

Processing instructions V 4.2

REFRAJETCRETE® Nanobond

Note: Please read the product information sheet first, to ensure that these are the right processing instructions for your product. This document describes the application procedure for dense, cement-free **REFRAJETCRETE®** refractory concretes of the type **Nanobond** (three-component material).

The instructions contained in this document must be complied with during processing and installation of the respective refractory concrete. Modification of or deviations from the processing instructions can lead to major problems during installation, and possibly to total failure of the installed refractory material. These instructions provide general guidelines for storage, processing, and installation of the specific refractory material. If, due to specific site conditions, it appears necessary to deviate from the procedures described here, please consult Refratechnik Steel GmbH before starting work.

Storage

- In general: Store under cool, dry, and frost-free conditions.
- The liquid binding agent and the accelerator must always be stored at a temperature of > -20 °C.
- The shelf life stated in the product information sheet is valid from the production date, and only if storage is in accordance with our recommendations. The production date is stated on the packaging label.
- Under certain circumstances, material that has been properly stored may still be usable even after expiry of the stated shelf life. In such a case, conduct a setting test with a sample before using the material. In case of doubt, the expired material can be checked by Refratechnik Steel GmbH.
- Incorrect storage can greatly reduce shelf life, and can impair product quality.
- The original pallet wrapping foil should be left intact for as long as possible to

protect the product. However, the foil is not a substitute for storage under cover.

- Also standing water, e.g. due to inadequate drainage of the storage area, can damage the material.
- Stacking of the goods supplied by us (in sacks, Big Bags, etc.) is done under the sole responsibility of the shipping company or customer. Refratechnik Steel GmbH accepts no liability for possible consequential damage (damaged packaging, personal injury, etc.).

Health and safety

- Always wear suitable safety goggles, dust mask, protective clothing, and working gloves.
- Always wash thoroughly after working with the material.
- Observe the safety data sheets of the dry material, the accelerator, and the liquid binding agent.

General information

- This product is a cement-free, inorganically-chemically setting refractory concrete. Delivered dry in 25 kg sacks or in Big Bags, it is mixed with the liquid binder on site. Curing occurs at room temperature during gunning, and exclusively through the addition of an accelerator. When used as a casting compound, curing occurs at room temperature after an accelerator in powder form has been added to the dry component.
- The following application methods are possible:
 1. By means of the **JETCRETE** process (shotcreting)
 2. By casting the compound (only after consultation with Refratechnik Steel GmbH)
- **REFRAJETCRETE®** Nanobond products are three-component materials:
 - Component 1: Dry material, delivered in 25 kg sacks or in Big Bags
 - Component 2: Liquid binding agent, delivered in 1000 kg PE canisters or 3 l IBCs
 - Component 3: Accelerator, delivered in 30 or 100 kg PE canisters or drums

- Always mix complete packaging units (1 sack or 1 Big Bag). The use of partial quantities can lead to demixing and changed material properties.
- The dry mixture is then mixed exclusively with the liquid binding agent supplied – never add water.
- The liquid binding agent and the accelerator must always be stored at a temperature of $> -20\text{ °C}$. During processing, the temperature of the mixed concrete, binding agent and accelerator must be kept at $> 5\text{ °C}$.
- Low temperatures can retard or even stop the setting process. Therefore, the temperature of material and liquid binding agent must be at least 5 °C . In some cases, it might be necessary to heat the installation area.
- On the other hand, the setting process may be significantly accelerated at temperatures above 25 °C .
- Please take the expansion of the refractory material for your specific furnace application into account. The reversible and irreversible expansion values and the respective material properties are given in the product information sheet. Depending on the furnace operating conditions and the specific characteristics of the refractory material, any arising stresses and pressures must be compensated by suitably designed expansion joints.
- During installation of the monolithic refractory material, please ensure correct anchoring to the existing furnace structure and/or to the existing or adjacent refractory material (e.g. with steel anchors, ceramic anchoring systems, etc.).
- Suitable measures must be taken to ensure that the water or water vapour generated during the drying & heat-up process is removed from the refractory lining without pressure build-up.
- With certain kiln structures and refractory linings, the drying process can cause the generated water or water vapour to diffuse outwards in the direction of the furnace shell instead of inwards to the hot side (kiln chamber). Therefore, suitable measures must be taken to ensure that the water or water vapour can escape to atmosphere. For this purpose, 10-mm holes drilled into the kiln's outer steel shell (at least 5 per m^2) have proved to be successful.
- Regarding the build-up of water vapour pressure, attention must be given to the entire wall structure of the lining (wear lining/permanent lining/insulation). In the area behind the wear lining, it must also be ensured that only such materials are used, which provide an adequate (highest possible) permeability to the steel shell.
- If the permanent lining/insulating layers are used several times and only the wear lining is replaced, they can become clogged in the course of time due to moisture transport with dust contaminations, salts, etc., thereby also impeding moisture transport. Consequently, multiple use of such layers must be seen as counterproductive in terms of dewatering performance. It might even be safer also to replace the permanent lining, in order to ensure perfect flowthrough to the cold side.
- To ensure a continuous drying process, the complete kiln chamber must always be flushed with an adequate amount of fresh air during the entire drying and heat-up procedure. The air circulating in the kiln chamber may never be saturated with moisture.
- During heat-up, it is essential that flames do not impinge on the refractory lining only in small areas. Local overheating can result in severe damage of the refractory material. Therefore, it must be ensured that the entire lining surface is heated uniformly and without significant temperature differences.

