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In conjuction with Ankiros / Annofer / Turkcast fairs

«65T Çekirdeksiz İndüksiyon Ocağında Ferro Krom Ergitmesi İçin Refrakter Çözümleri»

«Refractory Solutions For The Melting Of Ferro- Chromium in High Powered 65T Coreless Induction Furnaces»

Dirk Holland*, Fangxin Ding*, Fırat Maral*, Robin Chakrabarti**
(*Calderys, **ABP Induction)

4.Oturum: Döküm Teknolojileri Kalıp

4th Session: Moulding Technologies

Oturum Başkanı/Session Chairman: Bülent Şirin (Componenta Dökümcülük Tic. San. A.Ş.)

REFRACTORY SOLUTIONS FOR THE MELTING OF STEEL IN HIGH POWERED 65 t CORELESS INDUCTION FURNACES

Dirk HOLLAND*, Fangxin DING**, Firat MARAL***, Robin CHAKRABARTI****

* Calderys Deutschland GmbH, Neuwied, Germany;

** Calderys China, Shanghai, China

*** Calderys Refrakter San ve Tic. A.S., Ankara, Turkey

**** ABP Induction Systems GmbH, Dortmund, Germany

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Introduction

High Powered Coreless Induction Furnaces for Steel

- Based on the example of one of the biggest and most powerfull inductive melting shops in the world, recently erected at TISCO in China by ABP Induction Systems in close cooperation with Calderys, the best lining technology for Coreless Induction Furnaces used for the melting of steel alloys will be explained.

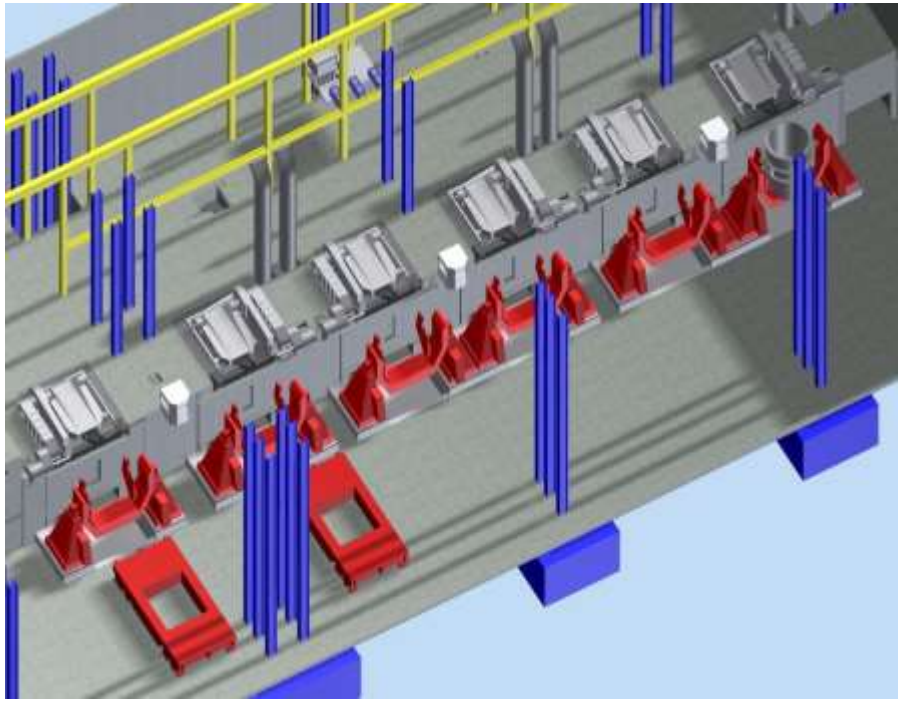
Refractory Solutions for Steel Applications

- The refractory selection, the lining design, the installation and finally the sintering are key for the success of this type of high powered Coreless Induction Furnaces.

