CALCULATIONS FOR CONVEYING SCREWS

1. Calculation of the flow rate

$$\dot{V} = A\, s\, n\, \varphi\, c \qquad \left[\frac{m^3}{h}\right]$$

$A = \frac{\pi D^2}{4}$ **Screw cross-section**

D = Outside screw diameter

The reduction of the cross-section by the screw shaft is negligible.

S = (0.5 ... 1.0) D — **Screw pitch;** Lower values for s with a large screw diameter D.

n = Speed of the screw shaft

φ = 0.15 ... 0.45 Filling level; higher values with free-flowing conveyed material with low friction.

c = coefficient of velocity; it takes into account the leaving behind of the conveyed material with respect to the screw analogous to the trough chain conveyor.

$c \approx 1$	with full screws
$c \approx 0.8 ... 0.9$	for conveyor screws

$c \approx 0.5 ... 0.8$: with segment screws

When conveying increases, the quantity of the conveyed material decreases by approx. 2% per 1º pitch angles, this applies for pitch angle δ to approximately 20º. If the pitch is greater or in vertical conveyors, the volume of conveyed material decreases to a higher degree depending on the type of material.

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2. Drive capacity

$$P_N = \frac{m \cdot g\,(l \cdot f_{tot} + h)}{\eta} \qquad \left[\frac{Kg\,m^2}{s^3} = 1W \right]$$

m	Conveying quantity
g	Gravity of earth with 9,81 m/s^2
l	Conveying length
f_{tot}	Displacement resistance (2 – 4 horizontal screw conveyors)
	(4 – 8 vertical conveyors)
h	Height difference between material infeed and discharge
$\eta \approx 0.8$	capacity reduction factor

The frictional power due to the inherent weight of the conveyor can therefore be ignored due to its low influence.

3. Axial force of the screw shaft

$$F_a = \frac{Mt}{\frac{Dm}{2} \tan(\alpha + \rho)} \qquad [\,N\,]$$

$Mt = \eta \frac{P_N}{\omega}$	Torque at the screw shaft
P_N and η	see above
ω	Rotational frequency of the screw shaft
$Dm \approx \frac{D}{2}$	Average screw diameter
D	Outside screw diameter
α	Pitch angle of the screw: relate α to Dm
ρ	Frictional angle between the conveyed product and the screw

The axial force of the screw shaft is necessary for specification of the axial bearing; the bearings are only radially subjected to strain by the inherent weight of the screw shaft, the material load is negligible.

DESIGN – U-trough screws in compliance with DIN 15261

The values in the table below refer to conventional, free-flowing conveyed materials. These conveyed materials are divided into three classes:

Class A

Free-flowing, light, non-abrasive conveyed material, such as
raw flour, mixed feed, grain, beans etc.

Displacement resistance up to 2.0
Conveying velocity
V = approx. 0.3 – 0.5 m/s
Filling level 0.4 – 0.5

Class B

Not quite free-flowing conveyed material with higher bulk density, somewhat abrasive or fine-grained or small-sized materials, such as sugar, sawdust, lime, salts, fertil-isers, etc.

Displacement resistance up to 3.5
Conveying velocity
V = approx. 0.2 – 0.3 m/s
Filling level 0.3

Class C

Very abrasive, viscous, fibrous or coarse-grained conveyed material with negative flow properties such as sand, ash, cement, limestone etc.

Displacement resistance up to 5.0
Conveying velocity
V = approx. 0.1 m/s
Filling level 0.3

SCREWS				**MATERIAL CLASSES** Conveying capacity and speed					
Ø	**Pitch**	**Tubular shaft**	**Surface**	**A** α = 45%		**B** α = 30%		**C** α = 15%	
mm	mm	Ø	m^2	m^3/h	n = Ump	m^3/h	n = Ump	m^3/h	n = Ump
100	100	35	0.007	2.6	140	1.4	112	0.5	90
125	125	35	0.011	5.4	125	2.8	100	1.1	80
160	160	44.5	0.018	9.0	112	4.8	90	1.8	71
200	200	51	0.029	15.5	100	8.4	80	3.4	63
250	250	57	0.045	27	90	15	71	5.8	56
315	300	63	0.073	47	80	25	63	10	50
400	350	76	0.121	80	71	42	56	17	45
500	400	108	0.167	127	63	67	50	27	40
630	450	133	0.302	180	50	96	40	38	32
800	500	159	0.555	260	40	138	32	54	25
1000	560	191	0.755	360	32	190	25	76	20
1250	630	216	1.200	500	25	270	20	110	16

The conveying velocity must be determined on the basis of the type and properties of the material.

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