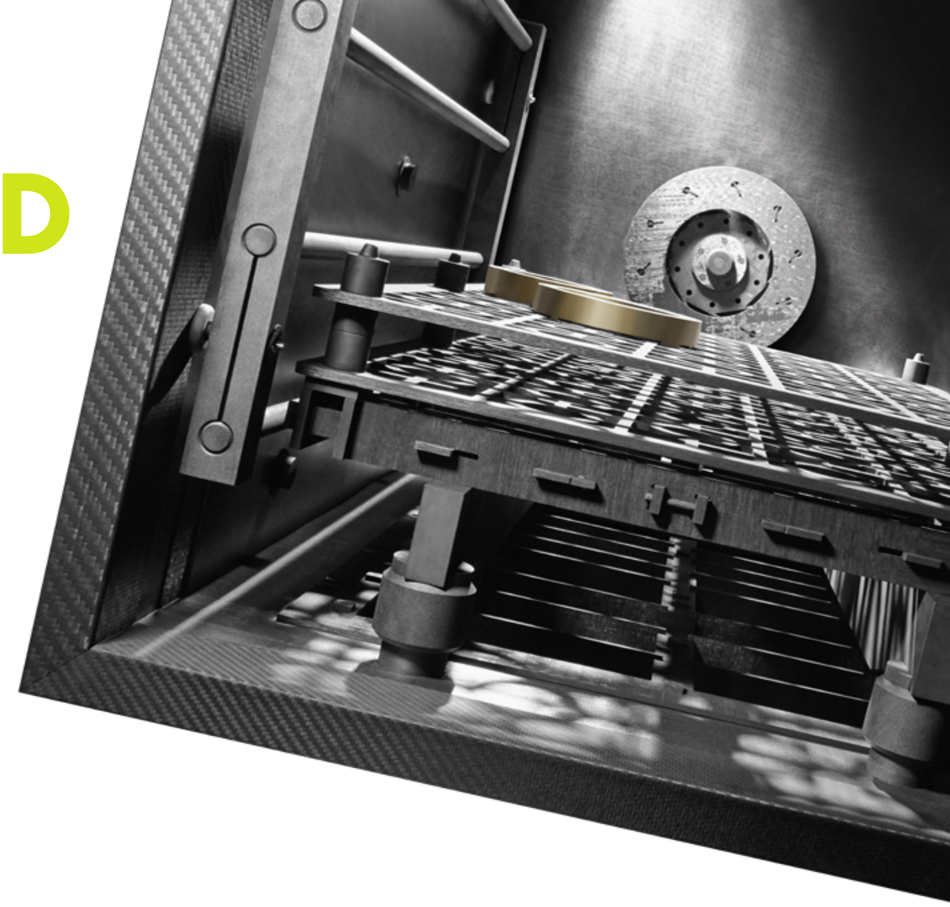
GRAPHITE MATERIALS

Heating chamber linings made of CFC, graphite and insulation

FOREWORD



The heating chamber is the heart of every high-temperature system.
It combines electrical power supply, thermal efficiency and mechanical stability, thereby significantly determining the performance, process stability and cost-effectiveness of the entire system.

This white paper shows how the combination of in-house production and simulation significantly improves the design, quality and efficiency of modern heating chambers.

Graphite Materials is occasionally abbreviated to ‘GM’ in the following.

Initial situation | Challenge

In high-temperature systems, the design of the heating chamber determines temperature homogeneity, energy consumption and service life. Traditionally, many components are purchased from third parties, which limits adaptability and optimisation options. However, increasing demands on precision, reproducibility and energy efficiency are increasingly requiring flexible, simulation-based solutions.

Solution approach | In-house production and integrated optimisation

In-house production of the heating chamber lining enables precise adaptation of all thermally and mechanically relevant components to the specific process requirements. These include, in particular, insulation layers, heating conductor guides, fastening elements and supplementary components such as fans and gas distribution plates for targeted temperature homogenisation. This customised design ensures optimal coordination of all components, which significantly increases the efficiency, process stability and service life of the furnace systems.

Heating | the active centre

A key aspect is the optimisation of the heating system. Through the targeted design, arrangement and routing of the heating conductors, a virtually homogeneous temperature distribution can be achieved throughout the entire furnace chamber. The result is uniform and efficient heating performance, which leads to stable processes and improved energy utilisation.

