

# Processing instructions V 400

## **REFRAMIX®**, **REFRARAM®**:

### Basic multi-purpose mixes

#### 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, basic **REFRAMIX®** and **REFRARAM®** for various installation methods. It does not apply for alumina-based **REFRARAM®**-, **REFRARAM® AB**- or other **REFRARAM® CB**- products. This range of basic multi-purpose mixes is used in foundries and steelworks for refractory repairs, and can be applied hot or cold. In cold conditions, and using slightly less water, these mixes can also be cast or rammed.

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 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 processing 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. Even short periods of exposure to frost can impair the dry material's shelf life, and also affect the quality of the liquid binding agent supplied.
- 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 and working gloves. Avoid eye and skin contact. Prolonged skin contact can lead to skin irritation
- Keep eye washing equipment ready.
- Always wash thoroughly after working with the material.
- Observe the safety data sheets of the dry mixture and the liquid binding agent. National and industrial safety regulations must be observed.

#### General information

- This product is a chemically binding ramming granulate for multi-purpose applications and installation methods. Delivered dry in 25 kg sacks or in Big Bags, it is mixed with liquid binding agent on site, and then applied. The material sets as it dries.
- The following installation methods can be used with this type of material:
  - As a ramming mix
  - As shotcrete
  - As castable concrete.
- 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 type of mixing liquid to be used (drinking water or liquid binding agent) is stated in the corresponding information sheet of the product.
- In cold weather, the dry material must be stored at higher ambient temperatures (at least 5 °C) before processing. Basic multi-purpose mixes may only be processed at temperatures above 5 °C (heat the installation site if necessary).
- 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<sup>2</sup>) 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.

#### Applied as a ramming mix:

##### Mixing instructions

- Mixer, tools, conveying equipment, etc. must be clean and free from any form of contamination.
- Mixing is done with a clean and powerful positive mixer that is suitable for processing plastic granulate ramming compounds.
- Mix only as much material at a time, as can be processed within about 20 minutes.
- Data on the maximum and minimum amounts of mixing liquid to be added is given in the product information sheet or on the packaging label.
- Make sure that you have the right kind of mixing liquid on site. The type of mixing liquid is stated in the product's information sheet.
- 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 3 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 mixing liquid. The material's consistency can change quite abruptly from "too dry" to "exactly right". If necessary, the remaining amount of mixing liquid can be added until the required consistency is obtained. Hereby, the maximum amount of liquid may not be exceeded.
- Then continue mixing for about 6 more minutes.

#### Processing

- If using formwork, make sure it is sufficiently stable, and that its surfaces are smooth. Unstable formwork has a tendency to bulge under the ramming pressure. Use formwork release oil.
- Before starting work, all surfaces that are to be lined with basic multi-purpose mixes must be carefully cleaned of rust flakes, scale, oil, grease, and other substances (e.g. paint, rust inhibitor, etc.) by suitable means, e.g. sand blasting.
- Depending on installation conditions, compaction is achieved by means of a suitable pneumatic ramming hammer or a motorized vibratory rammer. In some cases, a heavy hammer (mallet) may be used.
- During ramming, the desired lining thickness is obtained by individual rammed layers. Only in this way can the necessary compaction be achieved.
- Depending on the ramming tool used, the following layer heights are recommended: about 60 mm with a pneumatic ramming hammer, and up to 200 mm with a heavy vibratory rammer. Depending on the material, a compaction ratio of approx. 1,6 : 1 can be assumed.
- Continue ramming until no further compaction is observed.
- Apart from achieving optimum material compaction, the bond between the individual rammed layers is critical for the quality of the overall lining. Therefore, the previously rammed layer must always be intensively roughened before applying the next layer. This can be done by scratching, by ramming with splined ramming feet, or with vibratory rammers fitted with spikes on the ramming plate.
- During work interruptions, the most recently rammed layer must be covered with film to prevent it drying out.

- Remove residual material from the tools at regular intervals by washing thoroughly with water, and then dry them well.
- Depending on layer thickness and heating-up time, it may be advisable to drill or punch evaporation holes through the entire layer (not in areas subjected to the liquid phase)

#### Drying and heating up

- Due to the chemical bonding systems used, curing is very fast and permits the plant to be recommissioned immediately.
- In the unfired state, basic multi-purpose mixes are sensitive to damage from mechanical influences and the weather.
- The supporting formwork of suspended linings must also be heated up.
- To ensure homogeneous solidification of the material, a temperature of at least 1000 °C should be reached during the first heat-up, and must be maintained for at least 0.5 hours.
- Suitable equipment must be provided for drying. Do not use steam (boiler steam) for this purpose.
- Direct contact of newly lined surfaces with open flames should be avoided,

#### Applied as a dry gunning mix: General information

- Basic multi-purpose mixes can also be used for gunning applications. Delivered dry in 25 kg sacks or in Big Bags, suitable equipment is used on site to convey the dry material through a hose to the gunning nozzle. In the gunning nozzle, the dry material is mixed with water before it is ejected from the nozzle at high pressure. Curing occurs at room temperature.
- Only use clean drinking water, as otherwise the setting behaviour may be affected.

