

Safety Concept for Debinding in Air

Debinding of technical ceramics is a demanding process due to the released hydrocarbons which subject to the corresponding concentration can cause a formation of an ignitable mixture inside the furnace. Depending on the process and the quantity of binder, Nabertherm offers tailored passive and active safety packages to ensure a safe operation of the furnace.

Debinding in an Electrically Heated Furnace

For debinding in air with electric heating Nabertherm offers various debinding packages tailored to the individual process requirements. All debinding packages have professional integrated safety technology. Passive or active safety concepts are available, depending on the specific requirements. The passive safety concepts differ upon the requirements for the quantity of organic materials, process reliability, and temperature distribution.

Passive Safety Concepts

As standard Nabertherm debinding furnaces are equipped with a passive safety concept to allow for a slow vaporization of flammable substances. The electrically heated furnaces work according to the dilution principle by introducing fresh air to reduce the degassing from the charge to a non-ignitable atmosphere in the furnace. The customer has to choose the quantity of organic materials as well as the temperature curve, to make sure that the maximum permissible rate of vaporization is not exceeded. The furnace DB safety package monitors all safety-relevant process parameters and initiates a respective emergency program in case of a malfunction. The passive safety concept has proven itself in practice due to its good price performance ratio. Depending on the process requirements, the following equipment packages are available.

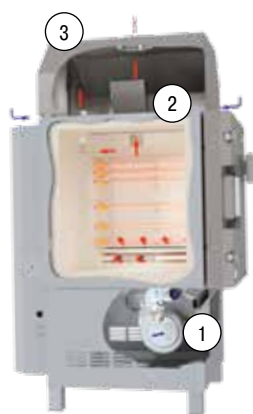
DB50 Debinding Package for Laboratory Furnaces

The DB50 debinding package is especially designed for laboratory furnaces and for processes with low evaporation rates e. g. for product and/or process development. The furnace is equipped with a fresh air fan. The fresh air fan is pre-set in the factory for the minimum volume of fresh air required for the debinding process. The furnace is operated with overpressure during the debinding process.

Monitored process states for safe operation:

- Fresh air volumetric flow rate

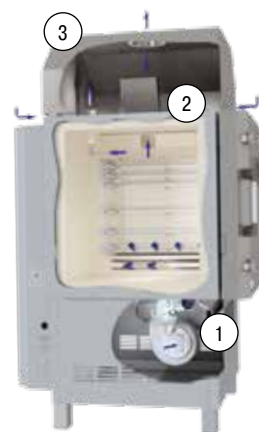
Air Management for the Process Steps Debinding (Left), Sintering (Middle) and Cooling (Right) with Debinding Package DB50:



Debinding: Supply of the defined amount of fresh air via fresh air fan (1), exhaust gases discharged via the exhaust air flap (2) into the exhaust hood (3)



Sintering: Sintering without fresh air supply via fresh air fan (1) and closed exhaust air flap (2)



Cooling: Supply of cooling air via the fresh air fan (1) into the furnace chamber, exhaust air discharged via the exhaust air flap (2) into the exhaust hood (3)

DB100 Debinding Package for Production Furnaces with Radiation Heating

The DB100 debinding package is the basic option for safe debinding in furnaces with radiation heating. The furnace is equipped with a fresh air fan and a fresh air preheater. The fresh air fan is pre-set in the factory for the minimum volume of fresh air required for the debinding process. The furnace is operated with overpressure during the debinding process. Exhaust air and exhaust gas are blown out via an outlet equipped with a motorized flap into an exhaust hood with exhaust interruption. The exhaust hood is the interface to the customer's exhaust air system.

Monitored devices and process states for safe operation:

- Electromagnetic door lock
- Redundant monitoring of fresh air volume flow
- Position of the fresh-air flap
- Position of the exhaust air flap
- Max. heating speed during debinding
- Power loss (emergency program after power has returned)
- Fresh air fan
- Thermocouple break
- The furnace controls respond differently depending on the specific malfunction and put the furnace into a safe condition.