Thermal insulation | Reduction of heat loss

The reduction of thermal bridges also contributes significantly to increased efficiency. The combination of molybdenum pins with GM threaded inserts minimises heat loss at the fastening points of the thermal insulation and reduces the number of thermal transitions to a necessary minimum. This prevents unwanted thermal bridges and improves the overall efficiency of the system.

Optimisation of flow control | Increase heat transfer

Another focus of development is the optimisation of flow control within the heating chamber. CFC lamella grids are used as gas distribution plates and precisely designed fans ensure targeted circulation of the process gases.

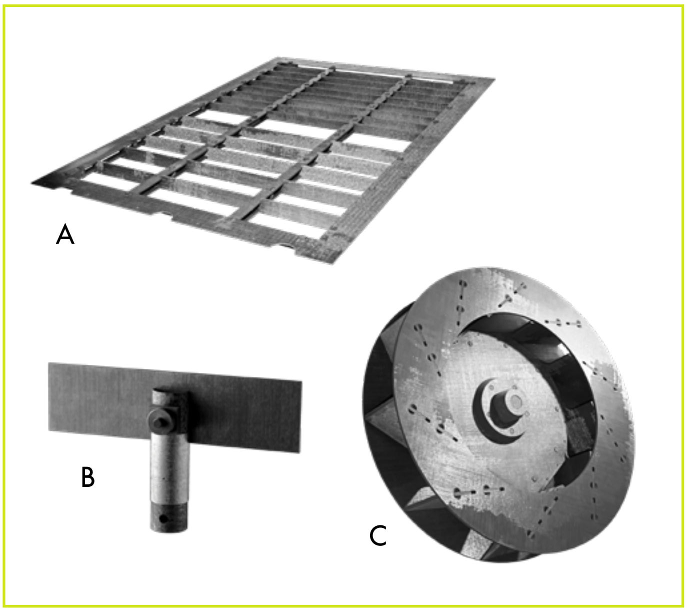


Fig. 1: A Gas distribution plate, B Fan paddle and C Fan wheel for flow control

Simulation-based development

The use of finite element analysis (FEM), computational fluid dynamics (CFD) and thermal models allows for accurate assessment of thermomechanical stresses and optimised arrangement of components within the heating chamber. This improves the design in terms of both energy efficiency and service life. An example illustrates the simulation of fans. Figure 2 shows a comparison of two types of fans – fan wheel and fan blade. While a fan blade requires a high speed to achieve high gas distribution, a fan wheel with angled, flow-optimised blades and coordinated control can achieve a more even gas flow distribution at a significantly lower speed range. In both cases, temperature gradients are minimised and heat transfer efficiency is improved.

