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INFLUENCE OF THE CHARACTERISTICS OF BULK MATERIALS ON THE DESIGN AND DIMENSIONING OF SILOS

1 - REFERENCES

This document forms part of document FEM 2 581 "Characteristics of bulk products" and is associated with document FEM 2 582 "General characteristics of bulk products with regard to their classification and symbolization".

2 - OBJECT AND PURPOSE OF THIS DOCUMENT

The aim of this document is to show the influence of the major characteristics of bulk materials in the design and dimensioning of silos. It mentions for user and manufacturer the essential criterias, indispensable to the engineer to make the choice of the best design of the silo according to the product to be stored.

3 - GENERAL

Silo design should be carried out with specific consideration of the flow properties of the bulk material (see document FEM 2 381) and in terms of statics. When designing silos, the silo geometry is determined on the basis of the flow properties in order to achieve a desired flow profile in the silo. A distinction should be made between mass flow and funnel flow. In silo design the outlet should always be dimensioned in such a way that on the one hand discharge problems cannot occur as a result of arching and piping, and on the other hand the desired flow rate of bulk material can be discharged (see document FEM 2 371). For that purpose it is necessary in some cases to install appropriate discharging devices. For this silo design, it is necessary to know the specific properties of bulk materials whose characteristics are described in document FEM 2 381.

In addition to the specific properties of bulk materials, the general properties of bulk materials provide important information for practice, especially regarding the necessary safety measures, the possibilities of choice of silo materials and the existing experience of similar bulk materials.

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4 - INFLUENCE OF THE CHARACTERISTICS OF BULK MATERIALS ON THE FLOW BEHAVIOUR AND PRESSURES IN SILOS

The following is a description of the influence of the various characteristics, as defined in document FEM 2 582 on their classification and symbolization, on the flow behaviour and pressures in silos.

4.1 - Name of the bulk material

The name of the bulk material can provide information to a specialist, especially if he can call on earlier experience of the flow behaviour, storage and discharge of this bulk material. In many cases however, the name does not constitute a sufficient description, since bulk materials with the same name can have different characteristics depending on their origin, processing, intermediate storage, storage time, temperature, etc. In the absence of a clear designation of the bulk material by its name, the chemical composition must be given.

4.2 - Grain size

Grain size has a great influence on the flow characteristics of bulk materials. For this reason it is useful to know the grain size distribution, such as it is determined either by a grain size analysis or by means of other grain size analysing devices (sedimentation, light diffraction, counting methods).

In the case of bulk materials flowing freely without cohesion, it is important to know the maximum grain size, as arching due to particle wedging can only be avoided by providing outlet diameters approximately ten times larger than the maximum grain size. Lumpy bulk materials may also block input slots in discharge appliances.

In addition, bulk material cohesiveness should be determined from the grain size distribution. With grains less than approximately 0.15 mm, cohesion usually occurs. Cohesive bulk materials may cause arching and piping. In the case of fine grain bulk materials and with smooth wall materials, the angle of wall friction is higher and should be taken into account when designing the silo. With large grain bulk materials heavy local loads may be applied during impulse loading.

The grain size should also allow to assess the risk of bulk material escape, as only the bulk materials within a certain range of grain size fluidize easily and show ability to hold air and may then have a flow behaviour similar to that of a liquid.

In the case of a large grain size distribution, there is still a risk of segregation within the silo which, in the case of mass flow, can only be avoided by later remixing. In the event of segregation in a silo with funnel flow, and in the event of a natural segregation, during which the fine grains flow through the large grains, further remixing is then necessary.

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