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Naprave za kontinuirni transport - Tračni transporterji - Preračun pogonske moči in sile v traku

Continuous mechanical handling equipment -- Belt conveyors with carrying idlers -- Calculation of operating power and tensile forces

Engins de manutention continue -- Transporteurs à courroie munis de rouleaux porteurs -- Calcul de la puissance d'entraînement et des efforts de tension

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INTERNATIONAL STANDARD

ISO 5048

Second edition
1989-09-15

Continuous mechanical handling equipment — Belt conveyors with carrying idlers — Calculation of operating power and tensile forces

Engins de manutention continue — Transporteurs à courroie munis de rouleaux porteurs — Calcul de la puissance d'entraînement et des efforts de tension

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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 5048 was prepared by Technical Committee ISO/TC 101, *Continuous mechanical handling.*

This second edition cancels and replaces the first edition (ISO 5048 : 1979), clause 2, subclauses 4.1.2 and 4.3.4, clause 5 and figures 3, 4 and 5 of which have been technically revised, and figure 6 and table 4 deleted. A new clause 2 (definitions) has been added.

Introduction

In the design of belt conveyors, it is advisable first to calculate the required driving force on the driving pulley and the belt tensile stresses resulting therefrom, since these values will effectively determine the choice of driving system and the construction of the belt.

The operating power requirements are derived from the driving force on the driving pulley and from the speed of the belt.

The necessary belt width is calculated on the basis of the maximum capacity of the belt and, possibly, of the particle size of the material to be handled.

Attention is drawn to the many varied factors which influence the driving force on the driving pulley and which make it extremely difficult to predict the power requirement exactly. This International Standard is intended to give a simple method of conveyor design calculation. Consequently it is limited in terms of precision but is sufficient in the majority of cases. Many factors are not taken into account in the formulae but details are provided on their nature and their effect.

In simple cases, which are the most frequent, it is possible to progress easily from the calculation of power requirements to those of the necessary and the real tensions in the belt, which are critical in the selection of the belt and in the design of the mechanical equipment.

However, certain conveyors present more complicated problems, for example those with multiple drives, or with an undulating profile in vertical elevation. For these calculations, which are not covered in this International Standard, it is advisable to consult a competent expert.

Continuous mechanical handling equipment — Belt conveyors with carrying idlers — Calculation of operating power and tensile forces

1 Scope

This International Standard specifies methods for the calculation of the operating power requirements on the driving pulley of a belt conveyor, and of the tensile forces exerted on the belt.
It applies to belt conveyors with carrying idlers.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 surcharge angle (of the material handled), θ : Angle formed with the horizontal by the tangent to the material cross-section at the intersecting point with the belt in motion (see figure 3). The surcharge angle is expressed in degrees.

2.2 angle of repose, α : Angle formed with the horizontal by the surface of a conical heap of material falling slowly and regularly from a small height onto a horizontal stationary surface. The angle of repose is expressed in degrees.

3 Symbols and units

Table 1 — Symbols and units

Symbol	Description	Unit
a_o	Idler spacing on the carrying side of the conveyor	m
a_u	Idler spacing on the reverse side of the conveyor	m
A	Contact area between the belt and the belt cleaner	m^2
b	Material-carrying belt width (i.e. width of the belt actually filled with or bearing material); usable width of the belt	m
b_1	Width between skirtplates	m
B	Belt width	m
C	Coefficient (secondary resistances)	—
C_ϵ	Trough factor	—
d	Belt thickness	m
d_o	Shaft diameter of inside bearing	m
D	Pulley diameter	m
e	Base of natural logarithms	—
f	Artificial friction coefficient	—
F	Average belt tension at the pulley	N
F_1	Tight-side tension at the pulley (see figure 2)	N
F_2	Slack-side tension at the pulley (see figure 2)	N
F_H	Main resistances	N
F_{max}	Maximum belt tension	N
F_{min}	Minimum belt tension	N
F_N	Secondary resistances	N
F_S	Special resistances	N
F_{S1}	Special main resistances	N
F_{S2}	Special secondary resistances	N
F_{St}	Resistance due to slope	N
F_T	Vectorial sum of the two belt tensions acting on the pulley and of the forces due to the mass of the revolving parts of the pulley	N
F_U	Required peripheral driving force on the driving pulley(s)	N
g	Acceleration due to gravity	m/s^2
$(h/a)_{adm}$	Allowable belt sag between idlers	—
H	Lift of the conveyor between the dumping area and the loading area	m
I_V	Capacity	m^3/s
k	Slope factor	—
k_a	Scraping factor	N/m
l	Length of the installation equipped with skirtplates	m
l_3	Length of centre idler (three-roller trough)	m
l_b	Acceleration length	m
L	Conveyor length (centre-to-centre distance)	m
L_o	Additional length of the conveyor	m
L_ϵ	Length of the installation equipped with tilted idlers	m
p	Pressure between the belt cleaner and the belt	N/m^2
P_A	Operating power requirement on the driving pulley(s)	W
P_M	Operating power requirement on the driving motor(s)	W
q_B	Mass per metre of the belt along the carrying side and along the return side	kg/m
q_G	Mass per metre of the material handled	kg/m
q_{RO}	Mass per metre of the revolving idler parts along the carrying side of the conveyor	kg/m
q_{RU}	Mass per metre of the revolving idler parts along the return side of the conveyor	kg/m
S	Cross-sectional area of the material on the belt	m^2
v	Belt speed	m/s
v_o	Velocity component of the conveying speed of material handled in the direction of belt movement	m/s

