EVONIK INDUSTRIES

Dust-Explosion Protection in Handling Systems for Surface-Modified AEROSIL®

Technical Information 1363

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1 Introduction

This information sheet is intended as an introductory guide to the regulations and directives that exist in Germany. The final decisions on ensuring the safe design of the system to be built can be made only on the basis of the technical literature indicated and/or expert opinions.

1.1 What is surface-modified AEROSIL®, and does it pose a hazard?

Obtained by flame hydrolysis, AEROSIL® is a synthetic amorphous silica, which in its original form is non-flammable and therefore non-explosive. Hydrophilic AEROSIL® grades (non-surface-treated) are in fact used in the production of fire-resistant materials. No risk of dust explosion exists here.

In the case of surface-modified AEROSIL® grades, each grade must be individually considered. Because there are organic chemicals on the surfaces of these AEROSIL® grades, the behavior may vary depending on the quantity and kind of the chemicals used.

Recent studies carried out in connection with changes in test standards, have shown that dust explosions were observed for some of the surface-treated AEROSIL® grades produced by Evonik. As described in the safety data sheet, however, these dust explosions occurred only at quite high concentrations and at high ignition energies, as shown in Table 1. For these AEROSIL® grades, therefore, safety must be considered and the necessary protective measures taken.

1.2 Handling systems

Handling, in this case, is understood to be all stages of storage and internal transport of AEROSIL®. This includes emptying the package and internally conveying the product, storing it in containers and silos, and metering it into the processing equipment. All the information given here assumes that nothing except AEROSIL® is present in the handling system. Other substances that may be present must also be taken into consideration because their presence could significantly change the information given below.

2 Dust-explosion hazards and surface-modified AEROSIL®

In the above mentioned tests, a dust-explosion potential was found for the following AEROSIL® grades.

Table 1
AEROSIL® grades with dust-explosion potential.

Product	Minimum ignition energy (as determined in a 1 m^3 container)	Lower dust concentration (lower explosion limit)
AEROSIL® R 805	1 kJ < MIE < 10 kJ	1,500 g/m^3
AEROSIL® R 208	1 kJ < MIE < 10kJ	500 g/m^3
AEROSIL® RY 300	1 J < MIE < 150J	125 g/m^3

Table 1 shows the dust-explosion hazard for the AEROSIL® grades. Because these AEROSIL® grades can be brought to explosion with energies as given in Table 1 in a 1 m^3 test apparatus, they are regarded as dust-explosible under the meaning of VDI 2263 [1]. Moreover, these AEROSIL® grades are to be classified in the lowest dust-explosion class, ST 1 ($0 < Kst \leq 200$ bar m s^{-1}). For further and more accurate estimation of the hazard, however, additional details must be considered. The necessary parameters, the minimum ignition energy, and the lower dust concentration can be found in the safety data sheets.

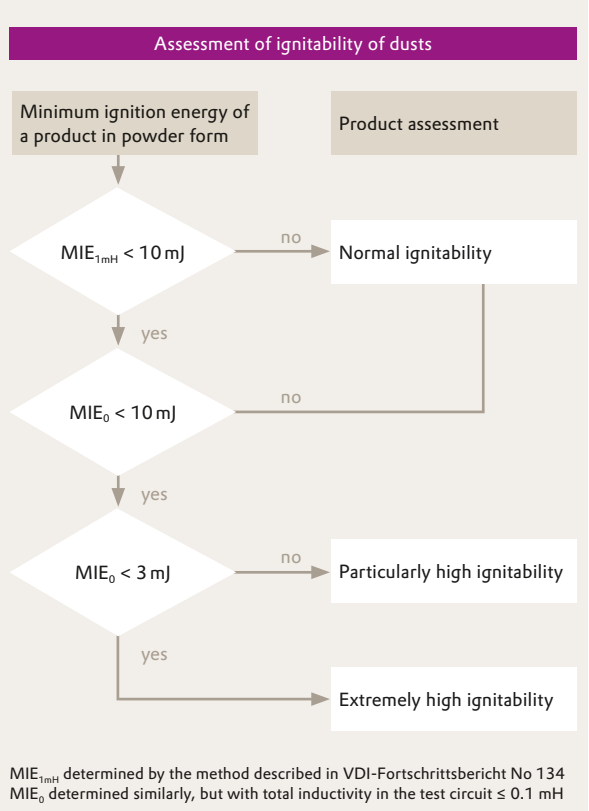
2.1 Assessment of ignitability

To determine the necessary safety measures for handling the AEROSIL® grades shown in Table 1, one must first assess the ignitability, as given by the minimum ignition energy. An assessment scale for classifying the ignitability of dusts has not so far been specified in German-speaking countries, but the generally recognized limit values are 10 mJ and 3 mJ. Various authors and the VDI (Association of German Engineers) have used them in their assessments [1,2]. A decision flowchart, as shown in Figure 1, can be used in this case.

