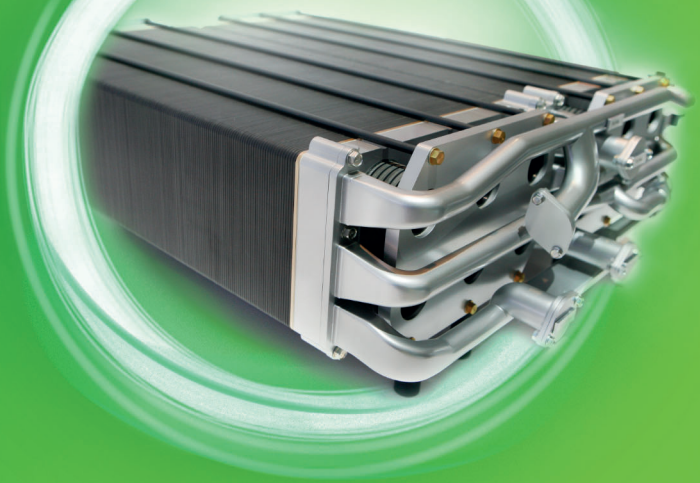
THERMAL SYSTEMS

Safe drying technologies for **fuel cell production**



Drying systems
Special Systems

www.rehm-group.com

Drying

Manufacturing sustainable energy sources with equipment from Rehm

Reliable drying processes
For your fuel cell production

In order to successfully implement the energy transition, it is essential to further reduce the use of fossil fuels. Hydrogen as a substitute for gas and oil is much discussed in this context and is already considered the energy carrier of the future and can be used in many ways. In view of the expansion of e-mobility solutions and other energy-hungry areas, it is becoming a particular focus of attention.

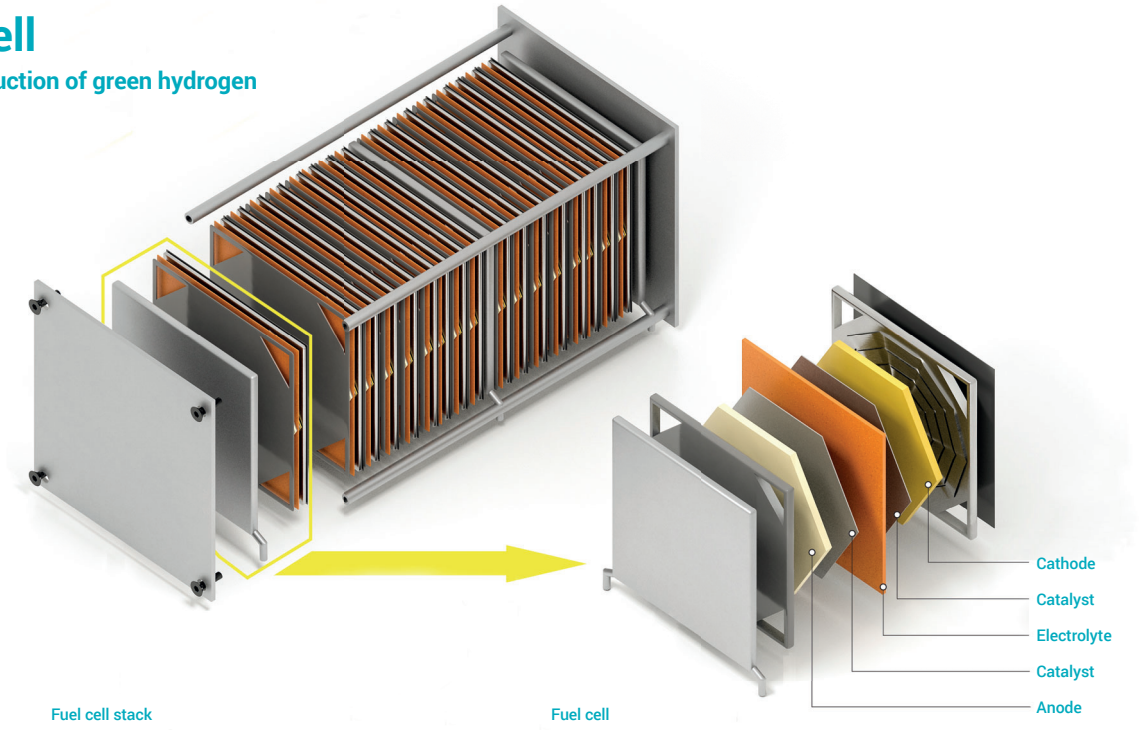
Compared to battery-electric vehicles, fuel cell vehicles are also lighter due to the storage of hydrogen in tanks and achieve significantly higher ranges, an important factor also for use in short-haul aircraft and also in rail transport, where we are already seeing the first trains achieving ranges of up to 1000 km with fuel cells. Currently, only about 60 % of the German rail network is electrified. This means that only diesel locomotives can currently be used on around 13,000 km of rail network. In the future, it will be possible to save up to 500,000 t of CO_2 in rural areas with passenger trains. Hydrogen can also contribute effectively to CO_2 reduction in industry. In the future, energy-hungry industries will be able to produce hydrogen cost-effectively in combination with stationary electrolysers, which are operated with surplus or their own green wind or solar energy, which can be temporarily stored and reused as needed in fuel cell units.