Mixing

- **REFRAJETCRETE®** products are always delivered together with a liquid accelerator for the **JETCRETE** gunning process (shotcreting). On no account may the accelerator be mixed with the concrete. The accelerator and the liquid binding agent must always be stored at $> -20\text{ °C}$.
- Mixer, tools, conveying equipment, etc. must be clean and free from any form of contamination.
- Use of a positive mixer is essential.
- Mix only as much material at a time, as can be processed within about 50 minutes.
- Data on the maximum and minimum amounts of liquid binding agent to be added is given in the product information sheet or on the packaging label. Please note that the quantities to be added are stated in l/100 kg or kg/100 kg.
- If in doubt about the reactivity of the liquid binding agent (e.g. if its shelf life has expired or undefined storage conditions, etc.), please contact the R&D Dept. of Refratechnik Steel GmbH before starting work.
- First, briefly mix the dry material for about 30 seconds to restore the consistency after any demixing that might have occurred during transport.
- Next, add the minimum amount of liquid binding agent while continuing to mix the material. Continue mixing for about 2 minutes until a thorough mix is obtained.
- Frequently, the required consistency is obtained only at the end of the mixing period, because the fine portions in the product must be broken down first. Therefore, you should wait until the full mixing time has elapsed, and don't try to obtain the required consistency in a shorter time by adding more liquid bind-

er. The material's consistency can change quite abruptly from "too dry" to "exactly right". If necessary, the remaining amount of liquid binding agent can be added until the required consistency is obtained. Hereby, the maximum amount of liquid binding agent may not be exceeded.

- Then continue mixing for about 2 more minutes.
- Do not exceed the maximum permitted mixing time of 5 minutes.
- No foreign bodies or particles of concrete that have already set must be allowed to enter the freshly mixed concrete, as these can cause premature setting.

Processing

1. Application with the JETCRETE process (shotcreting)

- Basics of the **JETCRETE** process: After mixing, the concrete is filled into the hopper of a dual-piston concrete pump, from where it is conveyed to the jet mixing chamber through pipes and hoses in a continuous stream of material. In the mixing chamber, a blast of compressed air and liquid accelerator breaks up and plasticates the material stream to such an extent that the concrete can be gunned horizontally and also vertically. By means of a control valve on the nozzle, the operator manually adjusts the precise amounts of compressed air and accelerator. Start with the lowest accelerator dosage, and then increase it until the material plasticizes on the installation surface. Avoid an excessive amount of accelerator liquid. The correct amount is between 0.2 and max. 0.7 percent by weight.
- The amount of liquid binder specified in the product information is based on a standardized conveying distance of 30 m via dual-piston pumps (straight pipe run, diameter = 50 mm, horizontal path). Practical applications can be sub-

ject to different conditions, such as e.g.:

- Conveying distance > 30 m
- Noteworthy vertical paths
- Use of hoses instead of metal pipes
- Pipe diameter < 50 mm
- Installation of pipe bends and pipe constrictions
- Etc.

Therefore, it could be necessary to compensate the higher frictional resistance by correspondingly higher dosing of liquid binder. Under these conditions, it is possible that the higher dosing exceeds the maximum values specified on the product information or bag labels. This is permissible under certain conditions, and if defined limit values are observed. In these cases, Refratechnik Steel GmbH should be contacted in advance.