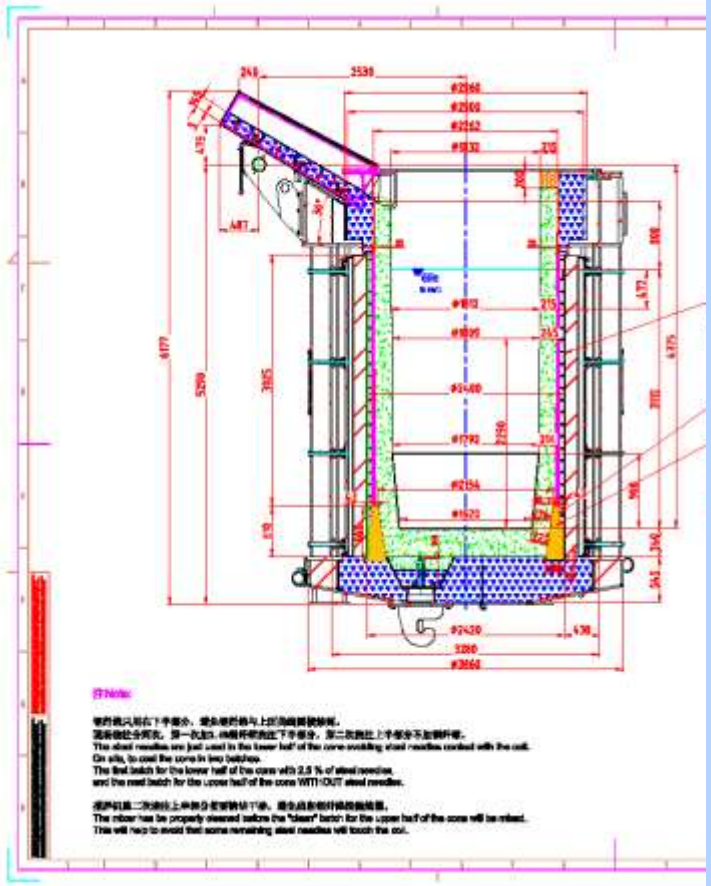
TISCO in Taiyuan / China – Biggest Stainless Steel Plant in the World

- **Target:**
  - Erection of a new inductive melting shop at TISCO « North » in 2013
  - Melting of minimum 150 t of FeCr per hour
  - Operation 24 h / day
- **Equipment**
  - 6 x 65 t MF Coreless Induction Furnaces
  - 3 x 42 MW power units
  - 6 x charging cars
- **Original Refractory Demands**
  - Gain lininglife of at least 70 heats before pushout
  - Tapping temperature at 1670 °C
  - Resist etremely high melting rates of ca. 50 t / h by furnace
  - Respect the defined wall thickness to reach the guaranteed melting rate
  - Design a coilscreed which allows a smoth pushout of the lining