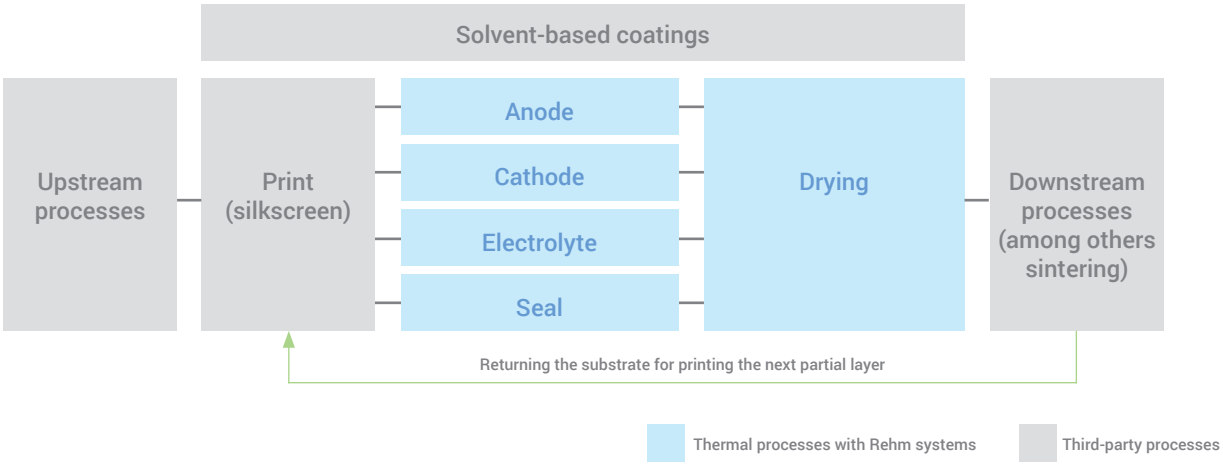
The fuel cell in detail
In focus PEM and SOFC

A fuel cell usually consists of a membrane electrode unit (MEA), which is enclosed by two metallic pole plates (bipolar plates). The media, such as oxygen, hydrogen and water, are supplied and removed via the bipolar plate. The actual power generation takes place through the membrane electrode unit. The PEM and SOFC cells belong to the currently most common and in the future most interesting membrane electrode units.

PEM cells belong to the group of so-called low-temperature fuel cells and operate in the range <100 °C to max. 200 °C operating temperature. SOFC cells, on the other hand, operate at approx. 700 - 1000 °C and therefore rely on ceramic membrane materials. The bipolar plate and membrane electrode unit are then combined as a fuel cell to form stacks in order to achieve the required total output. In the case of the bipolar plate, among other things, layers are dried, which contribute to corrosion protection and increase the electrical conductivity. Furthermore, the seals are usually applied to them, which separate the reaction gases from each other and seal the membrane electrode unit and bipolar plates from the outside.

Fuel cell
for the production of green hydrogen





Flexible, safe and efficient
Sophisticated technologies and know-how

The safe and optimal production of your fuel cells with the systems from Rehm Thermal Systems GmbH.

From sensitive substrates with thicknesses of 20 µm to the drying of hundreds of bipolar plates in one magazine, we will be happy to advise you on the individual options and system configurations that we can implement for your specific requirements. Rehm drying systems are flexible and offer enough scope to realize applications from a wide range of application fields. With well thought-out technologies, the drying of all paste systems on any mold and substrate is successful.

