ETS CONVEYOR SYSTEMS - INTRODUCTION

Quality and Service

When you are looking for a quality conveyor component, look at Easy Conveyors. We put our Leadership on the line for you. Our complete range of products combines stainless steel, carbon steel, aluminum and engineered plastics to achieve reliability, superior performance and a compact of design. We hope you will now take a moment to look through this comprehensive manual. Then, when you are ready to discuss your needs with the nearest Easy Conveyors representative, please consult the back cover of this catalog for further details about our services network. We are able and eager to assist you setting up a smooth running line. The components you want, when and how you want them. Easy Conveyors is ready and able to satisfy your needs with quick answers and delivery of standard or custom made products. Our customers around the world know that the shortest distance between a problem and its solution is to call us: innovations, research, engineering and production are always under a strict control to improve our service and products.

Technical manual for the ETS conveyor systems

This technical manual has been developed to assist you with specific engineering information when a new conveyor is designed as well as when an existing conveyor is going to be modified. Terms like TPM (Total Productive Maintenance) and SMED (Single Minute Exchange of Dies) are getting more and more important. With the right choice of chains and components you can design your conveyors to meet these principles. A large part of our program suits these principles. With this manual we intend to create some “CONvEyOR AWARENESS”. As you will notice, most attention will be given to the construction details for the modular belt or chain, because this is the ‘moving part’ in a conveyor and therefore more critical when it comes to construction details. We also emphasize on guides as together with the belts, these are in direct contact with the customer’s product and therefore of utmost importance. The right choice of type, style of the side guides can make the difference between a medium and a high production efficiency of a filling line.

For additional data and information about technical details of our products please refer to:

- Conveyor Belts catalogue
- Conveyor Roller catalogue
- Conveyor Chain catalogue
- Conveyor Support catalogue
- Conveyor Side guiding catalogue

Contact us To contact your local Technical Support check our website www.easy-conveyors.com or send an email to: support@easy-conveyors.com. We cannot take responsibility for imperfections, damage or injuries due to wrong conveyor design, poor installation or improper use of our products made with or without reference to the information in this manual. We appreciate your suggestions to improve this Engineering Manual.

Selecting the size

A product’s center of gravity, its inherent stability and its contours determine whether it is suited for transport on a mat top, table top, belt or roller conveyor system. The size of the conveyor system is selected according to the conveyed products, dimensions and weight. The maximum product width depends on its shape and the position of its center of gravity.

ETS designs

The EMBS & ETS version in aluminum is an economic solution for many transport tasks. Open profiles prevent large amounts of contaminants from accumulating in the system and are especially easy to clean. The stainless steel version is used in areas that require wet cleaning or the use of acidic or alkaline cleaning agents to comply with stringent hygiene rules, as for primary packaging in the food industry.

Notes for system layout

- Using a capture drive is related to short lightly loaded conveyor systems. This type of construction means the belt is tightened and tensioned by adjustment at one or both shafts. This conveyor system can be used in a reversing operation. It is important to be aware of temperature fluctuations when using this type of construction. In the event of low temperatures, the belt will contract significantly. At high temperatures the belt will expand, which could result in poor or even complete lack of engagement from the sprockets on the drive wheels.
- Using “sag” modules relates to longer and more heavily loaded conveyor systems. The first “sag” module must be placed after the drive unit. This ensures continuous positive engagement from the sprockets on the drive wheel. Another advantage is that it is possible to accommodate any belt contraction/expansion.
- Using a center drive is similar to the conveyor system with the “sag” modules. The only exception is that it can be used in a reversing operation. However, it cannot handle the same heavy loads!
- There is a limit on the maximum weight of the transported product and the maximum length of the conveyors due to the permissible belt tensile force.
- Belt width from > 340 must have an additional support profile for section loads >10kg/m
- The maximum weight of a transported product depends on the position of its center of mass and the lateral guides.
- When using a conveyor with cleats for vertical transport, the maximum weight of a single product is limited by the strength of the cleats.
- Accumulation operation is not possible with static friction belt or cleated belt.
- Pay attention that the slide rails and section profiles are clean when assembling the system. Metal shavings or dust are highly abrasive and cause an extreme amount of wear!
- Avoid accumulation before and in the curves.
- Accumulation must never occur at the drive wheels.
- Depending on the system’s construction and the product being conveyed, certain places pose a risk of pinching / crushing. Appropriate safety devices must be provided in the operating area, as required. Also observe the notes in the assembly instructions which can be found in the download section at http://www.easy-conveyors.com
- Avoid conveying materials with a temperature higher than 60°C
- The maximum pulling force of the ETS chain is 3900 N / m. In practice this means that the curve is the critical part when it comes to force. It also means that after the curve a pretty long straight section can be built without having to much force on out belt. A curve can better be close to the return unit then near to the drive unit. If there is an option, you can take this to consideration.
Conveyor length

Conveyor length depends on:
- Chain/belt type
- Lubrication
- Product
- Load
- Etc.

Operating temperatures

Dry: -40°C to +80°C
Wet: 0°C to +85°C

<table>
<thead>
<tr>
<th>Type</th>
<th>Max. advisable length [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic chains, side flexing</td>
<td>22 - 30mtr</td>
</tr>
</tbody>
</table>

These are indicative figures. In any case it is recommended to double check the conveyor length by calculating the resulting chain pull.

A phenomenon called slip stick effect occurs unpredictably. It depends on speed, load, construction and lubrication. Pulsating dynamic forces are the result and affect the service life of all components of a conveyor. More importantly it influences product handling in a negative way. Long conveyors should be avoided in such cases.

Long conveyors result in high chain load, which affects many components of the conveyor and their wear life.

Conveyor speed

Maximum speed in m/min

<table>
<thead>
<tr>
<th>Type</th>
<th>Max. advisable length [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic chains, side flexing</td>
<td>Dry 45</td>
</tr>
</tbody>
</table>

Under abrasive or high load conditions the maximum speed is reduced. Higher speed causes higher wear in any case. For higher wear resistant materials contact our technical support.

Curve systems

A chain has to be kept in a curve to avoid the chain to jump up from the curve.

Especially with unstable products and a multiple strand situation the Tab has a disadvantage: the link is lifting somewhat in the curve creating a ‘step’ between the individual strands:

Load on curves

When designing a layout, the curves tend to be the limiting factor. The curve adds significantly to the chain pull. The chain pull at the end of the curve is the curve factor times the chain pull at the beginning of the curve. The curve factor ‘Τ’ is depending on the angle of the curve and the friction between chain and curve (for further calculations we refer to our calculation program):

Because of this curve factor it’s generally better to position a curve close to the idler end rather than close to the drive end. Then the curve adds relatively less chain pull.

