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Gesellschaft für Anlagensicherheit
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Determining the Self-Ignition Temperature of Dust Deposits

Most solids produced or handled in the chemical industry are powders. These substances have a large surface/volume ratio enabling oxidation processes to occur already at room temperature. Due to the poor heat dissipation of bulk materials, the substance might heat up or even ignite on its own. According to the relevant standards and regulations "self-ignition" is defined as a temperature increase by more than 60 K (compared to the initial storage temperature). If the temperature increase is less, this is denominated "self-heating".

Generally, the self-ignition temperature is determined by several isoperibolic heat storage tests at different constant temperatures and different sample sizes. This method takes a lot of time and needs large amounts of the substance. However, our customers frequently can only provide a relative small amount of the material for the required investigations.

To gain an economy of time, costs and material for our customers, we offer the advantages of adiabatic wire basket tests. For this purpose the sample is filled into a wire basket of a volume of 400 ml for isoperibolic storage over 24 h. If no self-heating occurs within this period of time, the oven temperature is increased so slowly, that a uniform temperature distribution in the sample volume can be assumed. As soon as the sample temperature exceeds the oven temperature, the oven temperature is regulated to trace the sample temperature. Thus, adiabatic conditions are provided in this phase of the test.

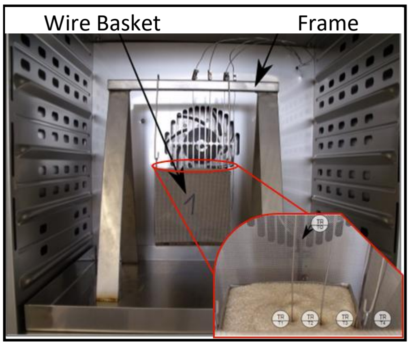

Figure 1

Figure 1 shows the experimental set up as used in our laboratory. Additionally to the core temperature, the temperature at the surface, and the temperature midway from center to surface are measured.

A typical kinetically evaluated test is depicted in Figure 2. The sample was tempered at 50°C and subsequently stored at 100°C for 24 h. As no self-heating occurred, the oven temperature was increased by 1 K/h. At approximately 152°C the sample temperature exceeded the oven temperature and self ignition came to pass.

This kind of experimental procedure induces advantages for our customers. Due to the adiabatic conditions the values for the activation energy EA, the Arrhenius prefactor k0 (from the linearized slope of the temperature rise curve caused by self-ignition), and the thermal conductivity a can be derived from the tests. From these values plus the geometry of the sample, the required self-ignition temperature can be evaluated iteratively using the “theory of stationary heat explosion” by *D. A. Frank-Kamenetskii*.

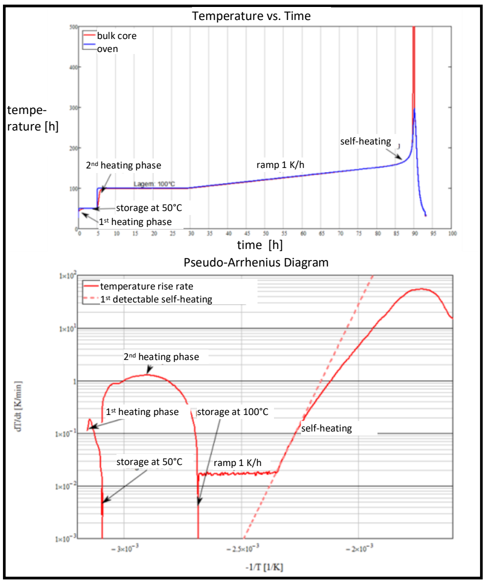

Figure 2

In contrast to isoperibolic experiments, the self-ignition temperature for larger bulk sizes can be directly derived from the measured values with respect to the geometry. An extrapolation procedure is not required, and the activation energy is considered. The obtained temperatures are significantly more reliable, which leads to a considerably higher safety level for our customers.

If we can support you at a similar task, please feel free to contact us. Our experts will be happy to place our services at your request.

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