Setpoint gradient

KS 90-1 application

Prevents material stress during start-up

Gradient after setpoint change

Monitoring for functional faults

Bumpless line-out after a disturbance

Ramp restart via relative limit value

Programmer

KEYWORDS

Bandwidth alarm, setpoint gradient, bumpless warm-up, ceramic components, sintered parts, sinter material, corundum, tempering furnaces, annealing furnaces, sintering furnaces, calenders, reactors

DESCRIPTION

Numerous applications involve gentle heating of material (plastic components, films, steel, sintered and ceramic parts, etc.) by various means, e.g. tempering or annealing furnaces, sintering furnaces, and calenders.Sudden temperature variations (e.g. due to power-up after a disturbance) or setpoint change can lead to the loss of an entire batch of valuable heat-treated products.

Therefore, control of the temperature setpoint must be easily adaptable to the changed conditions. A basic requirement for this is an integral programmer function in the controller, which allows free setpoint adaptation.

Without reliable adherence to the necessary heating requirements, there is always a remaining risk of malfunction, e.g. due to human error (incorrect settings), unforeseeable disturbances such as mains failure, heater failure, and faults in equipment or wiring.

In these cases, the KS 90-1 programmer is able to ensure that a setpoint ramp is activated automatically as soon as the control deviation exceeds a preset bandwidth. The programmer takes over at the actual process value, and gently brings the temperature back to the correct setpoint.

IMPLEMENTATION

Tempering describes a process in which the material is heated slowly to a specified temperature, where it is held for a defined period to remove internal stresses.
Usually, this temperature lies just below the material's melting point. Depending on the material, the working range can be anywhere up to 0...950 °C.

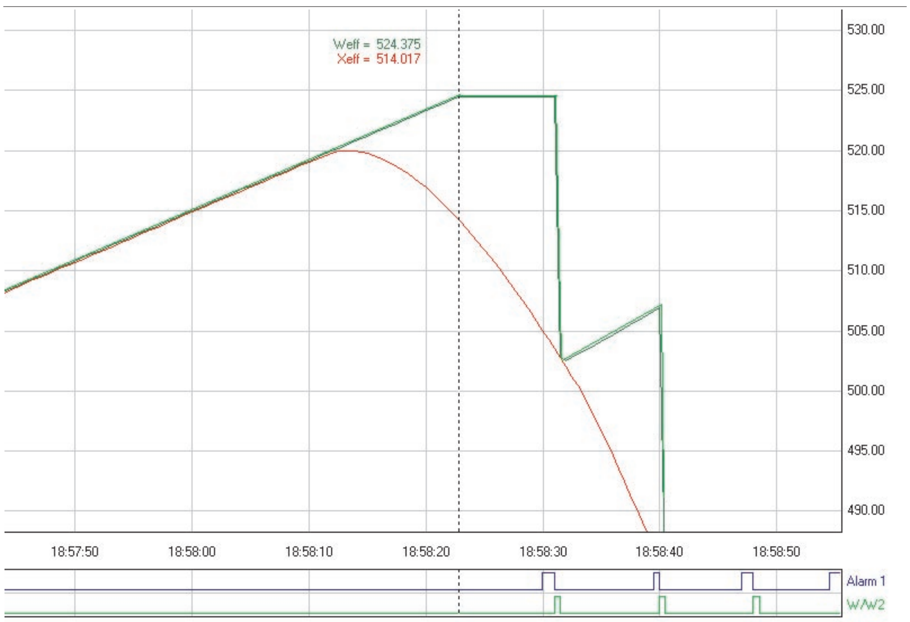
With injection molded parts, this process relieves the material of stresses induced e.g. by the injection cycle, irregular holding pressure or uneven cooling.