In general we recommend to keep the total curve angle in a conveyor below 180°.

The pressure on the inside of the curve increases through the curve and together with the speed of the chain it generates heat. The maximum allowable Pressure and Velocity (speed) together is called PV limit. This is an important factor next to the max allowable chain pull. The generated heat will warm up the curve material and when it gets too warm, it will become softer and wears out fast.

To maximize the PV limit, Easy Conveyors uses a special material:

TCS:

- TCS is a unique compound of UHMWPE and a solid lubricant.
- TCS drastically reduces the coefficient of friction whilst maintaining the characteristics of UHMWPE.
- TCS also has a better thermal conductivity compared to UHMWPE.
WEAR STRIPS

Construction:
There are different ways of supporting a chain or belt with wear strips:
• Parallel support => this way is as default for our systems;
• Heavy duty support => in case of heavy load and/or high impact;

Make sure the wear strip is chamfered at the entry side and that there’s enough space between the lengths of wear strip to absorb thermal expansion:

Thermal expansion TCP: 10-15 mm/m +10 °C (K)

Thermal expansion TCS: 0.10-0.15 mm/m / °C

Heavy duty support: In case of heavy loads or high impact, it’s advisable to support the belt. Bear in mind that a heavy duty support can also easily collect dust and dirt. Make sure abrasives can leave the system.

Selection of wear strip material:

<table>
<thead>
<tr>
<th>Wear strip material</th>
<th>Plastic chains &amp; belts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry</td>
</tr>
<tr>
<td>TCS</td>
<td>recommended</td>
</tr>
<tr>
<td>TCP</td>
<td>possible</td>
</tr>
</tbody>
</table>

Temperature limits of wear strip materials must be considered.

TCS
• UHMWPE with built in dry lubricant
• Offers even lower coefficient of friction and less noise emission than standard UHMWPE
• Basic material properties are similar to UHMWPE

TCP
• To be used in slightly abrasive conditions
• Absorption of humidity to be considered

APPLICATIONS

Gripper chains
• Chain tracks must be adjusted parallel. The tolerance for the parallel adjustment of the tracks is < 2mm. Incorrect adjustment can lead to overloading and a high wear of gripper-flights as well as of the basic roller chain.
• Gripper ribs must be oriented backwards relative to the running direction of the chain, as shown in the picture.
• The control system of the conveyor must assure that no backline pressure is created in order to avoid damage at gripper chains.
• The clearance between the chain tracks must be adjustable. Gripping forces must be adjusted according to the product. General rule: as tight as necessary, as loose as possible. The product must be removable by hand.
• A tensioning system is necessary. Tension should just take away the play out of the chain.
• Touching products must be avoided – particularly in curving sections. The gap between the products must be big enough.
• Lubrication helps to extend the service life of the chains as well as of the chain guides.
• EXTRA style curves with the stainless steel strip will significantly elongate the service life of the curves.
• Both chain strands must run at the same speed. Any speed differential causes damage at the chain and possibly also at the product. One central drive is recommended.

Selection of gripper version:

T1: soft containers, e.g. empty PET bottles, empty cans, non pressurized containers.
T2: solid containers, e.g. glass bottles, pressurized containers.
T3: containers with non-cylindrical shape.
T4: small containers.

ETS CONVEYOR SYSTEMS
APPLICATIONS

Static electricity
Anti Static (AS) chain and belt material has the following properties: Surface resistivity: $10^5 \Omega$/sq (According to IEC60093 test method) Volume resistivity: $10^4 \Omega$m

In order to avoid sparks:
- It must be assured on site that the electric charge is dissipated to the ground.
- Wear strips must be conductive and grounded.
- Sprockets and idler wheels must be conductive and grounded.

For further information regarding use of our AS chains in hazardous areas please contact our Technical Support.

Noise reduction
- Use plastic chains/belts instead of steel chains.
- When designing a layout use multiple strand or wider belt running at a lower speed rather than single stand or narrow belt running at higher speed.
- Avoid chain/belt colliding with conveyor parts.
- Reduce speed differentials and thus product impact.
- Adjust sprockets/idlers according to our recommendation in the catalogue
- Use materials with optimized sliding properties (e.g. TCS wear strips, product guides and curves).
- Apply lubrication.

Inclined and declined conveyors
Maximum angles to avoid product sliding down on the chain

<table>
<thead>
<tr>
<th>Chain type</th>
<th>Lubricated</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic chains/belt</td>
<td>2.5°</td>
<td>4.5°</td>
</tr>
<tr>
<td>Rubber top chains plastic</td>
<td>12 / 15°</td>
<td>15 / 20°</td>
</tr>
</tbody>
</table>

Pollution on the chain as well as on the product surface influences the maximum angles negatively.

Declines:
- $\tan(\alpha) > \text{friction coefficient between chain and wearstrips}$ Soft start/stop is recommended.
- $\tan(\alpha) < \text{friction coefficient between chain and wearstrips}$ Soft start/stop is recommended.

Dynamic tensioner is in both cases recommended.

Inclines:
- Drive is normally located at the upper end. Soft start/stop is recommended.

Curve construction in combination with inclines/declines:
ETS Side flexing chain can be used in inclined/declined conveyors only under the following restrictions:

- Incline is possible before curve
- Incline is possible after curve
- Otherwise the chain could be lifted out.

Accumulation
Accumulation of products results in increased load on the chain as well as in increased wear on chain/belt and product.

Cleaning:
The cleaning regime needs to be re-evaluated when going away from wet lubrication because:
- Wet lubricant has also cleaning effect
- More dedicated cleaning is required t.e. where product loss occurred

Product quality:
The type and quality of the material has an influence on the behavior on the conveyors like:
- Quality of PET
- Quality of Cans
- Quality of Glass
- Raw material - Steel/ aluminum - Raw material; origin
- Colorants - Painted or varnished - New or returnable
- Blockers - Design - Design
- Other additives - Material thickness - Surface finish of bottle
- Design/ settings of machine
ETS CONVEYOR SYSTEMS

Process:
When designing a layout please bear in mind that the line is going to run without wet lubrication. Think about:

• Wider conveyors -> slower speed
• Longer inliners/outliners
• Shorter buffer sections [?] Back Line Pressure
• Optimized line controls
• Larger radius curves

Mechanical:
Some small mechanical issues on conveyors that seem not to create problems need to be addressed when going away from wet lubrication. Make sure that the chains/belts are running completely free (without obstruction). Some points of attention:

• TCS wear strips and curves with built-in lubricant can replace the wet lubrication to a certain extent.
• Perfect alignment of different sections.
• Smooth transfers of wear strips.
• Stable and straight side guides at right position.
• Positioning of sprockets and idlers.
• Smooth transfer straight into curve.

