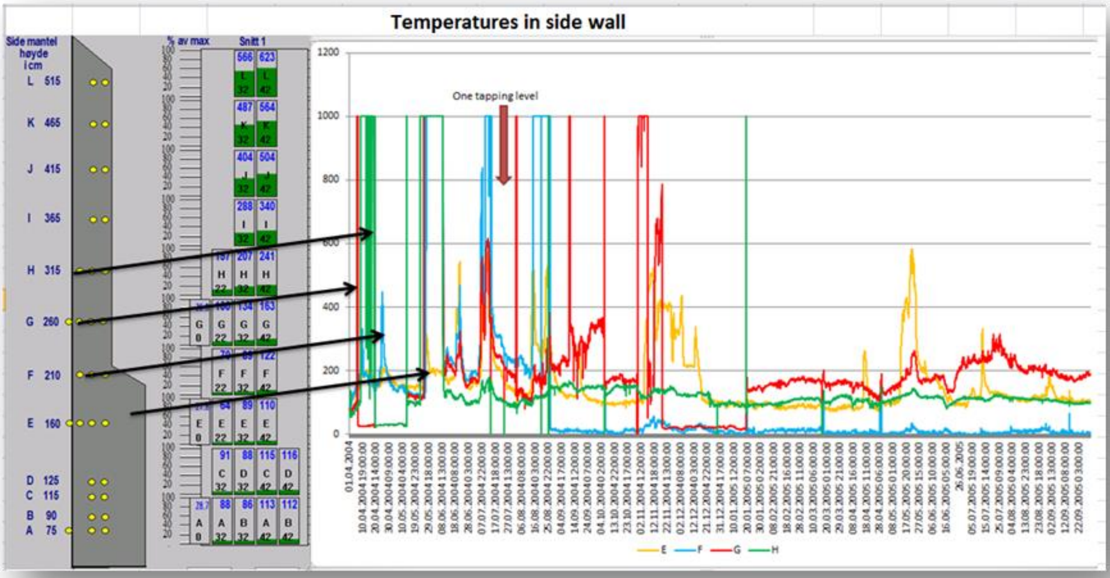

Figure 1: Temperatures in side wall ENS12 before and after bi-level

2 PREPARATIONS BEFORE EXCAVATION

2.1 Shutdown

Two days before the planned shut down the following changes were made:

- The Comilog ore was replaced with sinter. The reason for this was to avoid discharge of Mercury to the atmosphere while the furnace was disconnected from the gas cleaning equipment during burning down. In addition, Sinter is a less reactive material than highly oxidized ore giving less thermal strain on furnace equipment.
- The needle closing gates on the furnace charging tubes attached to the furnace bins were tested. Reason for this was that after the stop we wanted a plug left in the furnace bins in order to avoid gas and steam in the top floor.
- The desired liquid paste level in electrodes was set to 3.5 – 4 meters.
- In order to reduce electrode length before stop, desired holder position was changed from 60 to 40cms.
- The resistance set point was reduced from 0.60mohm to 0.57 mohm.
- The level in furnace bins was reduced from 50% to 30% and further down to 40 and 30% throughout the day. A low level was required in period before stop in order to be able to drop down the last remains of raw materials in the furnace after stop.

2.2 Burn Down

Visual inspection of the level in all furnace siloes was taken before burn down started.

Tapping was started and load was reduced to 20 MW. The needle gates to furnace siloes were closed. Shortly after tapping gas, fumes and flames were observed in the top floor. The furnace was stopped for control below roof.

During the following hours there were several stops and controls below cover in order to see the effect of the burn down.

25th of November: Final stop on the furnace.

Control below cover after stop showed very good effect of burn down. Mix burden was approximately 2-3 meters below mix chutes. Figure 2-5 shows the electrodes and charge during the burn down process.

Figure 2: Area around A electrode shortly after burn down started

Figure 3: Area around A electrode during burn down

Figure 4: A el during burn down

Figure 5: Area around A electrode after burn down

3 EXCAVATION

3.1 Cutting Of Electrodes

Before excavation started the electrodes were cut below clamps. The tool used for cutting was a diamond impregnated wire. Fig. 7 shows two of the electrodes after cutting.