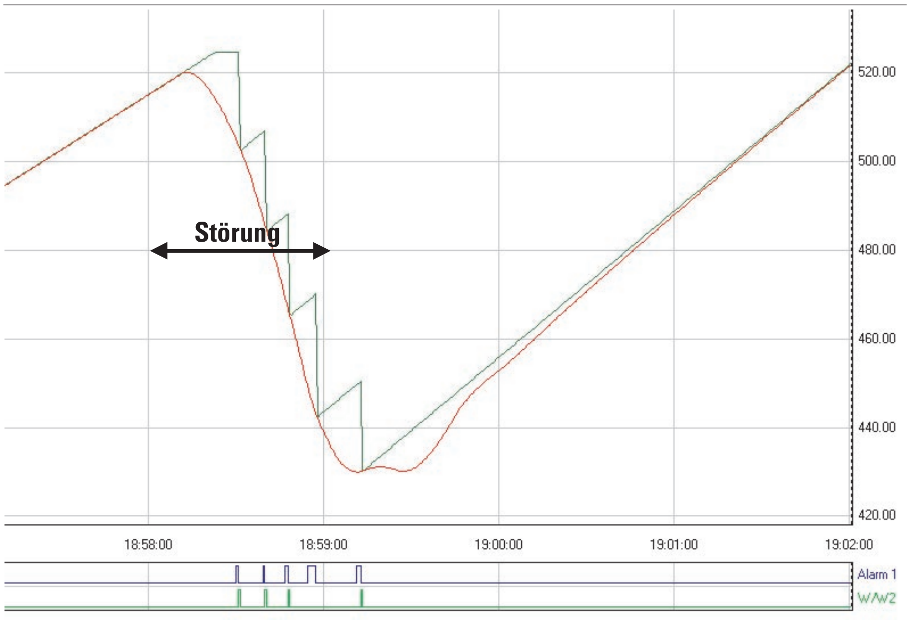
Sintering involves the heat compaction of finely-grained material at temperatures below the melting point.

During these program-controlled thermal processes, excessively high temperature increases in case of a disturbance must be prevented. Similar requirements are also found in the pharmaceutical industry.

Without suitable counter measures, the following could happen in case of a disturbance:
After a short heater failure, the process value has dropped below the permissible deviation bandwidth (e.g. ± 10°C), which triggers an alarm.

Normally, this alarm (configurable in the KS 90-1) would stop the programmer, to prevent the process value and setpoint drifting even further apart.





Should the process value continue to fall (disturbance still present), the procedure is repeated as soon as the new control deviation is more than -20°C, as described above.

Thus a pulse is generated every -20°C, which makes the setpoint gradient start from the respective new process value.

As soon as power returns to the heaters – after repair or fuse replacement – the controller will attempt to bring the temperature back into the permissible bandwidth as quickly as possible, i.e. by applying the full heating power. However, it is precisely this rapid temperature increase that must be prevented.

The reason is that the material being treated, as well as the plant itself, could be damaged by an excessively fast temperature change.

For example, in plants where the tempering zone consists of a thin-walled ceramic tube, a fast temperature increase can easily cause fractures in the tube. Consequently, a separate heating gradient must be activated to gently bring the process temperature back to the required setpoint.

A solution for the overall task is offered by the KS 90-1 programmer:
A programmer permits the adjustment of a predefined temperature profile. In case of an excessive control deviation, a bandwidth alarm stops the programmer. An additional relative limit value alarm is triggered in case of an even larger deviation (e.g. –20 °C).

By linking a digital output to a digital input, the relative alarm switches the KS 90-1 from W to W2.
A setpoint gradient (towards W2) is entered, which causes the program to start at the actual process value. The setting for W2 is fixed at 0.

The situation as shown in Fig. 2 above: With a control deviation of more than 10 °C from the programmer setpoint, the programmer is stopped (bandwidth control).

As soon as the temperature drops by more than 20°C below the effective setpoint, the controller is switched to W2 = 0.

This activates the setpoint gradient, whereby the actual process value is used as the starting setpoint for the gradient towards W2. During the next step, the additional limit value is deactivated.

Because the setpoint is now 0, the process value is considerably higher, so that W = X, and the bandwidth limit is still active (programmer stopped) because Wpg is higher than X.

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