Factor H:
The most important factor is the Human Factor: the people that are dealing with the line.

• How do the local people deal with the line?
• Who’s responsible?
• How are the contracts made?
• ‘Mind set’ change when reducing lubrication!
• Never mix products! -> f.e. teflon spray in combination with dry lubricant creates high friction

So, is Dry Lubricant a good idea?

• Yes, in a good number of cases it brings interesting advantages.
• But be aware of the down side to get the full benefit!

Completely dry may be better?

• In certain areas of the bottling line and certain products: yes
• Depalletiser + outfeed conveyors
• Labeling, coding and packaging areas
• Cans and PET and even glass
• Beware of abrasives & chemicals

Product handling Forces due to acceleration:
The force necessary to accelerate the chain and products is calculated by:

\[ F = M \cdot a \]

\[ F = \text{force in [N]} \]
\[ M = \text{mass of chain and product in [kg]} \]
\[ a = \text{acceleration in [m/s}^2] \]

This extra force is working not only on the chain but also on the bearings, the drive unit and the structure. Frequent start-stops create an extra fatigue load on the chain and thus shorten the life time of the chain. In the calculation there’s a factor included depending on number of start-stops per hour. Soft starts or frequency controllers are always advisable. Not only for the life time of the chain but also for smoother product handling and avoiding problems at start-up with products particularly unstable.

Maximum acceleration:
The max acceleration force on a product to be able to ‘take along’ the product with the chain is depending on the friction between product and chain. Maximum acceleration \(a_{\text{max}}\) can be calculated with:

\[ a_{\text{max}} = \frac{F_{\text{max}}}{M} = \frac{W \cdot \mu}{M} = \frac{M \cdot g \cdot \mu}{M} = g \cdot \mu \]

\[ W = \text{weight of product in [N]} \]
\[ M = \text{weight of product in [kg]} \]
\[ \mu = \text{coefficient of friction between chain and product} \]
\[ g = \text{gravitational acceleration} = 9.81 \text{ m/s}^2 \]

Maximum force on products to avoid tip page:
The maximum acceleration without products falling over is depending on the shape (position of centre of gravity), the weight and the material of the product. This is for instance also important when the product is being conveyed onto a dead plate. See below sketch:
The force \( F \) is the force due to acceleration or deceleration of the product \( (F=Ma) \), or due to a different cause like other bottles or a side guide. The bottle will tip over when the angle \( \beta \) is larger than angle \( \alpha \). Angle \( \alpha \) is determined by the diameter of the footprint of the product \( (B=\frac{1}{2} \times \text{diameter}) \) and the height of the centre point of gravity \( (=A) \). Angle \( \beta \) is determined by the horizontal force on the bottle \( (=F) \) relative to the weight of the bottle \( (=G) \).

The max force \( F \) is found by following formula:

\[
\frac{F_{\text{max}}}{G} = \frac{B}{A} \quad \text{or} \quad \frac{F_{\text{max}}}{G} = \frac{B}{A} \begin{cases} \mu < \frac{B}{A} & \text{OK} \\ \mu > \frac{B}{A} & \text{not OK} \end{cases}
\]

MSV = maximum speed variation

\[
\text{MSV} = \sqrt{2 \cdot g \left( \frac{H^2 + B^2 - H}{H + B - H} \right)}
\]

**Centrifugal forces:**

When a product is being conveyed through a curve there’s a centrifugal force working on the product. This force on the product is compensated by the friction between chain and product and by a side guide.

The centrifugal force is calculated with:

\[
F_c = \frac{M \cdot v^2}{r}
\]

\( M \) = weight of the product
\( v \) = speed
\( r \) = centre radius of the curve

Friction force between chain and product is calculated with:

\[
F_m = M \cdot g \cdot \mu
\]

\( g \) = gravitational acceleration
\( \mu \) = coefficient of friction between chain and product.

The minimum force \( F \) that needs to be generated by the side guide is:

\[
F = F_c - F_m = M \cdot \left( \frac{v^2}{r} - g \cdot \mu \right)
\]

**Pressure of accumulating products:**

When a product is standing still (e.g., against a stopper or guide), the chain running underneath the product creates a force on the product equal to the weight of the product multiplied by the coefficient of friction between chain and product. Each following product is pushing with the same force against the next product, so the resulting force is proportional to the total weight of products upstream.

\[
F_n = W_a \cdot L_a \cdot \mu
\]

\( F_a \) = accumulation force
\( W_a \) = weight of the accumulating products in Kg/m.
\( L_a \) = length of accumulation in m

\( \mu \) = coefficient of friction between chain and product.

**Side transfer action:**

Pushing the product sideward creates a force \( F \) on the product against the side guide

\[
F = F_a \cdot \sin(\alpha) = W_a \cdot L_a \cdot \mu \cdot \sin(\alpha)
\]

(see explanation of symbols above)

Nowadays cans and bottles are becoming thinner and thinner. At the same time more and more installations are running with less or no lubrication and are so increasing the coefficient of friction.

