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INFLUENCE OF THE CHARACTERISTICS OF BULK MATERIALS ON THE DESIGN OF TROUGHED BELT CONVEYORS

1 - REFERENCES

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

2 - OBJECT AND PURPOSE OF THIS DOCUMENT

The aim of this document is to describe the relationship between characteristics of the bulk materials to be conveyed and the design of troughed belt conveyors.

3 - GENERAL

The characteristics of the bulk material to be conveyed on a troughed belt conveyor together with the quantity of the material to be conveyed in a given time, control the design and dimensions of the conveyor.

For a given problem, it is necessary to select the belt width and trough layout which, associated with the conveying speed (also to be selected) and taking into consideration other parameters such as the conveyor inclination, will determine the conveyor capacity.

Technical publications on continuous handling by belt conveyors give information on standardized belt widths and on the most common idler set arrangements. Whilst the range of most commonly used belt widths covers 0.5-2 m, it should be noted however that the very large capacities necessary in some sectors now require the use of belt widths of 3 m and over.

These publications also give indications of belt speeds and, whilst the range of common speeds is 1.5-6 m/s, higher speeds are possible and are used.

These major parameters, i.e. belt width and belt speed, greatly depend on the characteristics of the bulk material to be conveyed.

It is therefore 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 interface between the material on the one hand and the troughed belt conveyor on the other hand must be examined in three particular areas, namely :

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1) the area where the material is loaded onto the conveyor
2) the running part of the conveyor
3) the area in which the material is discharged from the conveyor.

3.1 - The loading area

Some form of input hopper and metal sheets for centering the materials on the belt are essential for loading a troughed belt conveyor. The flow characteristics of the material control the minimum inclination of the hopper wall junction line and the required dimensions of inlets and outlets. The abrasive properties of the material, flowability and lump size may affect the material of which the hopper and centering device are made or with which they are lined. The design of the hopper will also be dependent on how the material is fed into it and on the bulk density of the material.

Between the hopper and the conveyor belt there may be sealing strip, the design of which will also be affected by the abrasivity, flowability, density and lump size of the material. Depending upon the method of feeding, it may also be necessary to accelerate the conveyed material to belt speed from little or no primary velocity in the direction of the belt and the characteristics of the material will control how this acceleration can be achieved, and which effects of friction and wear can occur.

Belt supporting devices in the loading area should protect the belt against impact consequences and also protect fragile materials against undesirable fragmentation (see 4.8).

Loading and acceleration may also produce dust emissions which depend upon the characteristics of the material handled.

3.2 - Running part

Material in transit may continue to exhibit dust problems and protection from the weather may also be needed, according to the characteristics of the material. If the material is being elevated, slip may occur above some critical angle of elevation according to the design of the belt surface, the belt speed and the extent to which the belt undulates due to catenarian sag between supporting idlers. In some cases skirt plates and skirt sealing strips may be continued over the length of the conveyor, in which case some of the problems encountered in the loading area (see 3.1) may be continued throughout the running part.

3.3 - The discharge area

The discharge area is affected by those characteristics of the conveyed material which influence cleanliness, dusting, separation, degradation and wear. In case of sticky materials, belt cleaning devices must be chosen and installed with care. Complementary devices can be needed to remove the material scraped off the belt.

If high belt speeds are involved the characteristics of the conveyed material influence its discharge trajectory.

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4 - INFLUENCE OF THE CHARACTERISTICS OF THE BULK MATERIALS

The following text deals in turn with the individual properties of the bulk materials listed in FEM 2 582 for classifying the bulk materials in the sequence laid down therein, with reference to their effects on conveying by troughed belt conveyors.

4.1 - Name of the 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 troughed belt conveyor. In most instances, however, the name of the bulk material does not suffice to give a precise description of the 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 by previous processing, conveying and storage processes.

4.2 - Grain size

For bulk materials with lumps biger than about 100 mm, the maximum grain size and the grain size distribution (sieve analysis) influence the selection of width and speed of the belt.

The minimum required belt width is normally in the range of 2.5 to 4 times larger than the maximum grain size. The smaller values of this ratio apply for large belt width and for small percentage of large lumps.

The lower this ratio and the higher the percentage of large lumps, the slower the maximum recommended belt speed will be.

The grain size and grain size distribution may also affect friction properties and the angle of repose of the bulk material and, therefore, the possible cross sectional area of conveyed material and the permissible angle of elevation of the belt conveyor.

It shoud be noted that for powdery bulk materials it may also be necessary to reduce belt speed in order to reduce dust emissions.

4.3 - Grain shape

Grain shape has a similar importance as grain size (see 4.2), principally because of its effect on the material cross sectional area and on the maximum angle at which a material may be elevated without slip or rolling.

Sharp broken material, whilst presenting an advantage from the point of view of surcharge angle and angles of elevation, presents on the other hand the disadvantage of possibly causing damage to the belt surface and perhaps to the surfaces of the hoppers and chutes. Apart from that, the troughed belt conveyor is not sensitive, as a handling system, to variety of grain shape in the materials handled.

4.4 - Angle of repose α

The angle of repose α as listed in FEM 2 582 may be used as a sufficiently

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