	FEDERATION EUROPEENNE DE LA MANUTENTION SECTION II CONTINUOUS HANDLING	FEM 2 127
	INFLUENCE OF THE CHARACTERISTICS OF BULK MATERIALS ON THE DESIGN OF VIBRATING CONVEYORS	original D edition E 1989

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 relationship between the characteristics of the bulk materials to be conveyed and the design and dimensioning of vibrating conveyors.

3 - GENERAL

Conveying by vibrating conveyors is characterized by the step's amplitude, frequency and direction of vibration.

The conveyor is a spring-and-mass system capable of vibrating, and it is designed in most cases as a single-mass vibrator or, with a vibrating reaction mass, as a two-mass vibrator.

The direction of the system vibration is either determined accurately ("guided vibrator") or free, in which case it is determined by the direction of the exciting vibration, in the direction necessary for conveying ("free vibrator").

Vibrations can essentially be generated in 3 ways : drive by slider-crank mechanism, unbalance motor drive, electro-magnetic drive.

The vibration frequency produced by the drive (exciting frequency) is either much greater than the natural frequency of the vibrating system ("higly hypercritical functioning") or it approximates (in most cases around 90%) the natural frequency of the vibrating system ("quasi-resonance functioning"). In any case, the conveyor vibrates at a high frequency and at a small step's amplitude. The peak value of the vertical component of the conveyor acceleration is greater than the acceleration due to gravity, which results in periodic projection movements of the conveyed material in the conveying direction ("microprojections").

The capacity of the conveyed material (volume capacity) is the product of the cross sectional area of the material to be conveyed by the conveying speed. The cross sectional area of the material to be conveyed is determined by the trough width and the material bed

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depth in the trough. The conveying speed results on the one hand from data relating to the trough, i.e. the frequency and step's amplitude of vibrations, the angle of projection (direction of vibration), the trough slope, the bed depth of the material to be conveyed in the trough, and on the other hand from the characteristics of bulk materials, such as bulk density, grain size, grain size distribution, grain shape, moisture content, properties of material grain internal friction and trough wall friction.

Vibrating conveyors are used for conveying numerous and varied bulk materials ranging from fine materials to large grain materials. Hot, abrasive or chemically aggressive bulk materials can also be conveyed with a vibrating conveyor. Bulk materials with a high moisture content, which are sticky or compact, can present conveying problems. Vibrating conveyors can also be used for dewatering, drying, cooling or heating bulk materials in the process of conveying.

4 - INFLUENCE OF THE CHARACTERISTICS OF BULK MATERIALS

In the following text the characteristics of bulk materials used in FEM 2 582 for classifying bulk materials are considered in turn in the sequence laid down there, with regard to their effects on conveying by vibrating 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 materials, particularly if he can call on earlier experiences of conveying this bulk material with a vibrating conveyor. 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 highly different properties which may result from the origin of the bulk material as well as from previous processing, conveying and storage processes. When the chemical formula of the material is known, it should be quoted as it can give information on the material properties. It is often useful to have a sample (tightly packed) of the bulk material to be conveyed in order to check experimentally if the bulk material is suitable for being conveyed by vibrating conveyors.

4.2 Grain size

Knowledge of the full grain size analysis of the bulk material to be conveyed is useful. Knowledge of the maximum grain size at least is necessary for designing the width and height of the trough for large lumpy materials. The trough width should be a minimum of 2.5 times the largest particle size and the height 1.5 time the largest particle size.

When using a vibrating conveyor for silo discharge, the distance from the silo outlet to the trough must be determined according to the size of the largest particle.

In the case of high impact forces from the large particles, the maximum grain size will also affect the design of the loading area with regard to its strength. The grain size analysis may also be useful to determine whether the material to be conveyed is fine enough to have a tendency to fluidization or to dust emission.

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Powdery bulk materials can be conveyed by vibrating conveyor only with difficulty (see 4.11). In such cases it is necessary at least to accept a considerable reduction of the conveying speed and of the material bed depth in the trough. For this purpose conveying tests with a sample of the bulk material are often necessary in order to determine favourable vibration data (frequency, step's amplitude, angle of projection). This also applies to bulk materials with a high percentage of fine grains.

4.3 Grain shape

Grain shapes of classes I to V according to FEM 2 582 are highly suited to conveying by vibratory conveyors provided that the ratio of grain length to grain width is not too high. Bulk materials with a flat grain shape, or sharp splintery or broken grains result in a reduction of the conveying speed.

Bulk materials with a grain shape of class VI according to FEM 2 582 convey in mass without any break-up, but can also present flow problems both at the feed and discharge points. Fibrous, knotted and elastic bulk materials can be conveyed more easily with a low vibration frequency rather than a high vibration frequency.

4.4 Angle of repose α

The angle of repose has not a great influence in the design and dimensioning of vibrating conveyors. At the feed point sufficient height allowance should be made for the material to form its angle of repose. The vibrations, according to data relative to vibration and friction conditions, will disperse the bulk material quickly to an almost even level. Determination of the maximum angle at which a conveyor may be elevated will be partially governed by the angle of repose.

When using a vibrating conveyor for silo discharge, the angle of repose has a determining influence on the minimum length of the trough according to the configuration of the silo outlet above the trough.

4.5 Tendency to pack (cohesion) (n)

The bulk material's own pressure as well as the capacity of particles to adhere to one another may result in a tendency to pack (cohesion).

Tendency to pack is of no influence on vibrating conveyors, since in the conveying process and on short conveying distances with vibrating conveyors packing possibilities do not exist.

4.6 Abrasiveness (o)

Hard, rough, coarse bulk materials are abrasive and cause wear mainly on the bottom of the trough. On vibrating conveyors wear can be reduced relatively easily by using wear-resisting and weldable steels for the construction of the conveyor trough, or by using wear-resisting steels, plastic or elastic materials, i.e. rubber, for the trough lining.

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