Optimal **line integration!**

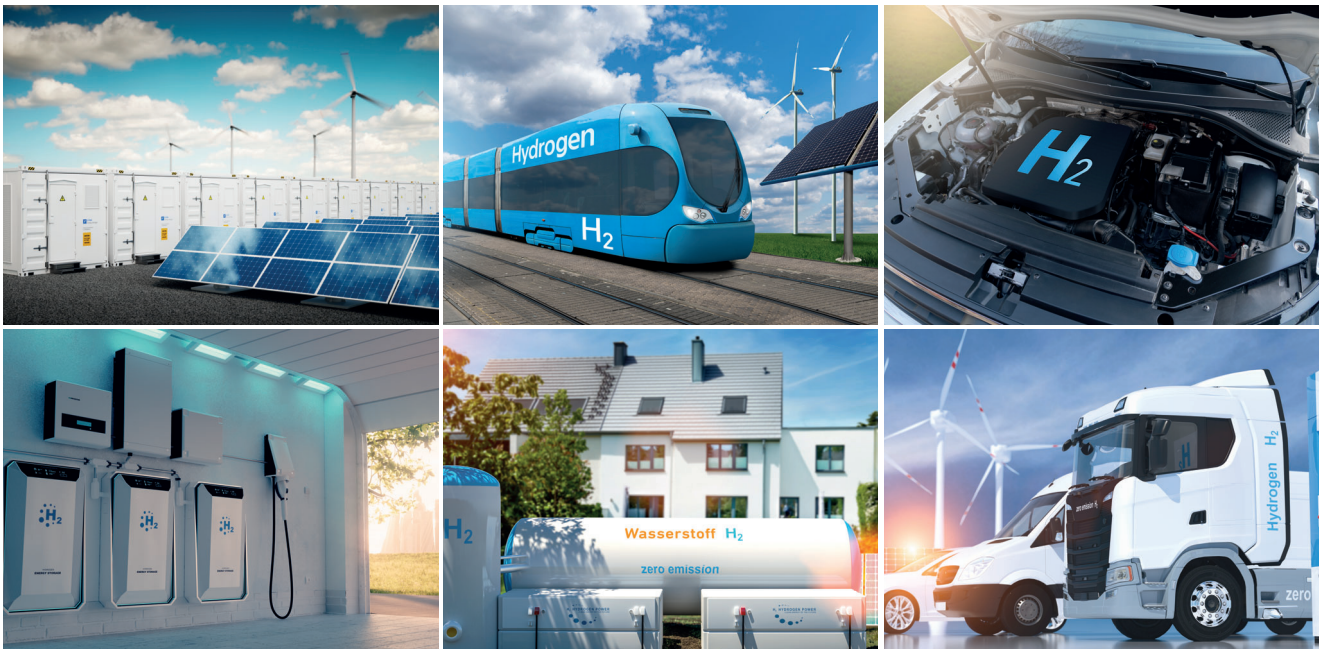
- Heat transfer via convection and IR radiation
- Flexible transport systems
- Optimal profiling
- Excellent energy efficiency
- Easy operation and process optimization
- Traceability

Individual line concepts
Turnkey solution for your requirements

Are you looking for a solution for your entire fuel cell production including screen printing processes and product handling?

Together with our strong partners, we can provide you with comprehensive advice and support. We work with you to develop a line concept as well as, in the sense of a continuously networked environment, concepts that also include a corresponding MES connection, depending on the production environment. The arbitrary combination of different expansion stages such as production data acquisition (PDA), traceability as well as process and material interlocking ensure flexible production.

Areas of application for the use of fuel cells

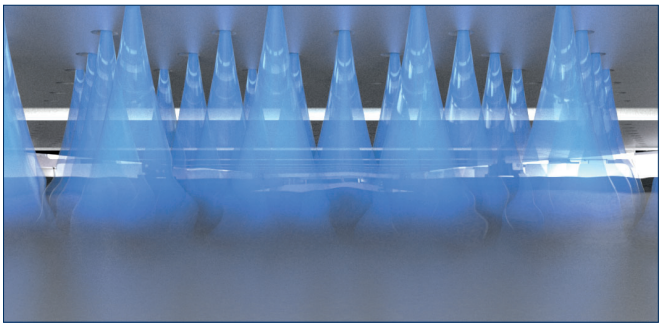


Application areas for the use of fuel cells, such as mobility, heavy-duty transport, rail transport, self-sufficient power supply, domestic application for power generation and hot water support.

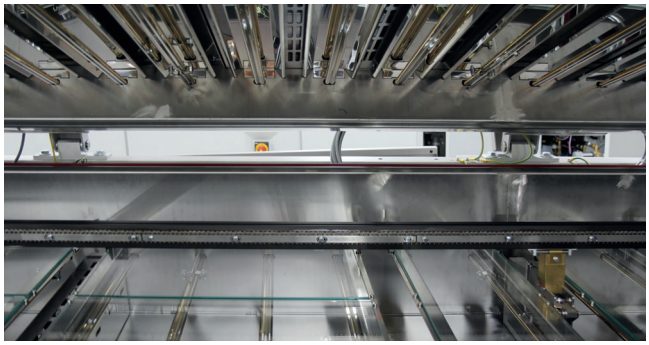
Flexible thermal systems
Variable Wärmequellen

Convective drying

In convection drying, the process atmosphere is heated by a hot air blower and then flows onto the substrates. The heating elements are located above and below the transport system. The flow rates and temperatures of the upper and lower heating zones can be controlled separately so that the assembly is heated evenly. This prevents stresses in the material.



Combination heating process with IR



In the combination heating process, heat is transferred by infrared radiation, which can be supported by central convection heating. All heating chambers are equipped with powerful IR radiators. This enables a faster and more efficient drying process. With the additional convection, the volume flow can be preset. To reduce residue and to protect against soiling and for easier cleaning, all IR emitters in the heating base can be optionally fitted with glass covers.

