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Dimensioning of belt conveyors (waste as conveyed material)

If possible do not employ cleat conveyors and conveyers with corrugated sidewalls because of the pollutions occurring below the belts! In case of lightweight products design the conveyor with slow belt speed. Caution: round, spherical parts roll back on ascending conveyor belts.

1. Volume flow rate Q in m^3/h

The volume flow rate of the conveyors is calculated based on the following formula:

Qm	=	average theoretical volume flow rate	[m^3/h]
v	=	conveyor speed	[m/s]
k	=	factor for conveyor inclination	[-]
bv	=	factor for feeding method	[-]
Qt	=	average theoretical mass flow rate	[t/h]
γ	=	bulk density	[t/m^3]

1.1 Theoretical volume flow

for horizontal conveyors, bulk materials as conveyed goods
with equal length of support rollers
We recommend for normal operating conditions to use a filling ratio of 80% (factor 0.8) in the calculation.
an angle of surcharge of 10° is to be used for biowaste and domestic waste, 15° can only be used for conditioned products such as mature rotting products.
minimal belt width: B = 1.5 x l max (l max equals the longest solid single part occurring in the bulk material)

Belt width [mm]	Angle of surcharge [º]	Theoretical volume flow rate Qm [m^3/h] troughed conveyor	
		2 rolls; 20º	3 rolls; 25º
500	10	70	
650		122	120
800			190
1000			300
1200			440
1400			610
500	15	82	
650		136	141
800			225
1000			363
1200			526
1400			720

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1.2. Conveyor speed v

Recommended conveyor speeds (for underground facilities): (depending on product)

Conveyor type	Conveyor speed [m/s] from	Conveyor speed [m/s] till max.
troughed conveyor	0.6	1.2
cleat conveyor	0.8	1.2
manual sorting conveyor		0.2
discharge conveyor	0.8	1.2
conveyor with corrugated sidewalls	0.8	1.2
loading conveyor	0.8	1.2
discharge conveyor (between units) variably till	0.4	2.6
displacement velocity of belt tripper 0	0.6 m/min	

1.3 Factor k for conveyor inclination

δ = angle of incline of conveyor [°]

δ [°]	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°
k	1.0	0.99	0.98	0.97	0.95	0.93	0.91	0.89	0.85	0.81	0.76	0.71	0.66	0.61	0.56

maximal inclination of troughed conveyors without cleats for waste:
18°
for bulk compost up to 25°

1.4 Factor bv for loading method

Depending on the respective conditions volume peaks have to be taken into consideration. Peaks regarding volume can usually occur due to three conditions:

breaking off of product packages
irregular loading

Changes in product bulk density, depending on composition and pretreatment (screening, mixing, moisturization, comminution etc.), have to be considered, i.e. are not included in bv.

Loading method[1]	bv
after slat conveyor feeding	0.20
after screw mill	0.40
after hammer mill	0.40 [2]
after drum screen	0.20

[1] The low figures correspond to domestic and residual waste and green waste, the higher figures rather to mixed bio/green waste.
[2] The hammer mill does not lead to any homogenization, i.e. bv equals bv of previous unit.

1.5 Bulk density γ

Conveyor dimensioning also has to consider the possibly different bulk densities before and after a treatment, that means the low bulk densities have to be taken as basis for the dimensioning (this has to be observed especially after hammer mills). In case of very lightweight fractions the volume created by the sidewalls of the belts can be taken into consideration in the calculation with app. 30 % (Caution: if too much volume is added the materials might dam up due to the bridging effect and thus impede transportation!).

One more time: long solid single parts always have to be considered.

2. Determining drive power Na

Source: DUNLOP

$$Na_{nom}[kW] = \frac{f * (L + L_o)}{367} + (3.6 + Gm * v + Qt) + Nz + \frac{Qt * H}{367}$$

$$Na_{max}[kW] = Na_{nom} * bm$$

Na_{nom}	=	required nominal drive power at drive drum	[kW]
f	=	coefficient of friction	[-]
Gm	=	weight of moving parts	[kg/m]
L	=	conveying length	[m]
Lo	=	additional conveying length	[m]
v	=	conveyor speed	[m/s]
Qt	=	theoretical mass flow rate	[t/h]
H	=	lift	[m]
Nz	=	additional power	[kW]
Na_{max}	=	required maximal drive power at drive drum	[kW]
bm	=	loading factor for drive power	[-]

Coefficient of friction f

e.g. Z.B. f = 0.03

Weight Gm of moving parts

belt width [mm]	Gm [kg/m]
500	28
650	35
800	45
1000	55

Additional conveying length Lo

Lo = 50 m

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Additional power Nz

Belt tripper		**Lateral guide rails (walls)**	**Belt scraper and belt plow**	
belt width [mm]	**Nz [kW]**	**Nz [kW]**	**belt width [mm]**	**Nz [kW]**
500	1.2	L x 2v / 102	500	0.6
650	1.5		650	0.7
800	2.0		800	0.8
1000	2.5		1000	1.0

loading factor for drive power bm

loading method of biowaste and green waste	**bm [-]**
after slat conveyor loading	2
after screw mill	2
after drum screen	1.5

loading method of domestic waste	**bm [-]**
after slat conveyor loading	2
after screw mill	2
after drum screen	1.5

Depending on the respective conditions weight peaks (power) have to be taken into consideration.

3. Conveyor performance of belt conveyors in m³/h, with different belt widths and incline angles, based on a conveying speed of v= 1 m/sec

At conveying speeds deviating from v = 1 m/sec the achievable conveyor performance has to be converted:

$$v_2 = v * v_2$$

conveyor capability

$$Q = v * \gamma_s [Mg/h]$$

minimal belt width

For bulk materials with long parts in general and for bulk materials with bulk density $\gamma < 0.3$it holds:

$$B = 1.5 * L_{max}$$

L = longest (biggest) single part occurring in bulk material

Example: UT Bühler, Utzwil