Layout of TISCO „North“ – 6 x 65 t Coreless Induction Furnaces

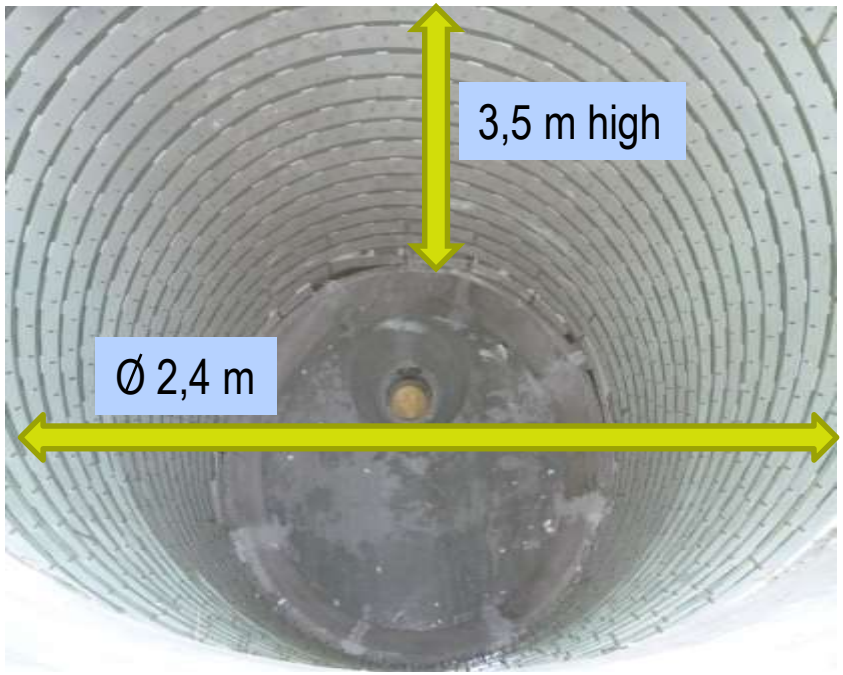


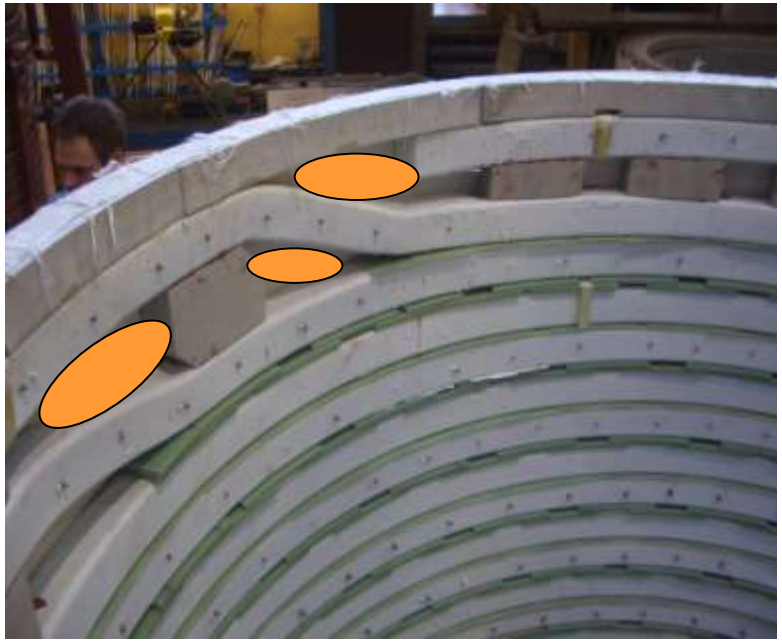
Design of the 65 T Coreless Induction Furnace



- Coil diameter ca. 2,4 m
- Coil height ca. 3,5 m
- Height of furnace body ca. 5,3 m
- Diameter of furnace body ca. 3,8 m
- **Wall thickness neutral lining ca. 215 mm**
- Bottom thickness neutral lining ca. 340 mm
- Cone height ca. 900 mm
- Coil screed thickness:
  - top ca. 25 mm, bottom ca. 43 mm
- Push out device available
- Length of spout ca. 2 m
- Material demand front lining:
  - ca. 22 t of DVM and
  - 1 t of plastic material for capping
- Material demand for coil screed ca. 4,3 t of self-flowing castable
- Material demand Mica: 33 m²