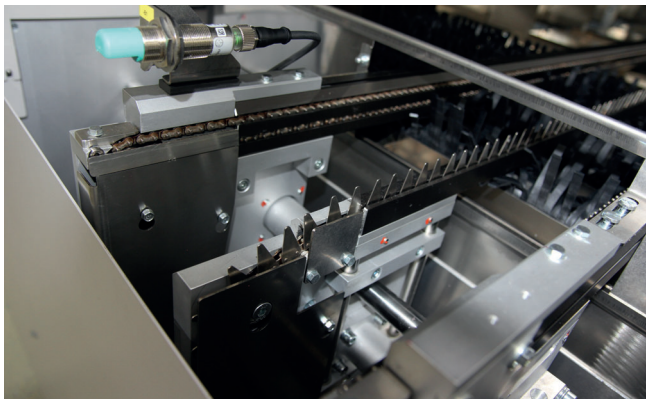
- **First-class heating performance and best thermal management**
- **Top and bottom heating by convection and/or IR heating elements**
- **Variable heating chamber length and optimum process adaptation**
- **All systems available according to DIN EN 1539** (dryer standard for combustible materials)
- **Flexible transport systems according to customer requirements**

Modular system variants
Customized transport options

Magazine

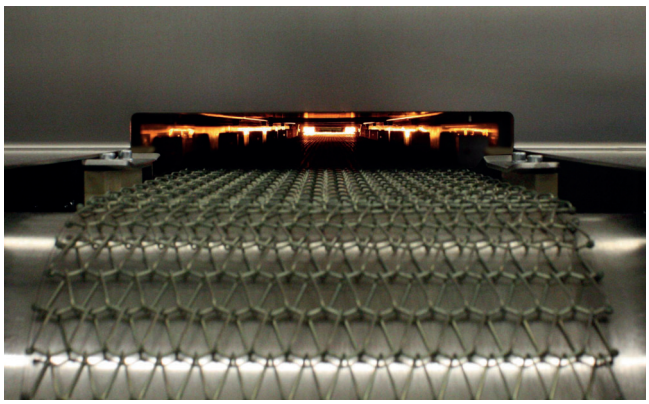
For bipolar plates, which are mainly dried in magazines, we also offer suitable equipment with our individual magazine dryers. The magazines can take on dimensions of up to 500x500x800 mm (LxWxH). Other dimensions can also be considered on request.
The magazines are dried in modular process chambers. Depending on the desired total process time and number of temperature profiles, systems with a length of between 3 and 15 m are available for applications with the highest throughput requirements.

Pin chain transport



For short process times, a pure inline process can also be used. In this case, a pin chain can provide the edge support for the products in the furnace, equivalent to holding the specimens in the system. The advantage is that heat can be introduced unhindered from above as well as from below. With pin chain transport, the transport width can also be variably adjusted so that the system can be adapted to different product widths.

Meshbelt/Band

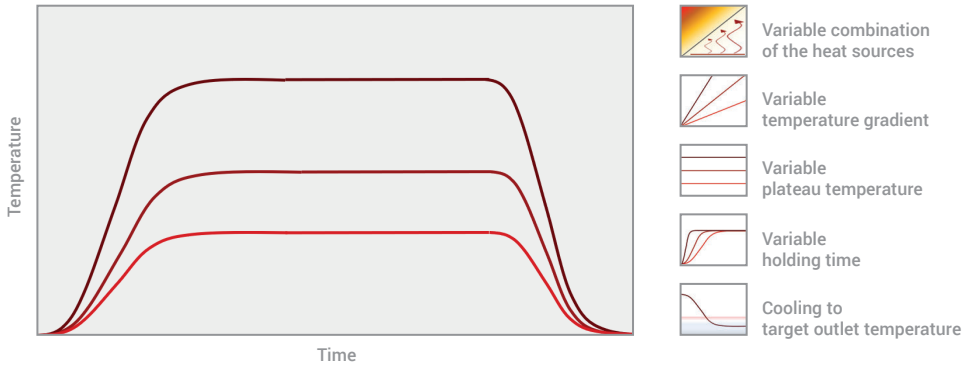


In the case of thin substrates, such as the membrane, full-surface support on a conveyor belt is recommended. Depending on the requirements of the product, a braided or woven belt made of different materials can be selected here.

