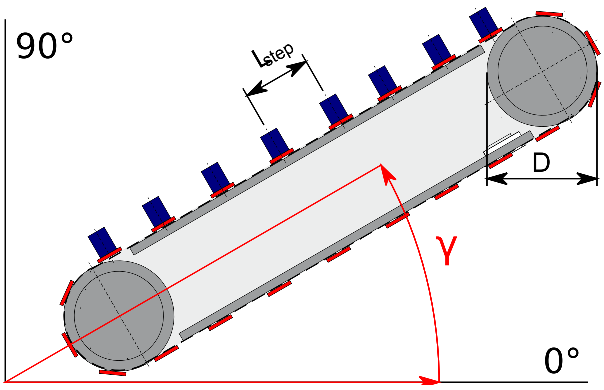
Conveyor



Precision Conveyor

Precision conveyors are used in a wide range of applications, such as dosing and filling machines, parts buffers in production lines, robotics, Cartesian coordinate robots, belt driven linear units, ink jet printers and plotters, component assembly machines, etc.

Most of the results provided by this tool also apply to conventional conveyors where high precision is not required, such as heavy duty belt or chain conveyors, etc.

Disclaimer

This tool has been created to assist engineers with the sizing of the different parts of the system. Calculations might not cover all corner cases. and results should always be checked by a qualified engineer. Under no circumstances shall we beheld responsible to any damages to persons or property due to correct or incorrect use of this tool, or to errors in it.

Pulley Circumference

$$L_D = \pi \cdot D \quad [mm]$$

No. of Divisions per Pulley Turn

$$N = \frac{L_D}{L_{step}} \quad [mm]$$

Time per Displacement

$$t_{on} = t_a + t_{cs} + t_d \quad [s]$$

Cycle Duration

$$t_{cycle} = t_a + t_{cs} + t_d + t_{dw} \quad [s]$$

Cycles per Minute

$$Z = \frac{60}{t_{cycle}}$$

System Efficiency

$$\eta_t = \eta_{bs} \cdot \eta_r$$

Constants	
Pi	$\pi \simeq 3.141592654$
Acceleration of Gravity on Earth	$g = 9.80665 \ \frac{m}{s^2}$
Inputs	
Acceleration Time	$t_a \ [s]$
Deceleration Time	$t_d \ [s]$
Constant Speed Time	$t_{cs} \ [s]$
Dwell Time	$t_{dw} \ [s]$
System Inclination	$\gamma \ [degrees]$
Displacement Distance	L_{step}
Pulley Pitch Diameter	$D \ [mm]$
Traveling Mass	$m \ [kg]$
Belt Mass	$m_b \ [kg]$
Pulleys Mass	$m_p \ [kg]$
Static Friction Coefficient	μ
Service Factor	K_A
Conveyor Efficiency	η_c
Max. Motor Speed During Cycle	$n_1 \ [rpm]$
Gearbox Efficiency	η_r
Positioning Accuracy	$A_P \ [mm]$
Gearbox Inertia	$J_R \ [kg \cdot cm^2]$
Motor Inertia	$J_M \ [kg \cdot cm^2]$

Weight Force

$$F_w = (m + m_b) \cdot g \cdot \sin\left(\frac{\gamma \cdot \pi}{180}\right) \ [N]$$

Friction Force

$$F_f = (m + m_b) \cdot g \cdot \mu \cdot \cos\left(\frac{\gamma \cdot \pi}{180}\right) \ [N]$$

Acceleration Force

$$F_a = (m + m_b + m_p) \cdot a \ [N]$$

Deceleration Force

$$F_a = (m + m_b + m_p) \cdot d \ [N]$$

Maximum Tangential Force

$$F_{T\,max} = max\begin{pmatrix} F_w + F_f + F_a, \\ F_d - F_w - F_f \end{pmatrix} \ [N]$$

Traveling Mass Inertia

$$J_L = 2500 \cdot m \cdot \left(\frac{D}{1000}\right)^2 \ [kg \cdot cm^2]$$

Pulley Inertia

$$J_P = 1250 \cdot m_p \left(\frac{D}{1000}\right)^2 \ [kg \cdot cm^2]$$

Belt Inertia

$$J_B = 2500 \cdot m_b \cdot \left(\frac{D}{1000}\right)^2 \ [kg \cdot cm^2]$$

Total Inertia

$$J_T = J_L + J_P + J_B \ [kg \cdot cm^2]$$

Total Inertia as Seen by the Motor

$$J_{T1} = \frac{J_T}{i^2} \ [kg \cdot cm^2]$$

Load to Motor Inertia Ratio

$$\Lambda=\frac{J_{T1}}{J_M+J_r}$$

Linear Acceleration

$$a=\frac{v}{t_a}\left[\frac{m}{s^2}\right]$$

Linear Deceleration

$$d=\frac{v}{t_d}\left[\frac{m}{s^2}\right]$$

Rotational Acceleration

$$\alpha_a=\frac{2\cdot\pi\cdot a}{\frac{D}{1000}}\left[\frac{rad}{s^2}\right]$$

Rotational Deceleration

$$\alpha_d=\frac{2\cdot\pi\cdot d}{\frac{D}{1000}}\left[\frac{rad}{s^2}\right]$$

Maximum Linear Speed

$$v=\frac{\frac{L_{step}}{1000}}{t_{cs}+\frac{1}{2}\cdot t_a+\frac{1}{2}t_d}\left[\frac{m}{s}\right]$$

Maximum Pulley Rotary Speed

$$n_2=\frac{60\cdot v}{\frac{L_D}{1000}}\ [rpm]$$

Motor Power

$$P_1=\frac{T_2\cdot n_2}{9550\cdot\eta_r}\ [kW]$$

Ideal Gearbox Ratio

$$i = \frac{n_2}{n_1}$$

Ideal Gearbox Backlash

$$\Delta\phi = \frac{60 \cdot A_p}{\frac{2 \cdot \pi}{360} \cdot \frac{D}{2}} \quad [arcmin]$$

Required Gearbox Output Torque

$$T_{2max} = \frac{F_{T\,max} \cdot D}{2000 \cdot \eta_c} \quad [N \cdot m]$$

Required Gearbox Output Torque, Adjusted for Service Factor

$$T_{2KA} = K_A \cdot T_2 \quad [N \cdot m]$$