Coil & Coilscreed Design of 65 t ABP Coreless Induction Furance

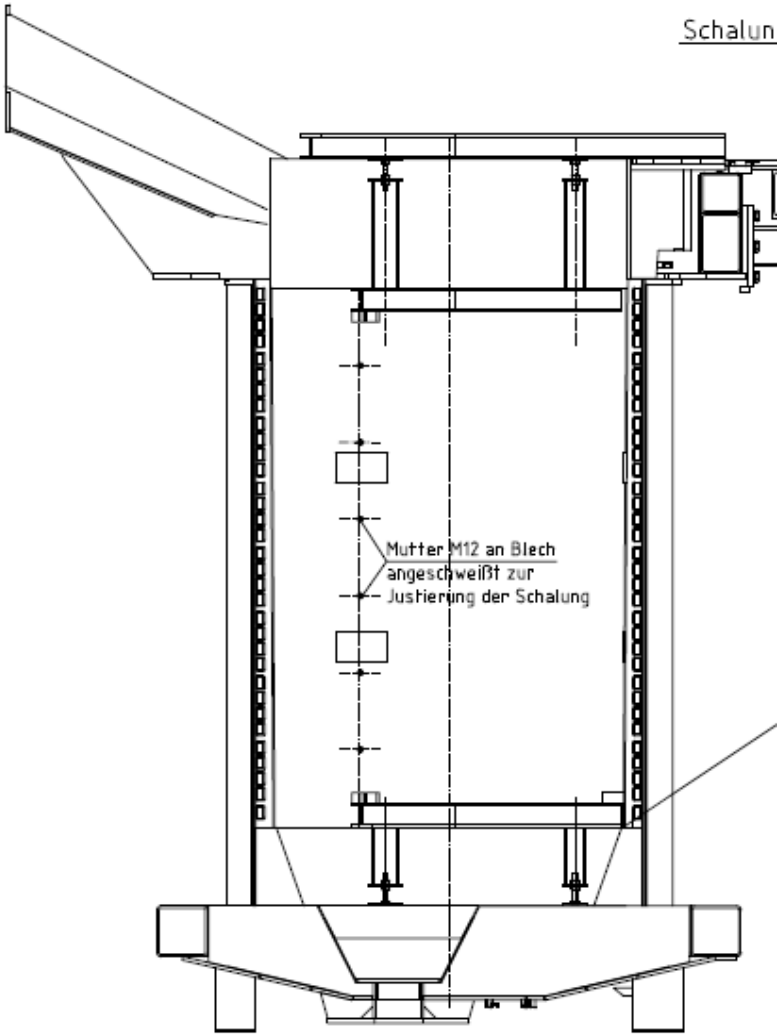




Coil sealing with CALDE PATCH C 90

before casting with CALDE FLOW UT 92

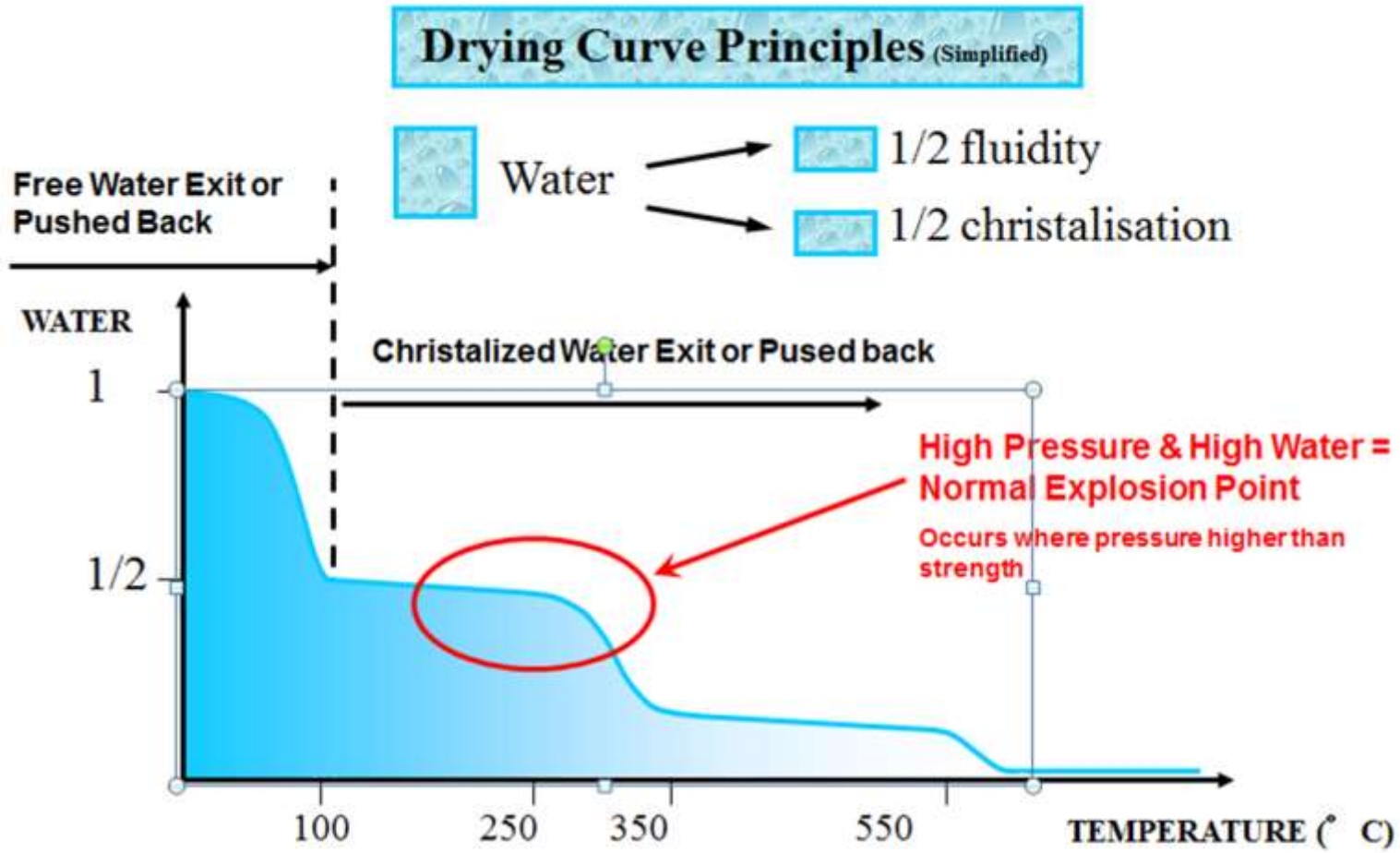