Air Management for the Process Steps Debinding (Left), Sintering (Middle) and Cooling (Right) with Debinding Package DB100:



Debinding: Supply of the defined amount of fresh air via fresh air fan (1) and monitoring of the amount of fresh air (2), preheating of the fresh air via fresh air preheater (3), discharge of the exhaust gases via the exhaust air flap (4) into the exhaust hood (5)



Sintering: Sintering without fresh air supply via fresh air fan (1) and closed exhaust air flap (4)



Cooling: Supply of cooling air via the fresh air fan (1) into the furnace chamber, exhaust air discharged via the exhaust air flap (4) into the exhaust hood (5)

DB200 Debinding Package for Production Forced Convection Furnaces or Radiation Heating

The DB200 debinding package is the professional solution for the ceramics production because it can be used flexibly for different debinding processes and also for changing debinding processes. Like with the DB100 debinding package, the fresh air required for the process is preheated. The system is available in different performance levels depending on the required evaporation rate. The air is introduced via ceramic tubes that blow the preheated air into the furnace chamber horizontally. This ensures very good heat transfer and improves the temperature uniformity during debinding.

As opposed to the DB100 debinding package, exhaust air and exhaust gas are extracted via separate outlets, each equipped with a motorized flap. The furnace is equipped with a fresh air fan and an exhaust gas fan. Both devices are reconciled so that the volume of air required for the debinding process is blown in and, at the same time, negative pressure is controlled in the furnace chamber. The exhaust gases during the debinding phase are extracted through the exhaust gas outlet, which is connected directly to the local exhaust gas piping. Due to the direct connection, the exhaust gas volumes are reduced and subsequent exhaust gas treatment systems can be dimensioned smaller. Nabertherm also offers catalytic or thermal post combustion systems for furnaces with safety package for debinding.

For cooling, the exhaust air blown out into the exhaust hood with exhaust interruption, which is the interface to the customer's exhaust air system.

Monitored devices and process states for safe operation like DB100, but:

- Position of the exhaust gas flap
- Malfunction of exhaust gas fan
- Underpressure in the furnace chamber

The Main Advantages of the Described DB200 Debinding Package Compared to the DB100 Debinding Package Are:

- Automatic control of the exhaust gas fan in relation to the selected volume of fresh air. This is beneficial for temperature management (uniform temperature) and an adaptable extraction of the exhaust gas volumes. Reduced odors and condensation in the exhaust gas piping.
- Horizontal, even supply of preheated fresh air in the charging levels of the furnace chamber via perforated air inlet tubes
- Extension with catalytic or thermal post combustion for a single furnace or for alternating operation with two furnaces. The design of the performance of the post combustion is adapted to the performance of the debinding package DB200.

Air Management for the Process Steps Debinding (Left), Sintering (Middle) and Cooling (Right) with Debinding Package DB200:



Debinding: Supply of the defined amount of fresh air via fresh air fan (1) and monitoring of the amount of fresh air and exhaust gas as well as the oven pressure (2), pre-heating of fresh air via fresh air preheater (3), discharge of the exhaust gases via the exhaust gas flap (4) with exhaust fan (5)

Sintering: Sintering without fresh air supply via fresh air fan (1) and closed exhaust gas (4) and exhaust air flap (6)

Cooling: Supply of cooling air via the fresh air fan (1) into the furnace chamber, exhaust air discharged via exhaust air flap (6) into the exhaust hood (7)

Assignment of the Debinding Packages to the Furnace Groups

	LH 30/.. - LH 120/..	NA 120/.. - NA 1500/..	N 100/..	N 200/.. - N 1500/..	W 1000/.. - W 7500/..	H 125/.. LT - H 1000/.. LT	HT 16/.. - HT 40/..	HT 64/.. - HT 450/..	HT 64/.. LT - HT 400/..LT
Catalog page	52	48	16	16	22	28	34	34	40
Debinding package									
DB50	•		•				•		
DB100				•	•	•	•	•	•
DB200		•		•	•	•	•	•	•

Active Safety Concept

Alternatively, the passive safety concept DB200 can be upgraded with an active safety concept. Compared to the passive safety concept, the limit concentration of hydrocarbons in the furnace chamber is constantly monitored using flame temperature analysis (FTA).

Accordingly, the fresh air and exhaust fans as well as the furnace heating are automatically adjusted to the hydrocarbon concentration that occurs during debinding. The temperature curve can be optimally adjusted or shortened depending on the amount of exhaust gas. In case of an unsafe situation in the furnace, e.g. due to overloading, a too fast heating gradient or too low fresh air supply, the necessary emergency program is initiated in stages, depending on the process step and error category.

Furthermore, the amount of fresh air supplied and the amount of exhaust gas removed is actively reduced in process phases during debinding, in which only little or no binder outgassing are present. As a result, energy consumption of the entire system for these process phases is reduced and respectively energy efficiency is enhanced.