- In the past, the equipment from Montanbüro, Allentown, and Pumpmore has proved to be suitable for processing **REFRAJETCRETE®** products.
- The accelerator pump must be capable of delivering a pressure of at least 20 bar.
- The compressor used for injecting the accelerator/air mixture must have a minimum capacity of 7.5 m³/min and 7.5 bar.
- The transport distance should always be kept as short as possible. Therefore, the machine should be located as close as possible to the installation site.
- Rigid pipes are preferable to rubber hoses for conveying the mixture, because their internal friction losses are less.
- Before starting work, pipes and hoses must be flushed out with a suitable lubricant.
- A continuous flow of material is a prerequisite for a homogeneous material structure. Therefore, an adequate

amount of material in the hopper of the dual-piston pump must always be ensured.

- No moisture may be drawn out of the gunned material by adjacent dry and absorbent surfaces. Therefore, any existing refractory lining should be pre-wetted before gunning. Any moisture-sensitive materials, such as insulation, should be covered with foil.
 - The distance between gunning nozzle and application surface must not be more than 30 cm.
 - On no account may rebound material be reused.
 - Individual bays (bay size about 1 m²) should be gunned successively, taking care not to gun areas that have already stiffened or cured (risk of layer formation and spalling).
 - The surface can be touched up immediately after gunning.
- ### 2. Application as casting compound
- **REFRAJETCRETE®** concretes are intended primarily for gunning (shotcreting) applications. Within certain limitations, the material can also be processed like normal grouting concrete. Please consult Refratechnik Steel GmbH before processing the material as a casting compound.
 - **REFRAJETCRETE®** products are always delivered together with an accelerator for the **JETCRETE** process. Do not use the accelerator if the material is to be processed as a casting compound.
 - Before processing the casting compound, an additive in powder form must be added to the dry material. This additive can be purchased from Refratechnik Steel GmbH on request.
 - If using formwork, make sure it is sufficiently stable, and that its surfaces are smooth. Use formwork release oil.

- No moisture may be drawn out of the cast material by adjacent dry and absorbent surfaces. Therefore, any existing refractory lining should be pre-wetted before casting. Any moisture-sensitive materials, such as insulation, should be covered with foil.
- While casting the material, or shortly afterwards, the concrete must be compacted by vibration (e.g. with an internal vibrator).
- If an internal vibrator is used, continue the vibration only until no further compaction is evident. To prevent air inclusions, withdraw the vibrator slowly from the concrete.

Setting and curing

- As opposed to cement-bonded refractory concretes, Nanobond bonded concretes generate a negligible amount of heat during curing. Cooling of the concrete surface by spraying it with water, as generally done with cement-bonded concretes, is not required for Nanobond concrete.
- The following applies for processing as a casting compound: Generally, it takes between 6 and 12 hours before the concrete has cured sufficiently to permit removal of the formwork. Ambient temperatures in midsummer may considera-

bly shorten this time, while winter temperatures or the use of material stored in cold places may lengthen it. Of course, the formwork may only be removed after the material has fully cured.

Caution: In some cases, the lining might not yet be solidified. Therefore, if in doubt, wait with removal of the formwork.

- Full setting of the refractory concrete requires at least 24 hours. Until that time, the concrete must be protected from frost.
- In a direct comparison, the strength of Nanobond concrete after setting (24 hours) is lower than that of hydraulically bonded concretes. However, its strength increases significantly after drying, and above a temperature of about 800 °C it is equal to that of liquefied, hydraulically bonded refractory concrete.

Drying and heating up

- Compared with hydraulically bonded refractory concretes, Nanobond bonded concretes are significantly less sensitive during heat-up. Drying and heating up can be started immediately after removal of the formwork (for cast material) or after completion of the **JETCRETE** application.

- Refractory linings should be dried or heated up immediately after installation in order to expel the contained water. Freshly installed refractory linings should not be left undried for longer periods. In exceptional cases, please contact Refratechnik Steel GmbH beforehand.
- Please check the product information sheet to ensure that you have the right heat-up instructions for your product.
- During the first heat-up, also make sure that no other materials are heated up, which are not suited for fast heating up.
- The heat-up instructions must always be followed precisely. Hereby, it must be ensured that the respective heating curve is followed, monitored, and recorded by means of several correctly-positioned thermocouples. Moreover, a homogeneous temperature distribution must be ensured throughout the refractory lining.