That’s why it’s important to take also these forces on the products into consideration. In the above mentioned formula the angle \( \alpha \) plays an important role in a smooth transfer and reduced forces on the products. This angle should be kept as small as possible.
Shaft size:
The shaft must fulfill the following conditions:
• max shaft deflection under full load (Fw). fmax is 2.5 mm. If the calculated shaft deflection exceeds this max value, select a bigger shaft size.
• Torque at max load must be below critical value

Shaft deflection can be calculated with following formula:

\[ f = 0.013 \cdot F_w \cdot \frac{1}{E_2} \left( \frac{l}{b} \right) \left[ \text{mm} \right] \]

For uni-directional head drive Fw = Ts
For bi-directional centre drive Fw = 2 * Ts
For uni-directional pusher drives Fw = 2.2 * Ts

The torque on the shaft is calculated with:

\[ T_{\text{max}} = \frac{F_w \cdot d^2}{2} \cdot 10^{-3} \quad \text{[Nm]} \quad T_{\text{adm}} = \text{admissible torque} \]
\[ T_{\text{adm}} = \eta_{\text{adm}} \cdot \frac{d^3}{5000} \quad \text{[Nm]} \]
\[ \eta_{\text{adm}} = \text{admissible shearing strength [N/mm}^2\text{]} \]

for max. admissible shearing strength see table below:

<table>
<thead>
<tr>
<th>Maximum allowable torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft diam. [mm]</td>
</tr>
<tr>
<td>Ø20</td>
</tr>
<tr>
<td>Ø25</td>
</tr>
</tbody>
</table>

Bearings:
Relubrication is depending on the operating conditions. Dust, load, humidity, temperature, vibrations: all affect the relubrication interval. Below table show indicative values for relubrication intervals. Please note that all our bearing are pre-greased in the factory. These is no need for immediate re-greasing. Furthermore, regreasing should be done in small amounts and with care.

<table>
<thead>
<tr>
<th>Use conditions</th>
<th>Temperature</th>
<th>Re-lubrication period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>up to 50°C</td>
<td>1-2 years</td>
</tr>
<tr>
<td>Clean</td>
<td>50 to 70°C</td>
<td>4-8 months</td>
</tr>
<tr>
<td>Clean</td>
<td>70 to 100°C</td>
<td>1-3 months</td>
</tr>
<tr>
<td>Dirty</td>
<td>up to 70°C</td>
<td>2-8 week</td>
</tr>
<tr>
<td>Dirty</td>
<td>70 to 100°C</td>
<td>2-4 week</td>
</tr>
<tr>
<td>Humid + wet</td>
<td>-</td>
<td>1-2 week</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shaft size [mm]</th>
<th>Inertia [mm4]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø20</td>
<td>7850</td>
</tr>
<tr>
<td>Ø25</td>
<td>19170</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shaft material</th>
<th>Modulus of elasticity E</th>
<th>Shearing strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel (low strength)</td>
<td>195000 N/mm2</td>
<td>60 N/mm2</td>
</tr>
</tbody>
</table>
**MATERIALS**

**Standard PIN Material**
Special reinforced acetal resin.

**Benefits:**
- Suitable for metal detectors
- Easy disposal of chains after use

**Plastic belt materials**

**Low Friction Acetal Resin**
This material is commonly used in the market and offers an improved co-efficient of friction. It is also suitable for use in high speed applications.

Color: White

This material is FDA (Food and Drug Administration) approved for direct contact with food.

**Rubber materials**

**TPR**
TPR is used for ETS chains and EMBS belts and for some gripper chains. TPR is a SEBS type rubber, which assures an optimum bonding on the plastic base material.

**Storage of plastic chains and belts**
- Materials of our plastic chains and belts offer best stability and resistance against environmental effects at appropriate storage:
  - in the original packaging,
  - without environmental radiation / UV light,
  - dry - in a non aggressive environment - a temperature between 5°C and 35°C
- First IN, First OUT.
We have applied that procedure in our logistic department.
We recommend this procedure to any external warehouse.

- Do not stack pallets or other heavy goods on top of chain packs. Chains inside the packs might get damaged.
- Do not stack chain packs higher than the original stacking height – as dispatched from our shipping department.

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**Coefficients of friction**

Below listed coefficients can be used as a guideline. Dependent on environmental and application requirements (temperatures, lubricant, material combinations, dirt/debris, product and chain/belt surfaces, etc.) the coefficients are subject to variation.

**Coefficient of friction between chain and wearstrip:**

<table>
<thead>
<tr>
<th>Friction coefficient Chain/Slide rail (µf)</th>
<th>Dry</th>
<th>Dry</th>
<th>Dry</th>
<th>Water</th>
<th>Water &amp; Soap</th>
<th>Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight sections TCP</td>
<td>0,2</td>
<td>0,4</td>
<td>0,5</td>
<td>0,16</td>
<td>0,10</td>
<td>0,10</td>
</tr>
<tr>
<td>Straight sections TCS</td>
<td>0,18</td>
<td>0,35</td>
<td>0,45</td>
<td>0,14</td>
<td>0,10</td>
<td>0,10</td>
</tr>
<tr>
<td>Head drive unit</td>
<td>0,3</td>
<td>0,40</td>
<td>0,50</td>
<td>0,24</td>
<td>0,15</td>
<td>0,15</td>
</tr>
<tr>
<td>Return unit</td>
<td>0,3</td>
<td>0,40</td>
<td>0,50</td>
<td>0,24</td>
<td>0,15</td>
<td>0,15</td>
</tr>
<tr>
<td>Center drive unit</td>
<td>1,0</td>
<td>1,25</td>
<td>1,70</td>
<td>0,8</td>
<td>0,5</td>
<td>0,5</td>
</tr>
<tr>
<td>Connection drive unit</td>
<td>0,6</td>
<td>0,80</td>
<td>1,0</td>
<td>0,48</td>
<td>0,3</td>
<td>0,3</td>
</tr>
</tbody>
</table>

**Coefficient of friction between chain and product (µST):**

<table>
<thead>
<tr>
<th>Lubrication</th>
<th>Paper carton</th>
<th>Metal (steel)</th>
<th>Aluminum incl, PET</th>
<th>Plastics</th>
<th>Glass (return)</th>
<th>New glass, ceramics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>0,28</td>
<td>0,25</td>
<td>0,25</td>
<td>0,21</td>
<td>0,24</td>
<td>0,20</td>
</tr>
<tr>
<td>Water</td>
<td>0,20</td>
<td>0,18</td>
<td>0,16</td>
<td>0,18</td>
<td>0,18</td>
<td>0,15</td>
</tr>
<tr>
<td>Water &amp; Soap</td>
<td>0,15</td>
<td>0,14</td>
<td>0,13</td>
<td>0,14</td>
<td>0,14</td>
<td>0,12</td>
</tr>
</tbody>
</table>
### Chemical resistance

Data shown in the table was taken from laboratory tests performed on unstrained samples and are merely indicative. Chemical resistance under normal working conditions can depend on various factors, such as stress and temperature, concentration of the chemical agent and duration of its effects, valid for ambient temperature (21°C).

