



DOSING FURNACE LINING WITH INSURAL PRE-CAST SHAPES REDUCES DOWNTIME IN FOUNDRIES

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By using INSURAL pre-cast shapes for furnace relining, sintering can be dispensed with and a constant density index can be achieved. The use of high-quality insulating materials in the lining process enables significant energy savings and thus a reduction in CO₂ emissions.

INTRODUCTION

The relining of a dosing furnace in aluminium foundries is always labour-intensive and particularly time-consuming. In the case of a monolithic lining, the sintering phase in particular extends the downtime of the furnace. A market analysis among relevant customers shows that there is a need for optimisation in the area of furnace lining and cleaning of dosing furnaces in connection with corundum formation.

The solution for your dosing furnace in pressure and low-pressure die casting foundries: A completely dry lining with INSURAL pre-cast components combined with high-quality insulation materials.

THE FORMATION OF CORUNDUM

There are basically two types of corundum formation: external and internal corundum generation.

External corundum formation occurs on the bath surface by oxidation of liquid aluminium with oxygen from the furnace atmosphere. Aluminium is sucked upwards through pores and oxides on the metal surface and forms corundum-lumps. This process is accelerated by a high proportion of oxygen, the presence of certain alloying elements and high temperatures.

In addition, there is internal corundum formation, also called penetration. In the contact area of the refractory lining with the liquid aluminium, a substitution reaction occurs due to the higher affinity of oxygen to the aluminium in the molten melt and the free oxygen from the SiO_2 in the refractory lining. This reaction takes place within the refractory structure and below the melt surface. A dense black zone is formed. This is accelerated by a high bath temperature and an increase in the pre-baking temperature, which burns out non-wetting additives.

In order to solve this problem, extensive tests were carried out with various INSURAL recipes. Suitable compositions were then determined and new formulations developed. FOSECO offers a completely dry lining with INSURAL pre-shaped parts for all common dosing and low-pressure furnaces, which is not only economically attractive but also offers the following further advantages:

- + Direct installation on site possible
- + No time-consuming sintering required
- + Stable density index after relining is achieved in a much shorter time
- + Corundum formation is reduced to a minimum
- + Easy cleaning, thus alloy change with little effort possible
- + Larger filling volume for some furnace types due to optimized design
- + Energy saving during operation
- + Reduction of CO_2 emissions

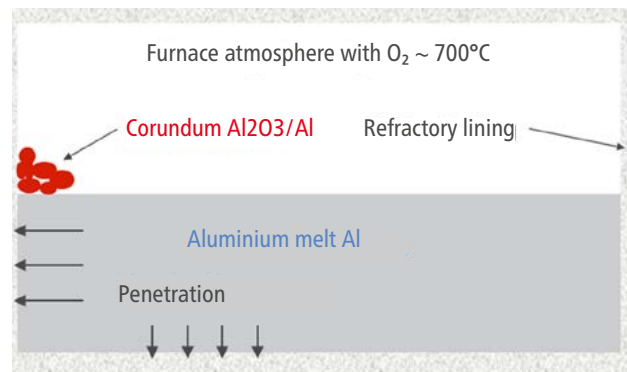


Figure 1: Schematic of corundum formation

THE INSTALLATION

The new lining consists of INSURAL pre-cast parts, which are assembled according to a modular principle. The time required for a furnace installation using a clean and empty steel shell is between two and four days, depending on the furnace type. In addition to the INSURAL pre-cast parts, high-quality insulation materials are used. The insulation materials are mounted between the INSURAL parts and the steel shell. After insulating the bottom area and the side walls, the main liner is inserted. The gap between the basin and the insulation is then filled and the heating and ceiling blocks are placed on top. The remaining insulation work is then carried out and the holes for the thermocouple and the compressed air supply are drilled. The last step is closing the furnace with the lid.