Steel Former for the Casting of the Coilscreed



Casting of Coilscreed

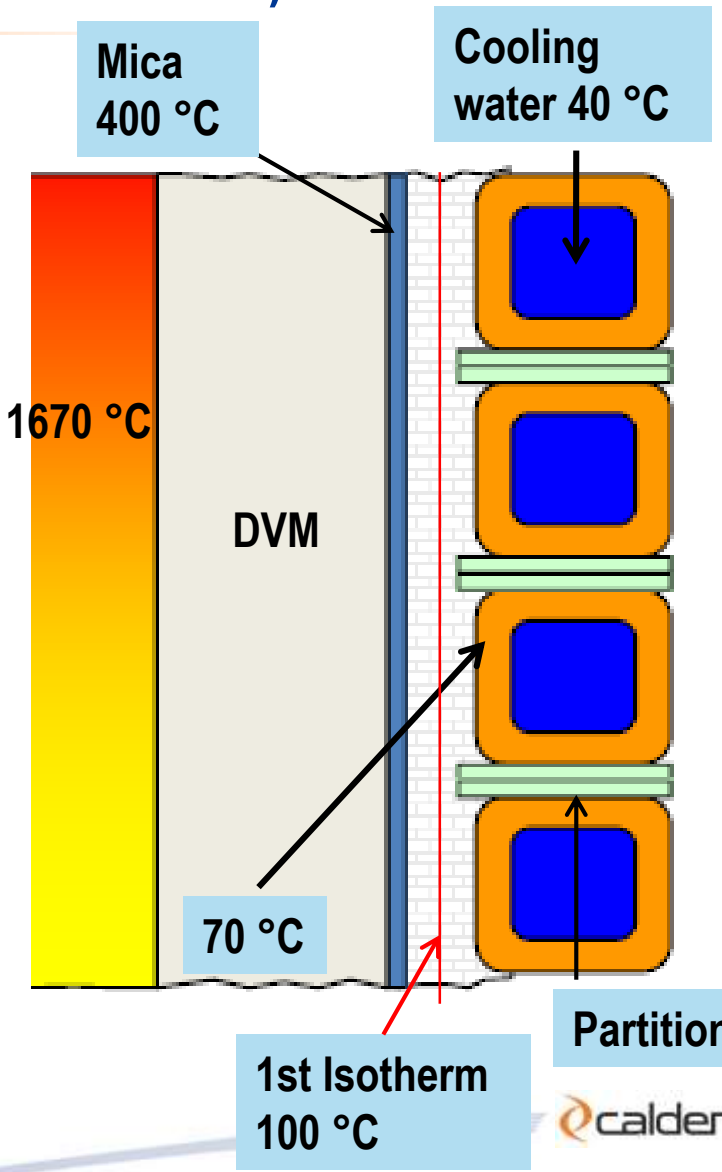
A self-flowing castable is needed due to the very small gaps available