<table>
<thead>
<tr>
<th>Chemical agent</th>
<th>METALS</th>
<th>PLASTICS</th>
<th>RUBBERS</th>
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</table>

**ABBREVIATION**

C = concentration
SA = saturated
G = good resistance
I = insufficient resistance (not recommended)
○ = fairly good resistance depending on use conditions
Blank spaces = no tests performed
Parameters affecting wear rate

Operating conditions:
- Load
- Speed
- Number of starts per hour
- No soft start/frequency inverter
- Controlled drive
- Product accumulation
- Lubrication
- Water quality
  - Concentration of chlorines
  - Water hardness
  - Contaminations
  - Discontinuous water supply
- Lubricant
  - Suitability/performance
  - Dosing
  - Efficiency of nozzles

Conveyor construction:
- Choice of chain/belt
- Suitability of selected chain/belt for the application
- Mounting of wear strips
- Flatness
- Chamfers
- Raised portions
- Expansion compensation gaps

Conveyor components:
- Material quality
- Construction
- Dimensional accuracy of:
  - Wear strips
  - Sprockets
  - Idlers
  - Return rollers
  - Shaft alignment

Cleaning:
- Cleaning agent
- Frequency
- Intensity
- Rinse
- Concentration
- Temperature
- Efficiency of nozzles

Cleaning instructions:
- Cleaning is necessary to:
  - Minimize dirt and debris build up
  - Keep bacteriological situation under control
  - Elongate service life of chains/belts
  - Ensure smooth running of chain/belt for optimum product stability
  - Prevent crashes due to etc., glass debris
  - Prevent malfunction due to sticky residues
  - Keep friction low

Frequency:
- As a rule of thumb we say that cleaning the line once every week is sufficient.
- Of course in practice depending on the circumstances this can be more frequent (i.e., during product changes in case of product loss or other pollution) or less frequent in a relatively clean environment.

In the direct surrounding of the filler cleaning will be more frequent anyway. Depending also on the bacteriological situation it may be necessary to clean at least once a day or once every shift.

Also chemicals coming from a pasteurizer may ask for more frequent cleaning to prevent the chemicals from affecting the chain/belt materials.

In a can line where aluminum cans are filled, there’s the aluminum oxide that has to be kept under control. This can occur also far away from filler-pasteurizer, where the line is running dry. When the cans are accelerating on an incliner the remaining drops will fall down with the aluminum oxide on the chain causing a highly abrasive sludge to build up on the incliner. Therefore it may be necessary to clean more frequent also further down the line due to ‘local’ circumstances.

Method:
- Important for an optimum service life of the chains and belts is a general inspection on the conveyors already during operation. Listen for strange – rattling or squeaking – noises, Check transfer plates, return rollers, bearings, etc. Make sure the chain/belt is still running free without extra load or obstruction. Often the service life of a chain/belt is reduced for mechanical reasons that can be sorted easily.
- When cleaning we advice to go thr following steps:
  1. Check for foreign parts on the conveyor, Check also the return part.
  2. Rinse with warm (max 60°C) or cold water thoroughly while chain/belt is running.
  3. Use mild (PH 5-9) detergent according to suppliers instructions.
  4. If necessary clean mechanically (brush) when pollution is hard to remove.
  5. Rinse thoroughly with warm (max 60°C) or cold water, Make sure all detergent is rinsed off while chain/belt is running.
  6. Final mechanical check that chain/belt is running free and without obstruction. During this process it’s important not to forget to clean in between carry and return section and underneath where the return support system is.

Especially with plastic chains/belts the detergent in use needs to be checked for compatibility with the plastic materials of the chain/belt.

General:
- As obvious as it seems, cleaning is important! Since nowadays pressure on production rates and production costs are getting higher and higher, companies tend to look at cleaning when trying to cut costs.
- Less time and resources are available while at the same time the capacity of the lines (and thus pollution and product loss) has to go up.
- When companies are setting up a cleaning regime they tend to focus on the individual machines (mainly filler and surrounding) and not so much on the conveyors, Therefore we want to promote ‘CONVEYOR AWARENESS’ in this respect.

Dry versus wet:
- When a wet lubricant is in use (water & soap) product loss is normally flushed off by the water & soap, Often the soap also has a ‘cleaning function’ built in. But wet circumstances also attract dust and dirt and wet circumstances will increase the growth of bacteria. When a line is standing still during a stop or during the weekend without cleaning, the lubricant will dry in which may cause pollution and changing sliding characteristics of the chain/belt.

Under dry circumstances the conveyors generally remain cleaner; But product loss needs to be cleaned to avoid functional problems of the line.

Therefore functionally speaking wet lubrication is more safe but requires just as well regular cleaning and is a high cost factor.

All together with the present state of conveyor technology it is possible to run a major part of a glass, can or a PET line dry taken into consideration that a regular cleaning regime is in place.

Inspection procedure:
1. Inspect chains for unusual wear patterns or damage.
2. Look for excessive gaps between chain flights.
3. Check conveying surface for Flatness, bent or broken Flights.
4. Inspect fold-down tabs or beveled sliding surfaces for excessive wear.
5. Review chain catenary sag for proper amount.
6. If take-up are used, check that take-up tension is not excessive. Do not preload chain.

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7. Check all idlers, rollers, turn discs and sprockets for freedom of rotation,
8. Examine sprockets for excessive wear,
9. Look for debris build up in sprocket tooth pockets,
10. Check for excessive guide ring wear,
11. Check all wear strips and fasteners for excessive wear,
12. Check all transfer points, dead plates, turn tables, turn discs and sprockets for proper elevation and alignment,
13. Review function of lubrication system,
14. Inspect general cleanliness of conveyor system,

Installation procedure
1. Check all sprockets, idlers, turn discs and rollers for proper elevation and alignment with regard to the conveyor tracks,
2. Check all wear strips (carrying and return), dead plates, dividers and transfers mechanism for proper location, elevation, spacing and Flatness,
3. Check all fasteners for proper tightness (torque), Fasteners used on wear strips and dead plates must have recessed heads,
4. Check all conveyor splice points for proper elevation, alignment and fastening,
5. Inspect conveyor system for obstructions by pulling a short section of chain (1 meter) through the entire conveyor,
6. Check lubrication system (if present),
7. Install conveyor chain, assuring that the following has been done:
   A. Check for correct direction of chain travel,
   B. Assemble chain in 3 meters sections and avoid twisting or damaging the chain,
   C. Connect chain sections on the conveyor, Make sure that the connecting pins are not protruding,
   D. Adjust chain catenary (sag) to the proper elevation, Note: readjustment is usually necessary after a certain operating time,
8. Insure that lubricant is evenly dispersed through conveyor system,
9. Start up conveyor by jogging and/or using short running periods before loading the system, Be alert to unusual noises or actions, If a problem should occur, refer to the trouble shooting guide,