Figure 7: Furnace cover removed and electrodes after cutting

Figure 8 shows the lifting of the side-wall lining blocks during removal of the furnace cover.

Figure 8: Lifting of carbon blocks in side wall

3.2 Excavation

Figure 9 and 10 shows the opening made in the furnace shell between the two metal tapholes to remove the old lining and charge materials. There seemed to be no lifting in the lower parts of the furnace, but in the upper side walls the blocks were tilted and lifted. The carbon blocks themselves are not worn or damaged

Fig 9: Area outside B el. Lifted blocks

Fig 10: Lifted blocks in area left of tap hole A side

3.3 Observations inside furnace

During excavation we discovered several banks in areas between electrodes. Samples from burden were taken with assistance of people from Eramet Research.A discussion of the analysis of the burden is beyond this report.

Fig 11: Bank in area left of tap hole A side

4 RELINING

Relining of furnace started up on the 4th of January and was completed on the 24th of January. A new supplier had been responsible for the lining materials. The quality of materials was considered as very good. The lining is designed to have the possibility to operate the furnace as a bi-level furnace in the future.

5 RAMP UP ENS12

The furnace was started up in star connection on the 10th of February at 14:20. Starting up was successful with immediate contact on all electrodes. Addition of mix was done regularly during ramp up in order to avoid high temperatures/radiant heat. Fig.15 shows electrodes and mix burden during ramp up.

Fig 13: Mix burden during ramp up

Ramp up went according to plan as shown in Table 1 below until Sunday, the 16th of February.

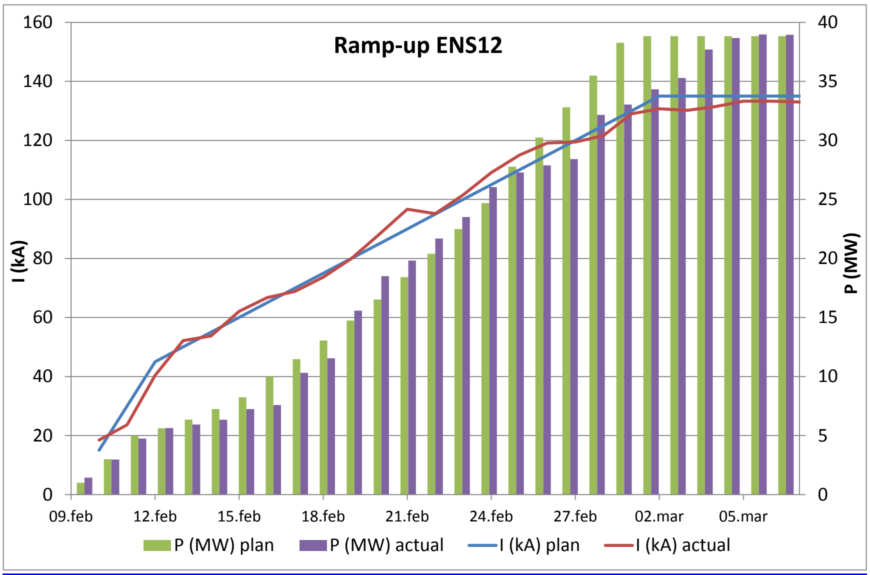

Table 1: Run up plan ENS 12

Then a breakage occurred on A electrode approximately 1.5 meters below clamps. The electrode was slipped 1.5 meters. This was followed the day after by a new breakage on B el.

Fig 14: Electrode breakage A and B el

Recovery finished and the operating load reached on the 13th of February.

6 CONCLUSIONS

Excavation has showed that an unstable freeze lining and water leakages can contribute to slag penetration in horizontal joints and lifting of the side wall lining. Hypothesis for lifting are stops and water leakages that lead to an unstable freeze lining. When the furnace was warmed up after stops, the freeze lining attached to the hot face of the lining expanded more rapidly than the carbon blocks, lifting the hot face and thereby opened gaps between blocks. To reduce slag penetration in the new lining we used large carbon blocks with few horizontal joints. No lifting has been observed since start up in February 2014.

In addition, we have thermocouples placed in the side wall and bottom in order to follow up temperature development. We have also developed a model in order to follow freeze lining thickness and lining lifetime.