Drying Hydraulic Refractories in CIF's
(Coil Screeds, Safety Lining and Castable Blocks etc)

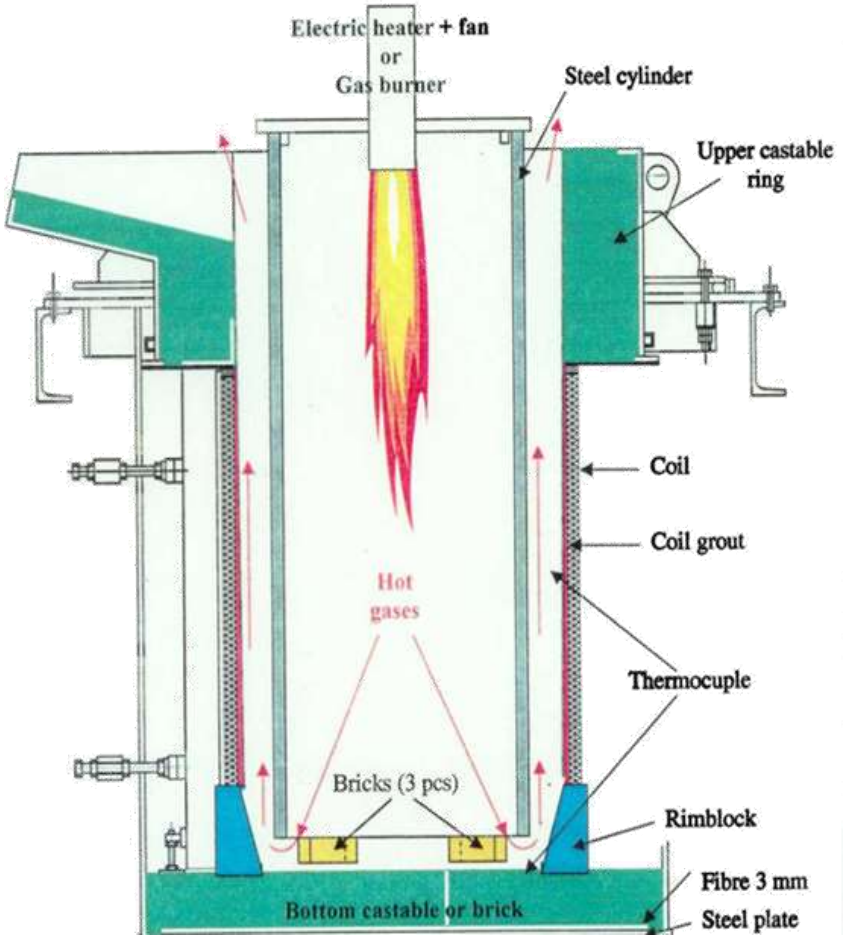


Drying Hydraulic Refractories in CIF's (Coil Screeds, Safety Lining and Castable Blocks etc)

