Save Time and Money in your Sintering-Process - with Thermo-Kinetic Simulation and Thermal Analysis!

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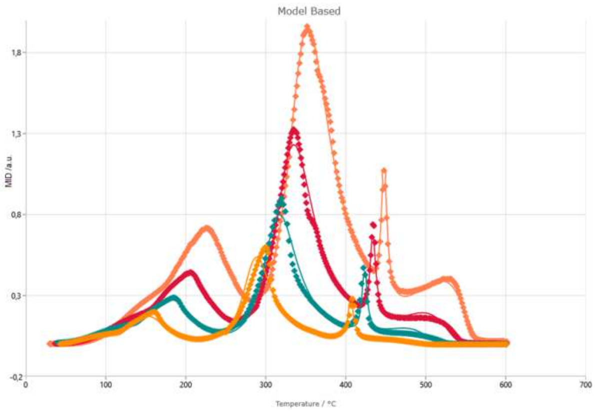

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NETZSCH customers in the ceramics industry were able to accelerate their sintering processes by up to 60% with KINETICS NEO without compromising material quality.

Whether technical ceramics, sanitary ware or tableware - the manufacturing process of every ceramic component basically undergoes similar basic manufacturing steps.

The tedious step in which the fragile, shaped green body becomes a robust, dense ceramic body at high temperature is called sintering. In this step, the goal is to achieve the theoretically highest density with low energy consumption in a short time.

During the sintering process, various processes take place simultaneously:

- Grain boundary diffusion.
- Surface diffusion.
- Lattice diffusion.
- Phase transitions.

Depending on the local temperature, particle size and atmosphere, the process with the highest conversion rate dominates. The kinetics (speed and time sequence) of the corresponding processes is difficult to predict in advance.

What happens at what time and at what temperature in a sintering component can be reconstructed with thermoanalytical and thermophysical measuring methods:

- Dilatometry - shows temperature dependent **length- and volumechanges** and gives information about phase transformations which are accompanied by a change of the expansion coefficient. It tells us, where **sintering-steps** accur.
- Thermogravimetry - gives information about **debindering and dehydration** my detection of temperature-depending mass-loss.
- Differential Scanning Calorimetry - characterizes **phase transitions** based on their energy expenditure and provides information about the specific heat capacity.
- Simultaneous Thermal Analysis - combines Thermogravimetry and Differential Scanning Calorimetry into one method.
- Laser- or Light-Flash-Method - shows the **thermal diffusivity** and by knowing the density and the specific heat capacity is gives the **thermal conductivity**. This helps to transfer sintering behaviour to **bigger parts**.

All these methods show us in time sequence and in relation to the temperature how a sintering body of a certain size and shape behaves.

Design and optimization of firing programs.

The process-engineer can use "trial & error" to find suitable firing programs. He tries to do justice to each individual process during the sintering process. This leads to long firing programs that do not optimally match the real course of the sintering process.

What can I do to find the optimum for my process?

At first, it makes sense to look at the dehydration and debindering by Thermogravimetry. With this Method you get worthwhile data about the temperatures, where the specimen lose weight - which tells us: "Something comes out of the material". If you see no longer mass losses, you can assume, that debindering is completed.

In a second step, you characterize your material with the help of dilatometry. With dilatometry you see, where sintering starts and on which temperatures sintering steps accur. Finally, if you see no longer shrinkage, the sintering is completed.

Running both tests under different heating rates, it tells you, how the processes are depending on speed.

Now "Thermo-Kinetics" come into Play!

If you load those data, which were developed under different heating rates into the simulation software KINETICS NEO, the reaction kinetics can be mathematically modeled. What you get is a simulation model that reliably describes the temperature-dependent and time-dependent processes in your material. The Picture shows the Dilatometer-Curves and the fit-calculation from the model.

With this model you can now simulate ANY burning program and the effect on your sintering process by simple tabular input.

Example 1: Modelled sintering curve based on a simple temperature program with one isothermal segment (100 Minutes).

With the respect to the conversion rates in every sintering step, you can optimize you firing program directly in the software and see, how the change of program will affect the sintering process and the conversion rates for every step. Too big conversion rates can cause cracks or deformation on your parts. The model for the conversion rates can be seen in the picture based on different heating rates. The challenge is to find out, what the maximum conversion rate will be without compromising the quality.

Next to more complex sintering programs, the easiest first step is to simulate with a constant conversion rate - what you get as a result is the temperature curve:

Example 2: Modelled temperature curve based on a conversion rate of 0.5%/min.

With optimizing your debindering and sintering process with the respect to maximum conversion rates and the ability of your furnace in terms of heating- and cooling rates, you will get close to the optimum with modelling your firing programs in the software.With Thermo-Kinetic Simulation you'll get faster to the optimum!

Feel free to test our Software for 30 days - free of charge! See our WEBSITE!

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