#### Processing

- Low temperatures can retard or even stop the setting process. This can result in a risk of the material slipping. Therefore, the temperature of material and mixing water must be at least 5 °C. In some cases, it might be necessary to heat the installation area.
- Processing is done with suitable gunning equipment operating either with the rotor principle or a two-chamber system. Common to both processes is that they use compressed air to convey the dry mixture through hoses into a jet mixer chamber. The amount of water required for the setting process is applied to the dry material as a fine spray via a separate hose connected to the mixer nozzle. Depending on the gunning requirement, the precise amount of water is set manually by the gun operator via a control valve on the nozzle.
- The gunning unit requires a constant supply of water and air at a sufficient pressure. For this reason, separate air compressors and water pumps should be used.
- For correct operation, the gunning unit requires an air pressure of at least 7.5 bar and an air quantity of 7.5 m<sup>3</sup>/min.
- The water pressure must be constant, and higher than the material pressure at the spray nozzle. Experience has shown that for short distances at ground level, a water pressure of 6 bar is sufficient, but if greater height differences must be overcome, pressures of 20...60 bar might be necessary.
- In order to avoid pressure drops, the gunning unit should be positioned as close as possible to the place of installation. However, to ensure as even a flow of dry mixing material as possible, the overall length of the delivery hose should not be less than 20 m, particularly for rotor gunning units.
- The design of the nozzle mixing chamber is decisive for obtaining a homogeneous

and complete wetting of the dry material in the nozzle. We recommend an 18-hole water ring with hole diameters of 1.2 mm, and a spray angle of 45° in the gunning direction. For the most precise and sensitive control of water injection possible, we recommend using a needle valve.

- The mixing section (distance between the water ring and the nozzle outlet) should have a length of 60 cm to ensure the greatest possible internal mixing.
- If possible, the diameter of the mixing section should taper down from 32 mm at the water ring to 24 mm at the nozzle outlet.
- For optimum material compaction, combined with the least possible water content, and taking the spray characteristics (rebound, formation of dust etc.) into account, the gunning pressure should be as high as possible.
- The distance between nozzle outlet and the surface being gunned should not be greater than 1 m. Perform circular movements with the nozzle, keeping it perpendicular to the surface being gunned. This procedure minimizes re-

bound and achieves a uniform material structure.

- While gunning, no moisture may be drawn out of the refractory material by adjacent dry and absorbent surfaces. Therefore, any existing refractory lining should be pre-wetted. Any moisture-sensitive materials should be covered with foil.
- Before gunning, the surface only needs to be roughly cleaned. The bonding system used is very well matched to all kinds of refractory linings. The material even bonds to surfaces that are contaminated with slag. A hot surface improves the gunning material's bonding ability.
- Very hot surfaces (>1400 °C) can have a negative effect on the gunning material's bonding ability. Therefore, the first gunning layer should be applied to the refractory lining with a bit more water, in order to cool the wall surfaces.
- Only walls and ceilings may be gunned. If floors are gunned, the material compaction will suffer, because rebound material will inevitably be mixed in. If possible, rotate/position a floor section into an upright position.

- On no account may rebound material be reused.

- Prevent layering.

- In general, bays are gunned individually, whereby they are divided by means of partitioning formwork so that the bays are lined one by one. The surface of a bay can be touched up immediately after it has been gunned (caution: Do not seal the surface by trowelling it).

#### **Setting and curing**

- Due to the bonding systems used, curing is very fast and permits the plant to be recommissioned immediately.

#### **Drying and heating up**

- If the gunning mix is applied to a hot surface, no special drying or heating up phase is required.
- If the material is applied to a cold surface, e.g. at room temperature, a drying and heating up phase of at least 30 minutes up to a temperature of 1000 °C should be observed.

**Applied as castable concrete:**

**General information**

- The product is delivered dry in 25 kg sacks or in Big Bags. It is mixed with water on-site, and then cast. Setting occurs at room temperature.
  - Always mix complete packaging units (1 sack or 1 Big Bag). The use of partial quantities can lead to demixing and changed material properties.
  - Only use clean drinking water, as otherwise the setting behaviour may be affected.
  - Low temperatures can retard or even stop the setting process. Therefore, the temperature of material and mixing water 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<sup>2</sup>) 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.
- Processing as cast concrete**
- Mixer, tools, conveying equipment, etc. must be clean and free from any form of contamination.
  - We recommend the use of a positive mixer, but this is not essential. In some cases, use of a gravity or «standard» concrete mixer may require an increased quantity of mixing water, resulting in poorer general mechanical properties.
  - Mix only as much material at a time, as can be processed within about 20 minutes.
  - Data on the maximum and minimum amounts of water to be added is given in the product information sheet or on the packaging label.
  - 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 water 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 water. The material's consistency can change quite abruptly from "too dry" to "exactly right!". If necessary, the remaining amount of water can be added until the required consistency is achieved. Hereby, the maximum amount of water may not be exceeded.
  - Then continue mixing for about 2 more minutes.
  - If using formwork, make sure it is sufficiently stable, and that its surfaces are smooth. Use formwork release oil.
  - While casting the concrete, no moisture may be drawn out of the material by adjacent dry and absorbent surfaces. Therefore, any existing refractory lining should be pre-wetted. 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 rodding or 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.
- Depending on layer thickness and heating-up time, it may be advisable to provide evaporation holes (not in areas subjected to the liquid phase).

#### **Setting and curing**

- Due to the bonding systems used, curing is very fast and permits the plant to be recommissioned immediately.

#### **Drying and heating up**

- Because of the high hydration tendency of raw magnesia materials, the monolithic lining must be de-molded, dried or heated up as soon as possible after setting.  
Hereby, fast heat-up to a minimum temperature of 200 °C at up to 50 °C/h is possible. Subsequently, material heat-up must be slower, i.e. up to 1000 °C at 15 °C/h.
- If the material is processed cold, at room temperature on a cold surface, a drying and setting phase of at least 30 minutes at up to 1000 °C should be ensured.