Table 1 (*concluded*)

Symbol	Description	Unit
α	Angle of repose	degrees
δ	Slope angle of the installation in the direction of movement	degrees
ϵ	Tilt angle of the idler axis with respect to the plane perpendicular to the longitudinal axis of the belt	degrees
η	Efficiency	—
θ	Surcharge angle (of the material handled)	degrees
λ	Angle between the side axis of the troughed carrying idlers and the horizontal	degrees
μ	Friction coefficient between the driving pulley(s) and the belt	—
μ_0	Friction coefficient between the carrying idlers and the belt	—
μ_1	Friction coefficient between the material and the belt	—
μ_2	Friction coefficient between the material and the skirtplates	—
μ_3	Friction coefficient between the belt and the belt cleaner	—
ξ	Acceleration coefficient	—
ϱ	Loose bulk density of the material handled	kg/m^3
φ	Angle of the belt wrap on the driving pulley(s)	radians

4 Resistances to motion of belt conveyor

4.1 General

The overall resistance to motion of a belt conveyor comprises various resistances, which can be classified into the following five groups :

— main resistances, F_H (see 4.2);

— secondary resistances, F_N (see 4.3);

— special main resistances, F_{S1} (see 4.4);

— special secondary resistances, F_{S2} (see 4.5);

— slope resistance, F_{St} (see 4.6).

These five groups include all the resistance which a belt conveyor driving system has to overcome to counter friction and the route slope, and also to accelerate the conveyed material up to belt speed at the loading point.

The main and secondary resistances, F_H and F_N, occur on all belt conveyors, whereas special resistances, $F_S = F_{S1} + F_{S2}$, are only present in certain installations. The main resistances, F_H and F_{S1}, occur continuously along the belt conveyor, whereas secondary resistances, F_N and F_{S2}, are only present locally.

The slope resistance, F_{St}, may have positive, zero or negative values, depending on the gradient of the conveyor. Furthermore, it can occur in a continuous manner all along the conveyor or only arise on some sections of the length.

4.2 Main resistances, F_H

Main resistances, F_H, comprise the following :

a) rotational resistance of the carrying and return strands of idlers due to friction in the idler bearings and seals [see equations (3) and (4)];

b) belt advancement resistance due to the pressing down of the idlers into the belt, and the recurrent flexing of the belt and of the material.

4.3 Secondary resistances, F_N

Secondary resistances, F_N, comprise the following :

a) inertial and frictional resistances due to the acceleration of the material at the loading area;

b) resistance due to the friction on the side walls of the chute at the loading area;

c) pulley bearing resistance with the exception of the driving pulley bearings;

d) resistance due to the wrapping of the belt on the pulleys.

4.4 Special main resistances, F_{S1}

Special main resistances, F_{S1}, comprise the following :

a) drag resistance due to forward tilt of the idler in the direction of belt movement;

b) resistance due to friction against chute flaps or skirtplates, if these are present over the full length of the belt.

4.5 Special secondary resistances, F_{S2}

Special secondary resistances, F_{S2}, comprise the following :

a) resistance due to friction with belt and pulley cleaners;

b) resistance due to friction with the chute flaps or skirtplates, if these are present over only part of the length of the belt;