To assess the ignitability, use the minimum ignition energy MIE_0 indicated in the safety data sheet. Then classify the ignitability with the aid of the decision flowchart. The possible categories are "normal", "particularly high", and "extremely high" ignitability. In this classification, the AEROSIL® grades (see Table 1) are in the "normal" category.

The AEROSIL® grades are typically less ignitable by a factor of approximately 3 to 6 powers of ten (MIE approx. 1 J to 10 kJ) than dusts just exceeding the threshold of MIE = 10 mJ given here, and are thus assessed as having "normal" ignitability.

Figure 1
Decision flowchart for assessing the ignitability of dusts [2]



MIE_{1mH} determined by the method described in VDI-Fortschrittsbericht No 134
MIE_0 determined similarly, but with total inductivity in the test circuit ≤ 0.1 mH

2.2 Lower explosion limit

In addition to the minimum ignition energy, the lower explosion limit is also a relevant parameter. This dust concentration limit is also indicated in the safety data sheet. It is defined as the dust concentration necessary to obtain an ignitable dust-air mixture. This means that for correct handling in compliance with industrial hygiene requirements, such dust concentrations will generally be attained only in the interior of handling systems [5]. Those parts of the system where potentially explosive dust/air mixtures with the relevant AEROSIL® grades might occur "continuously, over the long term, or frequently" must be classified under Zone 20 as defined in the European Guideline 1999/92/EU.

3 Safety measures for avoiding dust explosions

The assessment of ignitability carried out under 2.1 is used to allocate appropriate safety measures. The allocation is made as in Figure 2.

The following ignition sources may in principle be effective, and must therefore be avoided:

- hot surfaces
- flames and hot gases
- mechanically produced sparks
- transient electric currents, cathodic corrosion protection
- static electricity
- strokes of lightning

Figure 2
Allocation of safety measures for ignitability [2]

Ignitability	Test criterion	Measures
Normaly ignitability	$MIE_0 \geq 10\,mJ$	Avoidance of effective ignition sources (TRBS 2152 part 3)
Particularly high ignitability	$3\,mJ \leq MIE_0 < 10\,mJ$	Expert opinion required
Extremely high ignitability	$MIE_0 < 3\,mJ$	Preventive explosion protection by inertization or avoidance of effective ignition sources, and by design measures

The AEROSIL® grades shown in Table 1 are classified as having normal ignitability although their minimum ignition energies are significantly higher than 10 mJ; it is therefore necessary to take explosion protection measures. However, risk assessment of normally used equipment will usually show that effective ignition sources can be excluded with adequate reliability.

It should be mentioned that electrostatic discharges cannot be effective ignition sources for AEROSIL® because their energy is normally lower than the MIE_0 of the AEROSIL® grades in Table 1. When handling AEROSIL® in pure metal apparatus, respectively using pure conductive material of construction, grounding (potential equalization) of all the conducting parts of the system therefore reliably excludes all static electricity risks for AEROSIL®. Any liners or coatings which are not electrostatically dissipative can change the situation significantly.

Detailed measures for avoiding ignition sources are available from the Technical Rules Plant Safety (Technische Regeln Betriebssicherheit), [3], [4] or VDI Guideline 2263 [1].

On the basis of the above regulations, it appears that an "explosion protected" design is not necessary for AEROSIL® handling systems if no other substance needs to be taken into account (see note under 1.2).

All the information in this bulletin is based on investigations carried out so far and on currently valid and generally recognized regulations. In case of doubt an expert opinion must always be obtained for the particular system concerned.

References

[1] VDI Guidelines VDI 2263. May 1992.

[2] VDI Reports 975. 1992.

[3] Technical Rules Plant Safety (Technische Regeln Betriebsicherheit) TRBS 2152, November 2009.

[4] Technical Rules Plant Safety (Technische Regeln Betriebsicherheit) TRBS 2153, April 2009.

[5] Evonik Industries AG, Technical Bulletin No. 28, Handling of Synthetic Silicas and Silicates

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