Process management
Flexible profile design

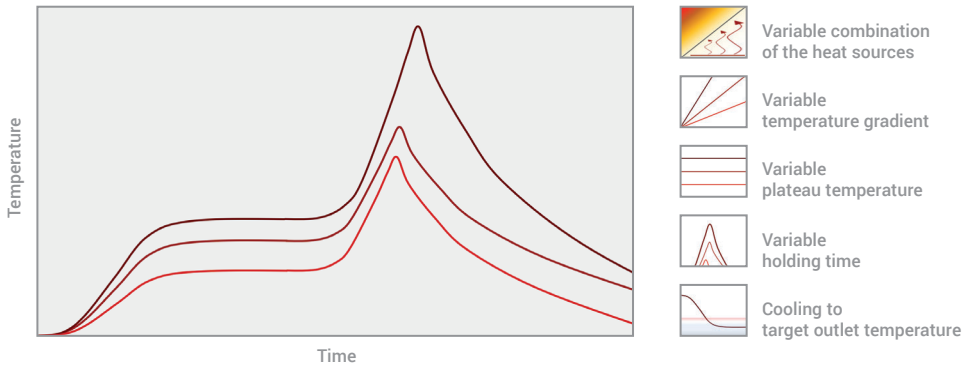
The outstanding thermal insulation of the heating zones and the individually adjustable temperatures enable optimal profiling of your drying processes - perfectly tailored to the requirements of the products.

Plateau profile - heat source combined

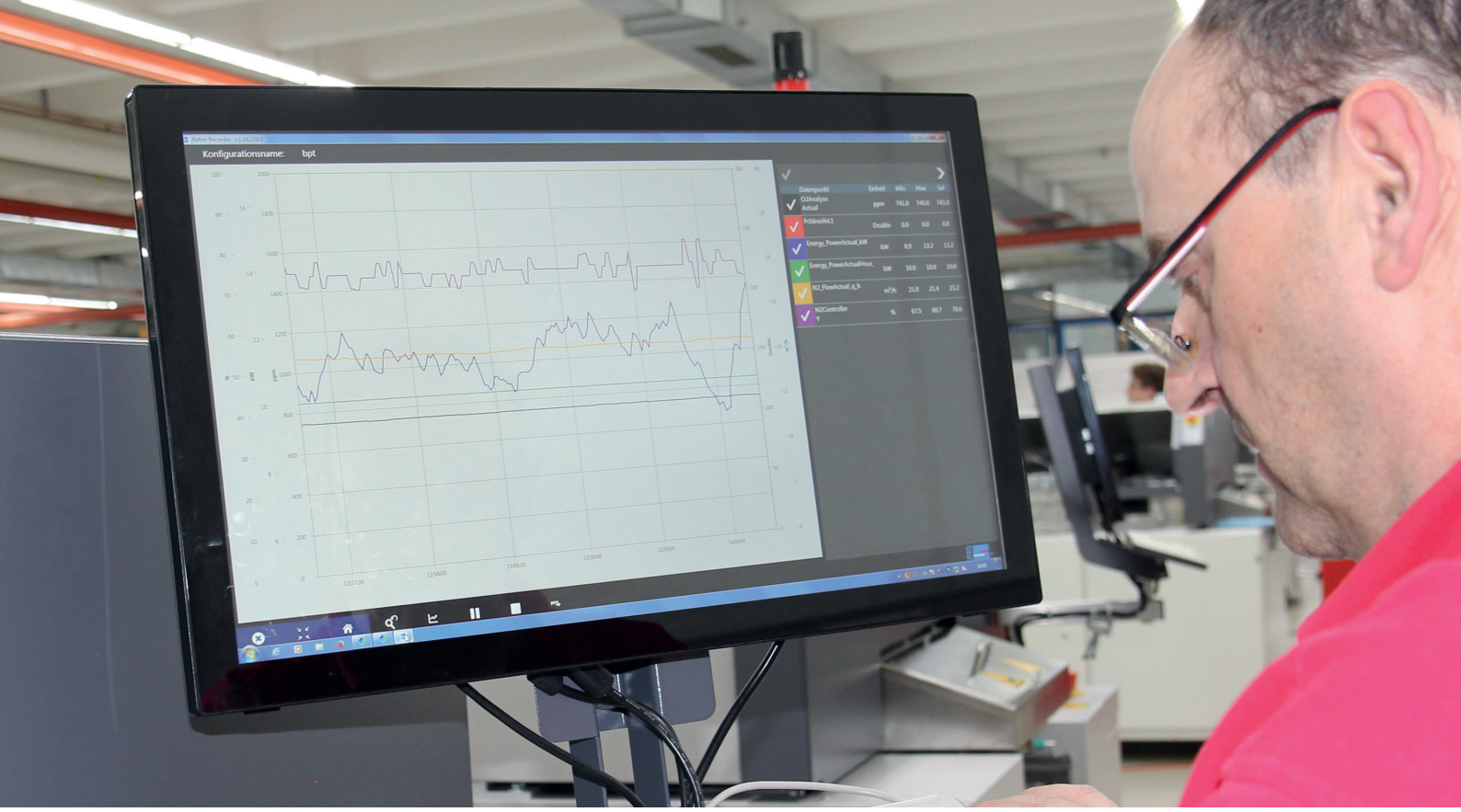


In RDS inline ovens, different heat sources can be used either individually or in combination. The use of IR radiation allows efficient and fast heating of the products to be dried. Here very high temperature gradients can be achieved due to the high heat transfer by absorption of the radiation. Through additional use of convection, temperature plateaus can be kept precisely within their tolerances. The continuous circulation of the atmosphere in the oven not only creates optimum conditions for drying, but also enables solvent management in accordance with DIN 1539.

