International Standard ISO 7119

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Continuous mechanical handling equipment for loose bulk materials — Screw conveyors — Design rules for drive power

Engins de manutention continue pour produits en vrac — Transporteurs à vis — Règles pour le calcul de la puissance d'entraînement

First edition — 1981-10-01

UDC 621.867.4 **Ref. No. ISO 7119-1981 (E)**

Descriptors : handling equipment, continuous handling, conveyors, screw conveyors, computation, power.

Price based on 4 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 7119 was developed by Technical Committee ISO/TC 101, *Continuous mechanical handling equipment*, and was circulated to the member bodies in May 1980.

It has been approved by the member bodies of the following countries :

Australia	France	Poland
Belgium	India	Romania
Chile	Ireland	Sweden
Czechoslovakia	Netherlands	United Kingdom
Finland	Norway	USSR

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Austria
Germany, F. R.

This International Standard is based on the work carried out by "Section II — Contrinous handling" of the European Mechanical Handling Confederation (FEM).

Printed in Switzerland

Continuous mechanical handling equipment for loose bulk materials — Screw conveyors — Design rules for drive power

1 Scope

This International Standard establishes a method for the calculation of drive power of screw conveyors.

2 Field of application

This International Standard only applies to a screw conveyor, used in a horizontal or inclined position (up to approximately 20°), for a regular, controlled and continual supply of the bulk materials.

Excluded from this International Standard are the special screws for the following special uses :

- extracting screws
- calibrating screws
- mixing screws
- moistening screws
- inclined screw (above 20°)
- vertical screws

3 Reference

ISO 2148, *Continuous mechanical handling equipment — Nomenclature.*

4 Comments

The necessary drive power and the rate of flow of the material which may be reached by a screw conveyor are interdependent.

Nevertheless, they also depend upon the operating conditions, the nature of the product conveyed and the design parameters, the most important of which are considered in this International Standard which describes a relatively easy design method and therefore only reaches a limited accuracy which is however quite sufficient in most cases.

A large number of less important parameters are not taken into account in the following formulae. Numerous factors in the formulae are empirical and result from long practical experience.

5 Symbols and units

Symbol	Designation	Units
A	Working section of screw conveyor	m^2
D	Nominal screw diameter	m
F_H	Main resistances	N
F_N	Secondary resistances	N
F_{St}	Resistances due to inclination	N
g	Acceleration due to gravity	m/s^2
H	Lifting height	m
I_M	Mass flow rate	t/h
I_V	Volume flow rate	m^3/h
L	Conveying length	m
n	Number of screw r.p.m.	r/min
P	Total power	kW
P_H	Power for material progress	kW
P_N	Power when operating at no load	kW
P_{St}	Power due to inclination	kW
S	Screw pitch	m
v	Linear speed of material movement	m/s
φ	Trough filling coefficient	—
ϱ	Density of bulk material	t/m^3
λ	Progress resistance coefficient	—

6 Calculation of the capacity of a screw conveyor

The nominal capacity to be considered is the capacity per hour of the maximum volume that may be reached by a screw conveyor.

The volume flow rate I_V is the product of :

the working section of the screw conveyor $A = \varphi D^2 \frac{\pi}{4}$, in square metres

by the conveying speed, $v = S \frac{n}{60}$ in metres per second

from which results the equation :

$$I_V = 60\ \varphi \frac{\pi}{4} D^2\ Sn$$

Selection of the trough filling coefficient φ

In the following cases :

— materials that do not flow normally,

— filling coefficient too high,

there is a large difference between the actual and the theoretical conveying speed introduced into the equation

$$V = S\frac{n}{60}$$

The maximum filling coefficients depend upon the friction and adhering properties of the conveyed materials, on the screw pitch and the inclination of the screw centreline.

In general, the following are used :

$\varphi \approx 0{,}45$ for screws without intermediate bearings and for materials which flow easily, scarcely abrasive (flour, cereals).

$\varphi \approx 0{,}3$ for the most current bulk materials, with average abrasive properties, with a grading varying from grains to small lumps (salts, sand, coal).

$\varphi \approx 0{,}15$ for heavy bulk materials, very abrasive, agressive (ash, gravel, minerals).