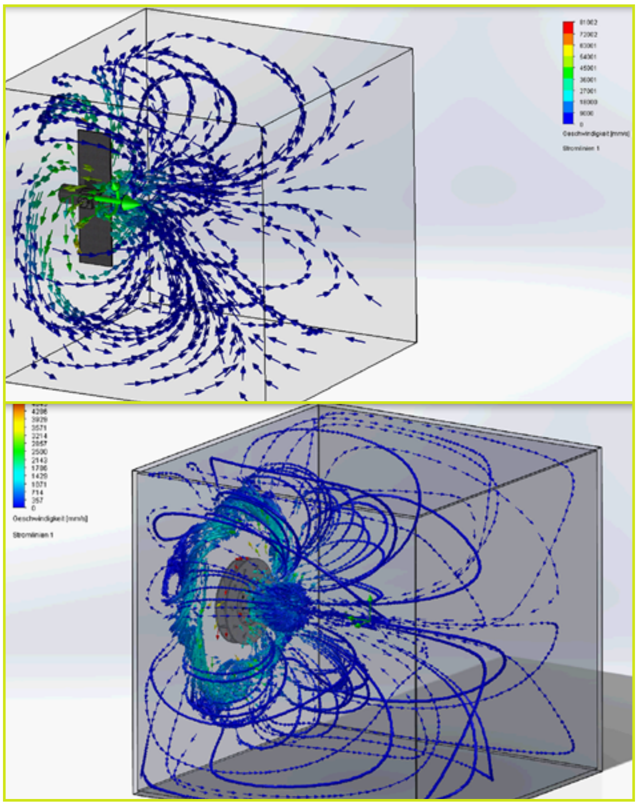


Fig. 2: Gas flow distribution, fan blades at top, fan wheel at bottom

Figure 3 below shows a simulation example of how heat loss can be reduced by optimising the fastening elements of furnace insulation. On the left is a simulated molybdenum bolt protruding from the heating chamber at 1400°C and fastened to the chamber's sheet metal casing with a split pin. On the right is a GM threaded insert screwed into the hard felt plate and shielded with a hard felt plug. The GM insert has an internal thread and acts as an internal nut that can be used to fasten hard felt plates to the sheet metal casing from the outside using a molybdenum threaded bolt. A comparison of the two simulations shows that the use of GM threaded inserts and the resulting outward shift and shortening of the molybdenum bolts reduces heat transfer to the outside. The use of inserts can have a significant impact on energy efficiency, especially in relatively large systems with many connection points.

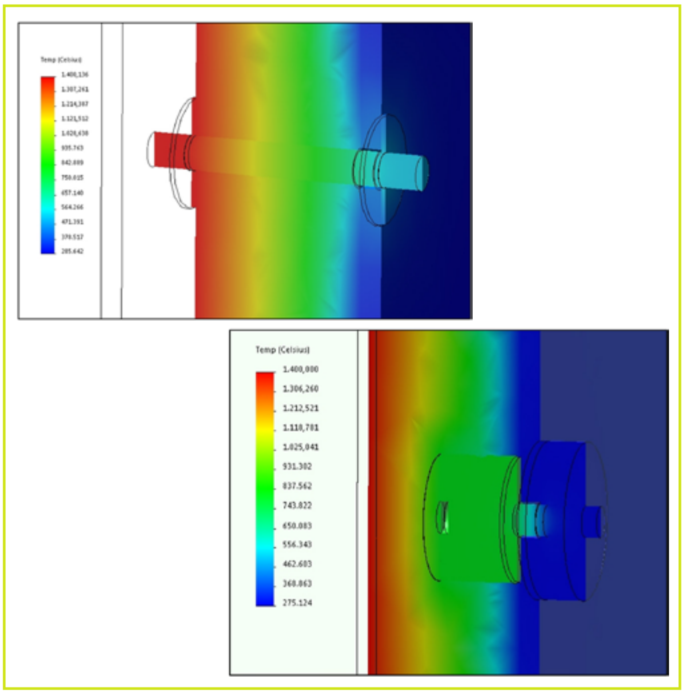


Fig. 3: The simulation shows GM threaded inserts in hard felt panels of oven insulation to reduce heat loss.

Cost-effectiveness | ROI

Investing in custom-made heating chamber linings not only offers immediate efficiency gains, but also long-term benefits for the entire operation of the furnace system. Targeted design and manufacture significantly reduce heat loss and optimise the heating output for the respective process. This leads to a noticeable reduction in energy consumption and thus to sustainably lower operating costs.

In addition, the service life of the components used is considerably extended. The optimised lining ensures homogeneous temperature distribution throughout the entire working chamber, reducing thermal stresses and minimising material loads. At the same time, the precise design ensures uniform heating performance and reliable sealing of doors and flaps.

CONCLUSION

As the central element of modern high-temperature systems, the heating chamber offers considerable potential for optimisation when design, simulation and manufacturing are understood as an integrated development process. The result is a significant reduction in operating costs combined with extended component service life. In addition, the optimised linings increase process stability and ensure reliable, reproducible heating performance. The technologies and design approaches presented thus illustrate the great potential of individual solutions for the further development of furnace systems – both in terms of energy efficiency and long-term plant availability.

Current status as of 10.2025

Graphite Materials GmbH
Rothenburger Strasse 76 | 90522 Oberasbach | Germany

+49 911 9990103-0
info@graphite-materials.com
graphite-materials.com

GRAPHITE MATERIALS

Contact

Graphite Materials GmbH
Rothenburger Straße 76
90522 Oberasbach

Tel +49 911 999 01 03-0
info@graphite-materials.com
www.graphite-materials.com

Graphite Materials GmbH
graphite_materials
Graphite Materials GmbH