Peak profile

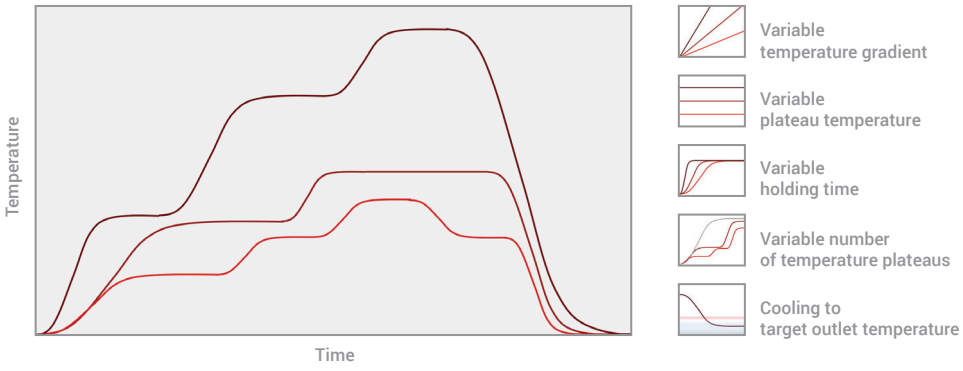


With the use of infrared emitters as heat sources, very high temperatures can be achieved for a short time on the products to be dried in inline ovens. In this way, temperature profiles with a temperature peak can be optimally reproduced. The temperature peak can be at temperatures of up to 900 °C. The integration of a preliminary plateau via convection at temperatures ranging from 100 to 300 °C into profile is flexibly. Depending on the height of the temperature plateau and the subsequent peak, very high temperature gradients can be achieved.



With the integrated Rehm Recorder, hundreds of different data points can be logged in real time

Step profile



In furnaces under pure convection, very variable profiles with any number of plateaus at different temperatures and of different durations can be realized. Maximum temperatures of up to 300 °C and total process times of up to 3 h can be implemented in the furnace. Temperature plateaus can be achieved within precise tolerances so that overheating is reliably avoided. Likewise, the product is cooled down to a target outlet temperature in the subsequent cooling process, so that there is no waiting time for subsequent processes. If such a process is achieved in an RSS magazine, efficient cycle times can be achieved in an inline system despite long process times.

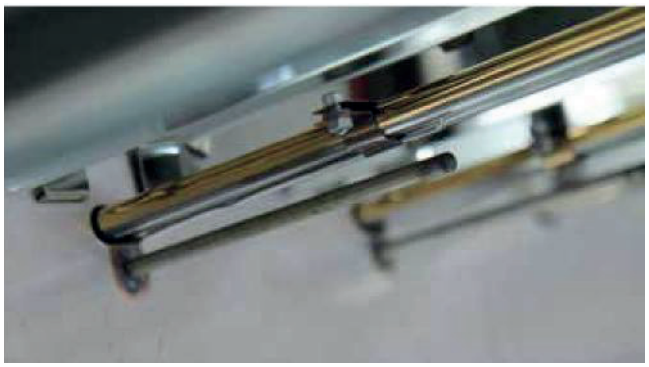
- **Flexible profiling**
- **Optimal zone separation**
- **Stable process control**
- **Safe processes according to DIN EN 1539**

Gentle cooling down
to below 60 °C

After the drying process, the warm process atmosphere is extracted. Nevertheless, the assembly still has an oulet temperature of about 60 °C. A separate air-cooled or water-cooled cooling unit is optionally available, with which significantly lower temperatures can be achieved.

In the air-cooled cooling section, the hot process exhaust air is extracted via the attached exhaust hoses. In addition, cold ambient air is drawn in and blown in via the nozzle array to cool the assemblies. With the water-cooled cooling option, the cooling process takes place via heat exchangers. Separately adjustable fans in the individual zones provide the option of precisely controlling the cooling process and influencing the cooling gradient accordingly.

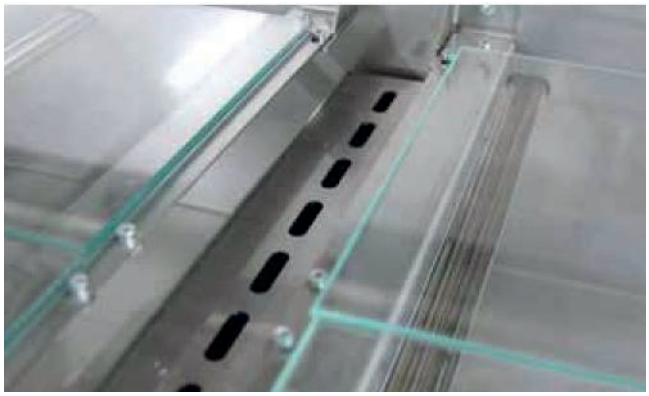
Internal temperature monitoring



To ensure that the components can be optimally cured, the dryers have internal temperature monitoring. Thermocouples are mounted in each heating zone, which precisely measure the temperature in the system. The values are displayed on the monitor. As soon as the tolerance values are exceeded, an acoustic alarm is triggered and the heating is switched off.