- 1 litre water = 1.6 m3 of water vapour.
- 100kg screed = ~10 ltr of water
  = ~16 m3 of steam
- Free water is evaporated at +100oC,
- Or lower temperature & longer time
- Chemically bonded water
  needs ~ 400oC to forced it out.
- Ensure all cooling water is operating,
- Coil windings MUST not superheat.
- Check with the furnace supplier



Coil screed - Cast & Ready for Drying



Front Lining – Installation of Mica

Why Mica?

Lining Slip Plane – Reduced Stress
Free Lining movement – Installation and operation
Reduced cracks
Pushout Systems
Gas Barrier – Reduced Earth Leakage
Moisture
Carbon
Zinc Oxide
Others
Freeze Point

Selection of Front Lining – Some General Comments

Typical Refractory Consumptions (Steel CIF)

- **Silica Bases (Silica Mix 7 – Q)**
  - **15 to 30 heats** (without sleeving)
  - (un-alloyed & low alloyed)

Selected for intitial lining at TISCO

- **Alumina Spinel Bases (CALDE™ MIX SC 84 M18)**
  ca. 85 % Al2O3 & 15 & MgO
  - **40 to 100 heats** (without sleeving)
  - (un-alloyed, low alloyed & high alloyed steel)

- **Magnesia Spinel Bases (CALDE™ MIX M B 85 SV10 etc)**
  - **25 to 45 heats** (contineuous operation or daily with repairs)
  - (un-alloyed, low alloyed & high alloyed steel)

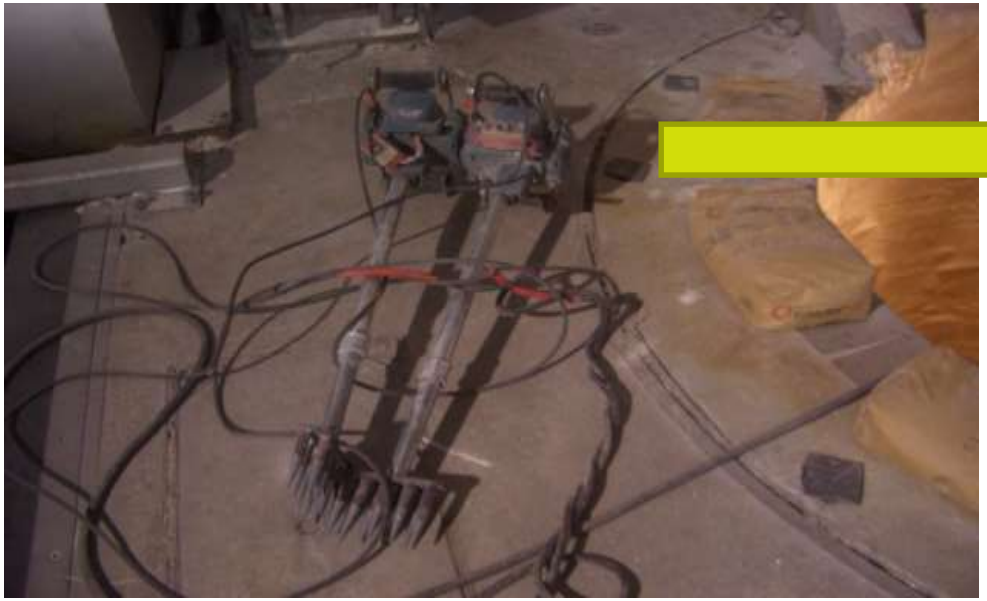
Base Lining Installation with Neutral DVM