Replacement criteria
Chains must be replaced when:
- The chain starts to jump on the sprocket due to elongation, This may start to happen at 3% elongation or more,
- The thickness of the module has been reduced by 1 mm from the top and from the bottom,
- The surface becomes uneven or scratched causing stability problems,

Belts must be replaced when:
- The belt starts to jump on the sprocket due to elongation,
- The thickness of the module has been reduced by 1 mm from the top and from the bottom,
- The surface becomes uneven or scratched causing stability problems,

When replacing chains/belts, it is recommended to replace wear strips and sprockets/idlers as well, Sprockets and idlers must be replaced when:
- teeth are worn flat
- chain/ belt does not release well
- teeth are damaged
- bore of idler is worn out and idler starts to oscillate
- hub or keyway are damaged
- new chain/ belt is installed

Wear strip must be replaced when:
- thickness is reduced by 50% and stability problems occur
- dirt or debris is embedded
- Fixing rivets protrude.

Layout procedure for a ETS conveyor system

Task definition:
Determine number and position of the work steps, calculate the available space.

Plan rough system layout:
Lengths, segments, curves, slopes (sketch)

Product specific data:
Determine conveyed material data:
Dimensions, mass, friction figures, antistatic environment needed?

Production specific data:
Determine conveyor parameters: Speed, conveyed material spacing and cycle, number of start-up operations/h, accumulation section

Detailed system layout planning:
Accumulation sections, product interchange points

Check drive torque:
M  *  2      >     F

OK? YES NO
ETS CONVEYOR SYSTEMS

Needed data

- The length and/or width of the belt conveyor (mm)
- The width of the belt (mm)
- Wanted speed (m/s/min)
- Product weight (Kg)
- Product length (mm) [1] (in direction of transport)
- Amount of products on the conveyor (pcs)
- Product to transport (bakery, food, plastic, cardboard, glass or metal)
- Slide profile (TCP / TCS)
- State of contact surfaces between slide rail/chain - (dry normal - dirty - rough/Water/Water & Soap/Oil)
- State of contact surfaces between goods/chain (dry/water/water & soap)
- Ambient temperature (°C)
- Start/Stop each hour (pcs/hr)
- Frequency controller (Yes or No)
- Accumulation (Yes or No)
- Amount of products to accumulate (pcs)
- Running hours per day
- Type of loading

<table>
<thead>
<tr>
<th>Weight (Kg)</th>
<th>Actual length (Lc)</th>
<th>Straight length (Ls)</th>
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<tbody>
<tr>
<td>(kp/m²)</td>
<td>Drive / return units (m²/m²)</td>
<td>Drive / return units (m²/m²)</td>
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<td>1,05</td>
<td>ETS80 FLAT TOP Return unit 0,777 Return unit 0,34</td>
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<td>3,2</td>
<td>ETS80 ROLLER 1,15 ETS80 FRICITION Drive unit 0,984 Drive unit 0,347</td>
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<tr>
<td>1,32</td>
<td>ETS140 FLAT TOP Center drive unit 1,56 Center drive unit 0,66</td>
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<td>1,43</td>
<td>ETS140 FRICITION Connection drive unit 1,34461 Connection drive unit 0,7</td>
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<td>1,75</td>
<td>ETS220 FRICITION</td>
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Belt length Hor. Curves (mm)

(two side)

- ETS HORIZONTAL CURVE, 30° R200 609,33
- ETS HORIZONTAL CURVE, 45° R200 714
- ETS HORIZONTAL CURVE, 60° R200 818,66
- ETS HORIZONTAL CURVE, 90° R200 1028
- ETS HORIZONTAL CURVE, 180° R200 1606

- ETS HORIZONTAL CURVE, 30° R500 923,33
- ETS HORIZONTAL CURVE, 45° R500 1185
- ETS HORIZONTAL CURVE, 60° R500 1446,66
- ETS HORIZONTAL CURVE, 90° R500 1970
- ETS HORIZONTAL CURVE, 180° R500 3540

Belt length Vert. Curves (mm) Degrees (β)

(two side)

- ETS VERT. SLIDE CURVE; 5° R=500 487,22
- ETS VERT. SLIDE CURVE; 10° R=500 574,14
- ETS VERT. SLIDE CURVE; 15° R=500 661,67
- ETS VERT. SLIDE CURVE; 30° R=500 923,34
- ETS VERT. SLIDE CURVE; 45° R=500 11
- ETS VERT. SLIDE CURVE; 60° R=500 1446,67
- ETS VERT. SLIDE CURVE, 90° R=500 1970

Friction forces occur in curves (µR)

0° (Straight sections) 1,0

Curve angle (vertical)

- 5° 1,03
- 10° 1,05
- 15° 1,05
- 30° 1,10
- 45° 1,20

WHEEL Curve angle (horizontal)

- 30° 1,05
- 45° 1,05
- 60° 1,075
- 90° 1,10
- 180° 1,15

SLIDE Curve angle (horizontal)

- 30° 1,2
- 45° 1,3
- 60° 1,4
- 90° 1,6
- 180° 2,2

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The permissible chain tensile force depends on the conveying speed as well as the ambient and operating conditions.

If the calculated chain tensile force exceeds the permissible amount, you can:

• divide the section into various chain conveyors.

• alter the system layout, e.g. by shorten the section.

• shorten the accumulation sections.

• reduce the speed.
MOTOR SELECTION

The drive torque of the selected gear motor must be greater than the calculated required drive torque. There are the following options to reduce the required drive torque:

• reduce the chain tensile force (F).
• reduce the speed (v) and use a gear motor with a higher drive torque.
• change the operating conditions (e.g. the ambient temperature)

Procedure for both calculations:
• Divide the conveyor section into segments. Segment 1 starts at the traction stand (e.g. at the return unit, at the connecting drive outlet), the last segment ends at the drive unit. The division is made according to operating mode (conveying operation / accumulation operation). When using horizontal or vertical curves the segment ends after the curve.
• Calculate the individual segments in ascending order. The chain tensile force of the current segment will enter the calculation of the following segment as a counter force. The result of the last segment is the required chain tensile force to operate the conveyor.
• The tensile force resulting from the chain return can generally be overlooked.