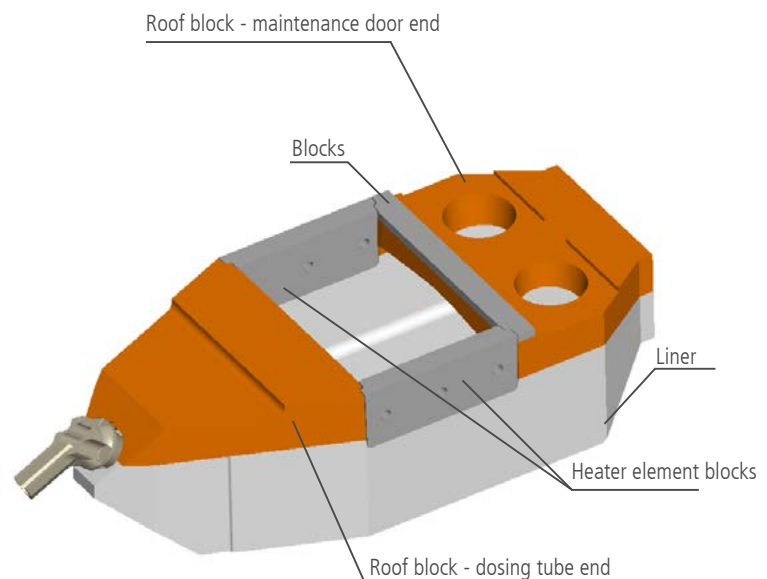


Figure 2: INSURAL precast components



Figure 3: Empty steel shell



Figure 4: Insulating materials for floor and side walls



Figure 5: Installation of the liner



Figure 6: Installation of heating and roof blocks

ADVANTAGES

After complete assembly, the furnace can be put into operation immediately and is ready for operation once the desired furnace chamber temperature has been reached. A sintering program as with a conventional installation is not necessary. As can be seen from Diagram 1, this step saves a great amount of time.

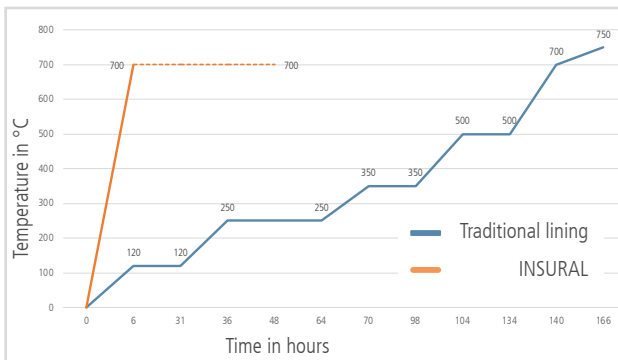


Diagram 1: Comparison of preheating curves

Depending on the casting process and quality requirements, the density index plays an important role in the availability of the dosing furnace. After reaching the furnace chamber temperature, a constant low density index value can be measured after only two days (Diagram 2). The availability of the system by lining it with INSURAL pre-cast parts has clear advantages over conventional lining. With conventional installations, the sintering process takes seven days. If INSURAL prefabricated parts are used, this part is completely obsolete.

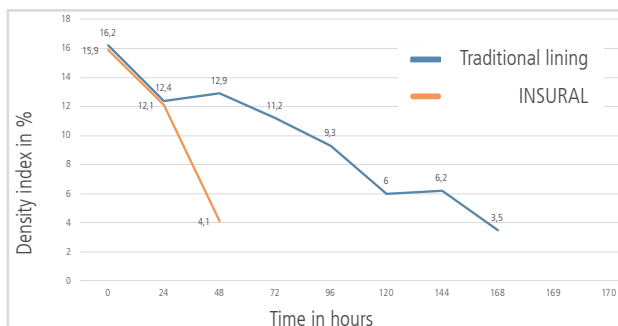


Diagram 2: Density Index

In addition, a constant density index is achieved much faster with an INSURAL lining. As a result, the furnace can return to the production process faster due to the shortened integration time.

The use of INSURAL prefabricated parts minimizes corundum formation and facilitates furnace cleaning. For this purpose, the method of corundum formation will be discussed once again. Parameters that can influence the formation of corundum are:

- + High proportion of O₂
- + Pores
- + SiO₂ ratio in refractory material
- + Temperature
- + Wetting properties

Based on these points, the INSURAL 270 recipe was developed in 2015, which has a small amount of SiO₂, low porosity and good non-wettability with liquid aluminium. With the INSURAL 270 recipe, dry lining with pre-cast parts for dosing furnaces has been successfully introduced to the market in recent years and excellent results have been achieved with a large number of customers.