Exhaust air system with integrated extraction unit DIN EN 1539

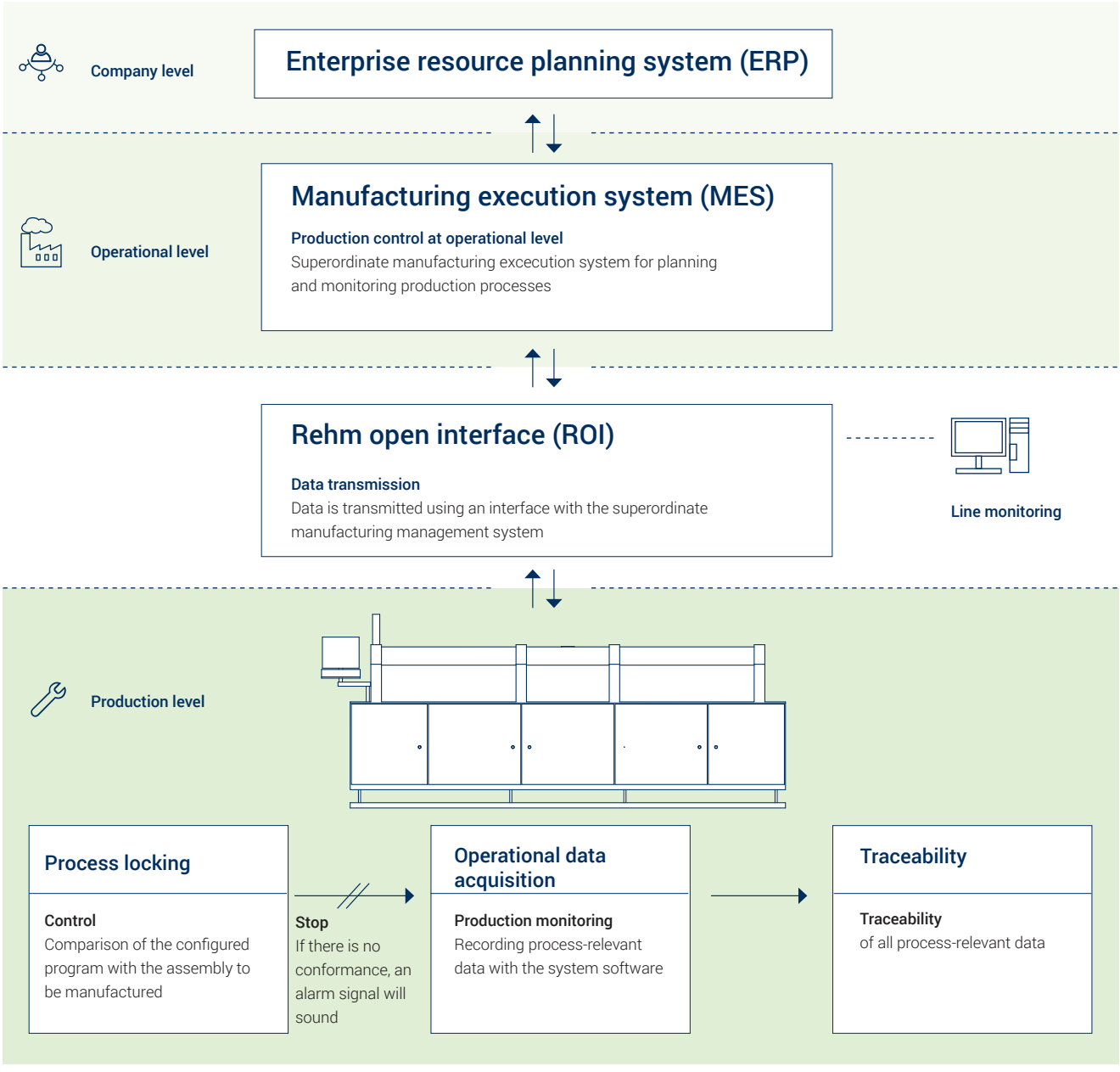
The exhaust air system ensures, among other things, the safe removal of solvents. Appropriate devices are installed at the inlet and outlet of the process chamber and between the heating zones. The process exhaust air is fed directly to the house exhaust system by the blower. The exhaust products released determine the exhaust volume. The exhaust function is monitored in accordance with the requirements of DIN EN 1539. In the event of a problem, the heater switches off automatically and the inflow of new assemblies is stopped. Thus, no flammable gas mixtures can form in the plant.