- Filling with 1 t Big Bags
- De-airing with pneumatic air forks followed by
- Compacting with Bottom Plate

Former for Front Lining – 65 t CIF

- Former horizontally splitted
- Perfect lining of the lower CIF part becomes possible
- Especially the cone area can be perfectly de-aired with air-forks

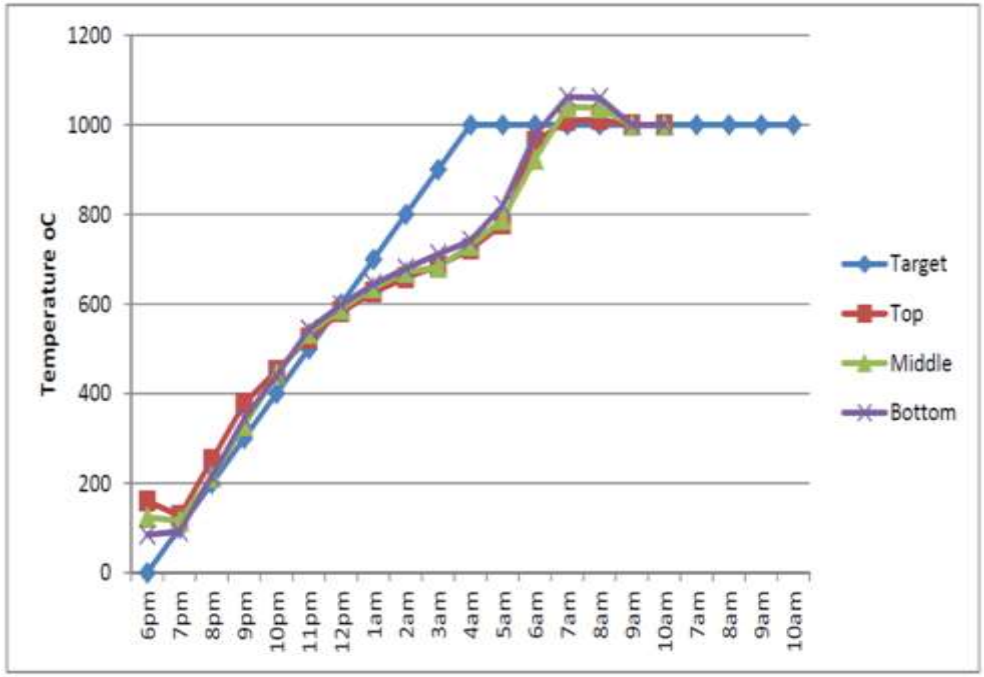
De-Airing of Neutral DVM



8 – Arm – Compactor for Sidewalls – Developed for TISCO

Capping with Phosphate Bonded Patching Material

Pre – Heating of Lining with Oxygen – Burner till 1000 °C



Liquid Sintering with 60 t of Liquid Steel for 2 hours at 1700 °C

Performance & Evaluation of the First Lining with CALDE MIX SC 84 M18

After Sinter Batch

After 57 heats

- After 57 heats it was decided to stop the first lining and to evaluate the front lining
- Lining was cut in vertical direction
- Lining thickness was still siginificantly above 50 % of the original wall thickness
- A good sinter layer and a loose powder zone on the rear side had been seen

Improvement of Neutral DVM

Incremental Steps

- During the last two years several incremental steps have been made to improve the front lining performance
- Finally **more than 100 heats** have been reached on a constant basis at TISCO

CALDE MIX SC 3002

- One of the currently best performing neutral DVM is CALDE MIX SC 3002 which is especially adapted to big Coreless Induction Furnaces melting high alloyed steels like for instance turbo chargers
- More than 30 different furnaces already have been lined with this latest product development

Acknowledgement

- We would like to thank Mr. Liu from TISCO for his strong support during the installation and startup of the ABP Coreless Induction Furnaces. Without his technical knowledge and his personal commitment it would have been much more difficult to make this project a success.