Exceptions:
• The conveyor contains more than 2 curves.
• The section load of the goods is lower than that of the chain (round trip): \( qF \leq 2 \cdot qK \)

In these cases, the first segment begins at the head drive outlet.

For all calculations
\[ Q_i = \frac{M_i \cdot g}{L_i} \]

ETS Straight
\[
F_i = \left[ F_{a0} + L_1 \left( qF_1 + qK_1 \cdot |v_1| \right) + \left( L_2 - L_1 \right) \left( qK_1 \cdot |v_1| \right) \right] \cdot |\mu_k| \]
\[
F_i = \left[ F_{a0} + L_1 \left( qF_1 + qK_1 \cdot |v_1| \right) \right] \cdot |\mu_k| \text{ (connection drive)}
\]

ETS Incline/Decline
\[
F_i = \left[ F_{a0} + L_1 \left( qF_1 + qK_1 \cdot |v_1| \right) \left( -\mu_k \cos \beta + \sin \beta \right) \right] + \left( L_2 - L_1 \right) \left( qK_1 \cdot |v_1| \right) \cdot |\mu_k| \]

ETS Accumulation (is not possible when using a friction or a cleated belt)
\[
F_i = \left[ F_{a0} + L_1 \left( qF_1 + qK_1 \cdot |v_1| \right) \left( \mu_k \cos \beta - \sin \beta \right) \right] \cdot |\mu_k| \text{ (connection drive)}
\]

LIST OF APPLIED ABBREVIATIONS

- \( F \): Chain Tensile force (at the drive pulley) (N)
- \( F_{perm} \): Permissible load capacity
- \( F_i \): Chain tensile force of individual segments (N)
- \( g \): 9.81 (m/s^2)
- \( |\mu_k| \): Friction forces occur in curves
- \( \mu_{pr} \): Friction coefficient Product/Chain
- \( \mu_{tr} \): Friction coefficient Chain/Slide rail
- \( L \): Conveyor section length (mtr)
- \( L_i \): Segment length (mtr)
- \( L_x \): Actual chain length (mtr)
- \( L_s \): Chain length straight (mtr)
- \( Q_i \): Section load of conveyed material on segment Li (N/mtr)
- \( Q_k \): Weight of the belt (N/mtr)
- \( \beta \): Angle for Incline or Decline (°)
- \( \eta \): Efficiency (%)
Example 1: Calculation ETS Incline

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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
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<td>Conveyor system</td>
<td>ETS Aluminum</td>
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<td>Pitch diameter</td>
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<td>Product weight</td>
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<td>Product Length</td>
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<td>Conveyor length L</td>
<td>6,232mtr</td>
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<tr>
<td>Chain section load QK</td>
<td>11,28 N/m (1.15*9.81)</td>
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<td>Slide rail</td>
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<tr>
<td>State of contact surfaces μT</td>
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<tr>
<td>Amount of products to accumulate</td>
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<tr>
<td>Running hours per day</td>
<td>16 hr</td>
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<tr>
<td>Type of loading</td>
<td>Uniform Load Permissible load capacity 2386N (see table 1 or 2 page 251)</td>
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</tbody>
</table>

ETS SECTION 1

\[ \tau = \frac{M \times g}{L} \]

\[ \tau = 0 \times \frac{9.81}{0.34} \]

ETS Section 1

\[ F_1 = (F_c + (L_1 \times (Q_K + Q_0) \times \mu_R + (L_1 - L_1 \times Q_K \times \mu_T) \times \mu_R) \times \mu_T) \times \mu_T \]

\[ F_1 = [0.0 + (0.34 \times 11.28 + 0.34) + (0.777 - 0.34 \times 11.28 + 0.34) \times 1.0) \]

\[ F_1 = [0.0 + (0.34 \times 3.84) + 1.479] \times 1.0 \]

\[ F_1 = [0.0 + 1.151 + 1.479] \times 1.0 \]

\[ F_1 \approx 2.63 \text{ N} \]

ETS SECTION 2

\[ \tau = \frac{M \times g}{L} \]

\[ \tau = 20 \times \frac{9.81}{0.986} \]

\[ \tau = 199 \text{ N/m} \]

ETS Section 2

\[ F_2 = (F_c + (L_1 \times (Q_K + Q_0) \times \mu_R + (L_1 - L_1 \times Q_K \times \mu_T) \times \mu_R) \times \mu_T) \times \mu_T \]

\[ F_2 = [2.63 + (0.986 \times 11.28 + 199) \times 0.2 + (1.17 - 0.986 \times 11.28 + 0.2) \times 1.60) \]

\[ F_2 = [2.63 + (0.986 \times 42.056) + 2.22] \times 1.60 \]

\[ F_2 = [2.63 + 52.04 + 2.22] \times 1.60 \]

\[ F_2 \approx 74.12 \text{ N} \]
ETS SECTION 3

\[ L_i = \text{Segment length (mtr)} : 1.17 \text{ (Vert. Curve 30° | 1 side) } + * 0.25 \text{mtr} \]

\[ L_k = \text{Actual chain length (mtr)} : 2.35 \text{ (Vert. Curve 30° | 2 side) } + * 2 * 0.25 \text{mtr} \]

\[ \mu_l = \text{Friction forces occur in curves} : 1.10 \text{ (Vert. slide curve 30°)} \]

\[ \mu_c = \text{Friction coefficient Chain/Slide rail} : 0.2 \]

\[ M_i = \text{Total product mass (Kg)} : 20 \text{ Kg} \]

\[ q_n = \frac{M_i \times g}{L} \quad q_n = 60 \times 9.81 \quad q_n = 167.70 \text{ N/m} \]

ETS Section 3

\[ F_3 = [ F_i + (L_i \times (q_k + q_i) \times (\mu_l \times \cos \beta + \sin \beta)) + (L_k - L_i) \times q_k \times (\mu_l \times \cos \beta - \sin \beta)] \times \mu_r \]

\[ F_3 = [231.07 + (1.17 \times (11.28 + 167.70) \times (0.2 \times 0.866 + 0.5) + (2.35 - 1.17) \times 11.28 \times (0.2 \times 0.866 - 0.5))] \times 1.10 \]

\[ F_3 = [231.07 + 178.98 \times 0.67 + (13.20 \times -0.33)] \times 1.10 \]

\[ F_3 = 231.07 \text{ N} \]