These values should be reduced in the following cases :

— extremely large propeller pitch (normally $S \approx 0{,}6\ D$ to $1{,}0\ D$)

— screw inclination (approximately 2 % per degree of inclination up to 20°)

— small diameter screws with cumbersome intermediate bearings.

It should be pointed out that the diameter of a screw should not only be defined by the capacity but also by the dimensions of the largest lumps and their percentage.

The peripheral speed of the screw should not be too high so as to prevent the material being thrown upwards which will spoil its transport. The peripheral speed should be chosen as a function of the screw diameter D, the physical properties of the material and the filling coefficient φ.

7 Resistances to the movement of the screw conveyor

As a whole, the resistances to the movement of the screw conveyor, are composed of :

F_H the main resistances — material progress

F_N resistances due to operating at no-load

F_{St} resistances due to the inclination.

Included in these three groups are all the resistances which the drive of a screw conveyor must overcome in order to surmount friction, the inclination, and the setting in motion of the material at the loading point.

The resistance due to the inclination does not exist in all the plants and it is a function of the path inclination.

Out of all these resistances, only the resistance due to the slope may be calculated accurately.

8 Drive power of loaded screw

The drive power of the loaded screw is given by the formula :

$$P = P_H + P_N + P_{St}$$

in which :

P_H power necessary for the progress of the material;

P_N drive power of the screw conveyor at no load;

P_{St} power due to inclination.

8.1 Power necessary for the progress of the material, P_H

In practice, the capacity of a screw conveyor is expressed by the formula

$$I_M = \varrho I_V$$

For a length L of the screw conveyor, the power P_H in kilowatts will be the product of the capacity I_M by the length L and an artificial friction coefficient λ also called the progress resistance coefficient.

$$P_H = \frac{I_M L}{3\,600}\lambda g$$

$$= \frac{I_M L \lambda}{367}$$

This formula stresses factors that are involved in the power input, which, for a horizontal screw, is proportional to the mass flow rate and length of conveyance.

Power is also proportional to the progress resistance of the material, λ.

In addition, it should be noted that the sliding of the material particles against each other gives rise to internal frictions.

Finally, other resistances due to the grading or the shape of the output show up.

All this gives the parameter λ a higher value than that of the friction coefficients μ.

Each material has its own coefficient λ. It is generally in the order of 2 to 4. The annex indicates the values of λ for a few bulk materials.

8.2 Drive power of the screw conveyor at no load, P_N

The power P_N is very low compared to the power required for the progress of the material.

This value is proportional to the diameter and the length of the screw. In practice it is given, in kilowatts, by the formula :

$$P_N = \frac{DL}{20}$$

8.3 Power due to inclination, P_{St}

The power, in kilowatts, will be the product of the capacity I_M by the height H and by the acceleration due to gravity g, i.e. :

$$P_{St} = \frac{I_M H g}{3\,600}$$

$$= \frac{I_M H}{367}$$

The height H is positive in ascending screws and will be negative in the formula for descending screws.

8.4 Total power necessary for the shaft of the screw conveyor

The total power necessary is the sum of the various powers described above :

$$P = \frac{I_M (\lambda L + H)}{367} + \frac{DL}{20}$$

Annex

Values for bulk density ϱ and progress resistance coefficient λ for a few bulk materials

(for information)

Materials	Bulk density ϱ in t/m^3	Progress resistance coefficient λ
Ash and slag	0,7 to 1	3
Lignite	1,1 to 1,3	2,2
Ferrous hematite	1,4	2,2
Heavy minerals (Cu-Pb)	2 to 2,5	2,2
Light minerals	1,25 to 2	2,2
Oats, barley	0,5	1,9
Graphite	0,4 to 0,6	1,9
Roasted lime	0,9	2,2
Hydrated lime	0,5	1,9
Potatoes	0,7	1,9
Gravel	1,5 to 1,8	3
Coke	0,5	3
Ordinary Coal	0,8	2,2
Classified Coal	0,9	1,9
Clay, damp loam	1,8	1,9
Flour	0,6	1,9
Marl	1,6 to 1,9	2,2
Mortar	1,8 to 2,1	3
Maize, rye, rice	0,5 to 0,7	1,9
Sand	1,4 to 1,7	3
Wheat	0,8	1,9
Cement	1,0 to 1,3	1,9

This page intentionally left blank

This page intentionally left blank