FEDERATION EUROPEENNE DE LA MANUTENTION
SECTION II
CONTINUOUS HANDLING

FEM
2 125

original E
edition E
1989

INFLUENCE OF THE CHARACTERISTICS OF BULK MATERIALS ON THE DESIGN OF HORIZONTAL AND SLIGHTLY INCLINED SCREW CONVEYORS (UP TO ABOUT 20°)

1 - REFERENCES

This document forms part of document FEM 2 581 "Characteristics of bulk materials" and is associated with document FEM 2 582 "General characteristics of bulk materials with regard to their classification and their symbolization". See also FEM 2 121 "Screw conveyors for bulk materials - recommendations for the design".

2 - OBJECT AND PURPOSE OF THIS DOCUMENT

The aim of this document is to show the importance of the characteristics of the bulk materials to be conveyed when designing a screw conveyor.

3 - GENERAL

The capacity and conveying action of a screw conveyor depend upon a combination of diameter, flight pitch and speed. The method of feed considerably influences both capacity and conveying action, but as the discharge is usually through an opening in the bottom of the case or directly through the end, the method of discharge is not usually a decisive criteria.

Knowledge of the characteristics of the material to be handled is important as this is the key influence on the capacity of the conveyor. It is necessary that the user shall disclose to the conveyor manufacturer all the relevant information about the material to be handled of which he is aware, and that he shall also point out any items of information he suspects may be relevant the effects of which are not within the scope of his knowledge.

The principal considerations to be taken into account are as follows :

- the method of feeding the conveyor, i.e. whether the feed is constant and controlled by other items, or whether the feed is intermittent, or whether the conveyor is to work under a load imposed by a heap of material
- the size of the feed opening and if more than one, their relationship to each other
- the slope angle of the conveyor (horizontal, inclined or declined)
- the number of discharge points and their relation to each other

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- whether or not the unit is to be used to control the rate of flow (i.e. to be used as a feeder)
- the working cross section of the flight.

Furthermore, the design may be either influenced by, or it may be desirable to incorporate various other features such as :

- change of screw geometry along the flight lenght either by altering the pitch or tapering the diameter
- the continuity of the flight
- the use of paddle flights
- the use of ribbon flights
- the interruption of flight caused by intermediate bearings
- the clearance between the flight and the casing.

Screw conveyors can be used for a variety of functions other than conveying such as :

- breaking up material
- the mixing of dissimilar materials in transit
- heating or cooling the conveyed material
- separation or addition of liquids and solids.

4 - INFLUENCE OF THE CHARACTERISTICS OF THE BULK MATERIALS

The following text deals in turn with the specific characteristics of the bulk materials used in FEM 2 582 for classifying the bulk materials, in the sequence laid down there, with reference to their effects on conveying by screw conveyors.

4.1 - Name of bulk material

The name of the bulk material to be conveyed can serve the specialist as an indication of the properties of the bulk material, particularly if he can call on earlier experience of conveying this bulk material with a screw conveyor. In most instances, however, the name of the bulk material does not suffice to give a precise description of the bulk material, since bulk materials with the same name can have completely different properties which are also determined by the origin of the bulk material, as well as previous processing, conveying and storage processes.

4.2 - Grain size

Knowledge of the full grain size analysis (sieve analysis) of the bulk material to be conveyed is useful, while knowledge of the maximum grain size d_{max} at least is necessary, since this constitutes a very decisive factor for the suitability of the bulk material for conveying by screw conveyors.

The limiting factor of grain size for screw conveyors is determined by the diameter of the flights (and in some cases by the size of the centre shaft if this is so large as to reduce the depth of scroll available).

Typical values for maximum grain lumps size are as follows :

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Screw diameter	% of maximum lumps size (from 0,8 d_{max} to d_{max})	
	under 25 %	over 25 %
100 mm	13 mm	10 mm
125	18	12
160	20	14
200	25	16
250	40	20
315	50	25
400	65	40
500	85	50
630	90	65
800	100	75

If foreign bodies are present, this must be stated and provision made for extracting them if necessary.

4.3 - Grain shape

Grain shapes of classes I to V according to FEM 2 582 are generally well suited to conveying by screw conveyors, with the proviso that the ratio of length to width is not excessive. The grain shape of class VI according to FEM 2 582 is generally unsuited to conveying by screw conveyors.

However, the classification of the grain shape according to FEM 2 582 is often insufficient to describe the effect of this characteristic of the bulk material on conveying by screw conveyors since it can be important to know how the bulk material reacts to the friction caused by moving the material along the case and to ensure that there is no danger of trapping material between the flights and casing. Both depend at least partially on the grain shape. The resistance to penetrating edges is also determined to quite a considerable extent by the grain shape.

Grain shape also affects the way material feeds particularly in elongated feed openings where it is often necessary to draw material evenly along the full length (e.g. under a storage hopper).

If the conveyor is inclined the grain shape may determine the admissible angle of inclination.

4.4 - Angle of repose α

The angle of repose α of material according to FEM 2 582 is a guide to determine the maximum angle at which a conveyor may be elevated, e.g. material may flow back down a conveyor between and over its flights and casing.

4.5 - Tendency to pack (cohesion) - (n)

Tendency to pack may result for instance from the material own pressure or the nature of particles which tend to cling to each other (cohesion).

Such tendency may alter the material contract grain size and affect the dimensioning of certain components, e.g. the screw, the material flow cross

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