Process documentation, traceability and co.

The variety of MES systems on the market requires individual adjustment of data transfer from the Rehm drying system to the client's superordinate manufacturing excecution system (MES). Superordinate to this is the ERP system, which keeps an eye on the whole company, and which allows for logistic optimisations across all sites. However, the MES focuses on a company's individual production lines. Rehm uses an ROI interface (Rehm open interface) to transfer individual data. Machine-specific operational data that is due for the respective system is collected and passed on to the MES as a bundle.

It is possible to ensure the seamless traceability of products, components or batches in this way. A data set is created for every assembly, which documents the relevant process parameter during the run. The assembly can be clearly identified and assigned via a barcode scan on the assembly itself, or by scanning the batch card. Process locking is also available as an option. Here, the scan is compared with the database and the assembly is only forwarded on to the system in the event of approval. Defects can be detected and prevented in this way and therefore lead to process improvements.



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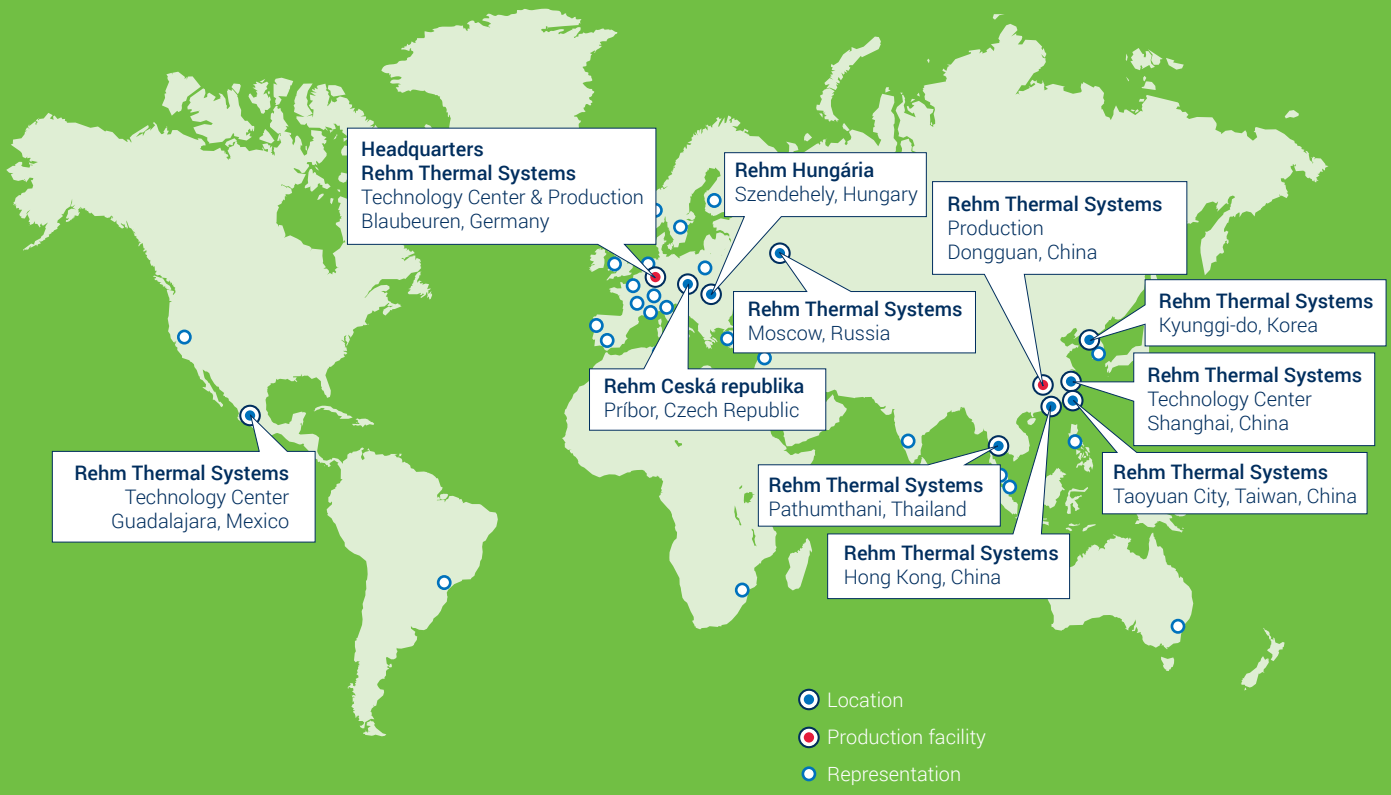

Rehm Worldwide

As a leading manufacturer of innovative thermal system solutions, we have customers on every continent. With our own locations in Europe, the Americas and Asia as well as 27 agencies in 24 countries we are in position to serve the international markets quickly and to offer outstanding on-site service – worldwide and round the clock!

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