INSURAL 270 has a SiO₂ content of 22 %, a porosity of about 17 %, a cold compressive strength of 50 N/mm² and excellent non-wetting properties compared to liquid aluminium. In order to meet the growing demands of the market, another INSURAL formulation has been developed, which has extended the product range since April 2019. The INSURAL 290 recipe has a SiO₂ content of less than 10 % only, a porosity of around 16 % and a higher cold compressive strength of 100 N/mm². The non-wetting properties remain excellent.

Another important point is the temperature in the furnace, which is a decisive factor for the formation of corundum. The compensation of temperature loss in dosing furnaces is controlled by the heaters and can be readjusted depending on the insulation. Since the heating takes place via radiant heat, the heating elements become significantly hotter than the melt bath temperature. This is a major reason why the formation of corundum accelerates and good insulation therefore has a positive influence on corundum avoidance.

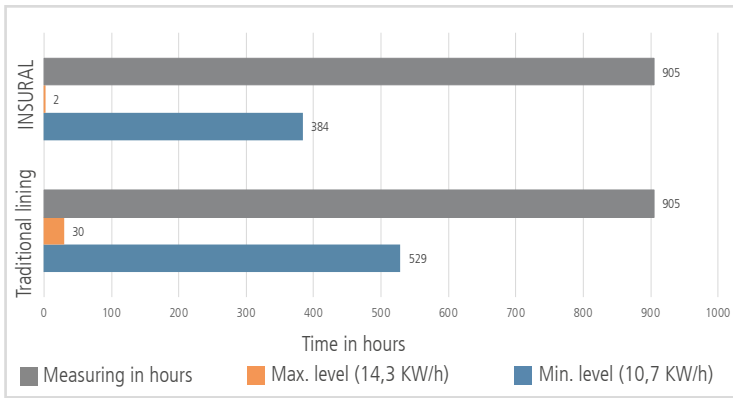


Diagram 3: Power consumption

FOSECOs insulation concept can counteract corundum formation and also save energy costs (Diagram 3). The power consumption measurements carried out in a foundry using a 650 kg dosing furnace show a lower energy requirement compared to conventional lining. The heating power remains at the lowest level for almost 98% of the time, which avoids overheating and effectively prevents corundum formation. Operation at low heating output levels also has an influence on the peak shutdown in the foundry's energy management and reduces weekly average consumption.

CONCLUSION

Furnace lining with INSURAL pre-cast parts offers a number of advantages over conventional lining. On the one hand, the actual lining process requires considerably less time, and on the other hand, time-consuming sintering is no longer necessary. Furthermore, the dry lining avoids the absorption of hydrogen by the melt in the first days after commissioning. The formation of corundum is minimized and furnace cleaning is simplified. Furnace cleaning remains important, so a weekly cleaning interval is recommended. Depending on the insulation concept selected, energy and CO₂ output can be significantly reduced. The current electricity mix in Germany indicates that for 1 kWh an average of 511.2 grams CO₂ are released to atmosphere. With a furnace that saves 48,000 kWh per year, the foundry achieves a reduction of 24.5 tons of climate-damaging CO₂.



Figure 7: Condition of furnace after 3.5 years

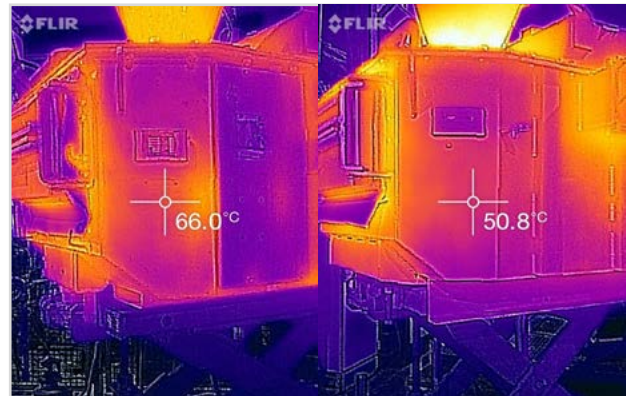



Figure 8: Furnace surface temperature (left: conventional lining, right INSURAL 270)

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