

Notes on heating up monolithic refractory products

Only the technically correct heating-up of monolithic refractories will result in the desired end product. Therefore, correct heat-up is just as important as correct processing of the material.

A distinction is made between initial heat-up and re-heating units that have already been in operation.

Initial heat-up

The initial heat-up lastingly determines the quality of the refractory lining.

Possible damage in case of an incorrect initial heat-up can be: cracking, spalling, layering, and – in extreme cases – explosions and destruction of the entire lining.

The instructions provided by Refratechnik Steel GmbH for initial heat-up are general, product-related heating curves that obviously cannot take all the different circumstance in plant engineering into account. In practice, only a few optimum heat-up possibilities are available, be it the burner positions or their controllability, especially in the lower temperature range.

Also the possibilities for positioning the thermocouples for temperature monitoring are often limited.

Therefore, Refratechnik Steel GmbH can only provide a warranty for heat-up, if our plant-related heating instructions are observed, and only if heating up is carried out by or under supervision of Refratechnik Steel GmbH.

Notes

- The front layer material determines the heat-up instructions to be used. The number of the heat-up instructions for your product is given in the product information sheet. With composite constructions (use of different materials in

one unit), the instructions for the slowest heat-up procedure must be used.

- With the exception of REFRARAM® products, the heat-up procedure may be interrupted at any time. This is done by controlled cooling in accordance with the instructions A 0 "Heating and cooling of already heated refractory linings". Renewed heating-up is then carried out in accordance with the curve in A 0, and at the temperature reached during initial heat-up, heating is continued along the curve for initial heat-up.
- Holding times, i.e. period without a temperature increase, are not provided for in our heat-up instructions, as they are not advisable. However, plant-dependent holding times will not damage the lining (exception: REFRARAM® products), but at the end of the holding time, the original heat-up rate must be resumed. Total heat-up time is therefore extended by the duration of the holding time.
- The wall thicknesses stated in the heat-up instructions refer to the overall thickness of all non-dried monolithic refractory materials.
- The heat-up instructions refer to temperatures applied to one side of the lining.
- Direct contact of individual areas with the flames must be avoided. Protect the lining in such areas by suitable means (fiber mats, metal plates, bricks, etc.). If this is not possible, the heat-up rate must be reduced.
- Particularly in the lower temperature range, controllability of the plant's burners is often problematic. Keep the temperature increase within the limits stated in the heat-up instructions, e.g. by means of intermittent firing or by a reduced fuel flow and operation above the stoichiometric air/fuel ratio (excess air).
- 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 m²) 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.
- Precise temperature measurement is essential. For this purpose, proceed as described below under "Temperature measurement".

Heating and cooling of already heated linings

Also when re-heating, the maximum heat-up rates must be observed in order to prevent damage. In this case, the problem of the lining being destroyed by the generated steam pressure no longer exists, so that heating can be carried out at higher heat-up rates, particularly in the low temperature range. However, the heat-up rate is now limited by the thermal stresses produced by thermal expansion. This applies equally for the cooling-down phase, so that also here it is necessary to proceed in a controlled manner to prevent damage. In the interest of the refractory material's service life, radical cooling, e.g. by means of cold air injection, should not be used.

Notes

- We recommend that our heating instructions A 0 "Heating and cooling of already heated refractory linings" are observed as far as possible. Unlike the instructions for initial heat-up, which differ according to product group and bond type, these instructions are applicable for all product groups and bond types.
- Precise temperature measurement is essential.

Temperature measurement

- Always use suitable thermocouples.
- If possible, the measured temperatures should be recorded automatically by means of a data logger or PC.
- Always measure the furnace chamber temperatures (not the surface temperatures of the lining). Consequently, the temperatures stated in our heat-up instructions refer to the furnace chamber.
- To ensure reliable measurements of the furnace chamber temperatures, the thermocouples must protrude at least 100 mm into the furnace chamber.
- Position the thermocouples at representative locations for the measurement, i.e. neither in (burner) shadow areas nor in areas exposed directly to the flames. This would falsify the measurements.
- Also take the measuring tolerance of the thermocouples into account, particularly when approaching the maximum operating temperature of the refractory lining. In this case, the tolerance must be added to the measured temperature.