ETS SECTION 4

\[ L_i = \text{Segment length (mtr)} : 1.0 \text{ (Straight section) } \]

\[ L_k = \text{Actual chain length (mtr)} : 2.0 \text{ (Straight section | 2) } \]

\[ \mu_l = \text{Friction forces occur in curves} : 1.0 \]

\[ \mu_c = \text{Friction coefficient Chain/Slide rail} : 0.2 \]

\[ M_i = \text{Total product mass (Kg)} : 60 \text{ Kg} \]

\[ q_n = \frac{M_i \times g}{L} \quad q_n = 60 \times 9.81 \quad q_n = 588.6 \text{ N/m} \]

ETS Section 4

\[ F_4 = [ F_i + (L_i \times (q_k + q_i) \times (\mu_l \times \cos \beta + \sin \beta)) + (L_k - L_i) \times q_k \times (\mu_l \times \cos \beta - \sin \beta)] \times \mu_r \]

\[ F_4 = [670.60 + (0.347 \times (11.28 + 0) \times 0.3) + (0.984 - 0.347) \times 11.28 \times 0.3] \times 1.0 \]

\[ F_4 = [670.60 + 3.384 + 2.16] \times 1.0 \]

\[ F_4 = 670.60 \text{ N} \]

\[ F_{\text{max}} = F_{\text{perm.}} \times C_1 \times C_2 \]

\[ F_{\text{max}} = 2366 \times 0.83 \times 1.0 \]

\[ F_{\text{max}} \approx 1964 \text{ N} \]

\[ F = 670.60 \text{ N} \]

\[ \text{System is OK} \]

\[ M_n = F \times (d_A / 2) \]

\[ M_n = 670.60 \times (147.3 / 2) \]

\[ M_n \approx 49.39 \text{ Nm} \]

Run-up Torque

\[ M_{\text{hi}} = M_n \times C_3 \]

\[ P_A = F_i \times \nu \]

\[ P_A = 670.60 \times 0.33 \]

\[ P_{\text{hi}} = 0.22 \text{ kW} \]

\[ M_{\text{hi}} = 74.10 \text{ Nm} \]

\[ P_{\text{hi}} = P_{\text{A}} \text{ (kW) chose, the next larger standard motor} \]

ETS SECTION 5

\[ L_i = \text{Segment length (mtr)} : 0.34 \]

\[ L_k = \text{Actual chain length (mtr)} : 0.777 \]

\[ \mu_c = \text{Friction coefficient Chain/Slide rail} : 0.3 \]

\[ q_n = \frac{M_i \times g}{L} \quad q_n = 0 \times 9.81 \quad q_n = 0 \]

ETS Section 5

\[ F_5 = [ F_i + (L_i \times (q_k + q_i) \times (\mu_l \times \cos \beta + \sin \beta)) + (L_k - L_i) \times q_k \times (\mu_l \times \cos \beta - \sin \beta)] \times \mu_r \]

\[ F_5 = [667.25 + 0.347 \times 3.384 + 2.16] \times 1.0 \]

\[ F_5 = [667.25 + 1.17 + 2.16] \times 1.0 \]

\[ F_5 \approx 670.60 \text{ N} \]

\[ F_{\text{max}} = F_{\text{perm.}} \times C_1 \times C_2 \]

\[ F_{\text{max}} = 2366 \times 0.83 \times 1.0 \]

\[ F_{\text{max}} \approx 1964 \text{ N} \]

\[ F = 670.60 \text{ N} \]

\[ \text{System is OK} \]

\[ M_n = F \times (d_A / 2) \]

\[ M_n = 670.60 \times (147.3 / 2) \]

\[ M_n \approx 49.39 \text{ Nm} \]

Run-up Torque

\[ M_{\text{hi}} = M_n \times C_3 \]

\[ P_A = F_i \times \nu \]

\[ P_A = 670.60 \times 0.33 \]

\[ P_{\text{hi}} = 0.22 \text{ kW} \]

\[ M_{\text{hi}} = 74.10 \text{ Nm} \]

\[ P_{\text{hi}} = P_{\text{A}} \text{ (kW) chose, the next larger standard motor} \]
ETS CONVEYORS

Example 2: Calculation ETS Connection drive

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyor system</td>
<td>ETS Aluminum</td>
</tr>
<tr>
<td>Belt width</td>
<td>140 mm</td>
</tr>
<tr>
<td>Wanted speed</td>
<td>15 mtr/min (0,25 mtr/sec)</td>
</tr>
<tr>
<td>Pitch diameter</td>
<td>ø147,3mm</td>
</tr>
<tr>
<td>Product weight</td>
<td>5 kg</td>
</tr>
<tr>
<td>Product Length</td>
<td>175mm</td>
</tr>
<tr>
<td>Product material</td>
<td>Cardboard</td>
</tr>
<tr>
<td>Conveyor length L</td>
<td>6,6mtr</td>
</tr>
<tr>
<td>Chain section load Qc</td>
<td>12,95 N/m (1,32*9,81)</td>
</tr>
<tr>
<td>Slide rail</td>
<td>TCS</td>
</tr>
<tr>
<td>State of contact surfaces μR</td>
<td>Dry</td>
</tr>
<tr>
<td>State of contact surfaces μT</td>
<td>Dry - Normal</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>45°C</td>
</tr>
<tr>
<td>Start/Stop</td>
<td>30/h</td>
</tr>
<tr>
<td>Frequency controller</td>
<td>Yes</td>
</tr>
<tr>
<td>Accumulation on Section 2</td>
<td>Yes</td>
</tr>
<tr>
<td>Amount of products to accumulate</td>
<td>6 pieces</td>
</tr>
<tr>
<td>Running hours per day</td>
<td>8 hr</td>
</tr>
<tr>
<td>Type of loading</td>
<td>Uniform Load Permissible load capacity 2591N (see table 1 or 2 page 251)</td>
</tr>
</tbody>
</table>

ETS SECTION 1

\[ L_1 = \text{Segment length (mtr)} : 1.97 (\text{slide Curve 180°}) + 0.2\text{mtr} \]
\[ \mu_k = \text{Friction forces occur in curves : 2.2 (Slide curve 180°)} \]
\[ \mu_t = \text{Friction coefficient Chain/Slide rail : 0.18} \]

\[ Q_p = \frac{M_i \cdot g}{L} \]
\[ Q_p = 0 \cdot 9,81 \]
\[ Q_p = 0 \]

ETS Section 1

\[ F_1 = [F_c + (L \cdot (Q_k + Q_p) \cdot \mu_k)] \cdot \mu_t \]
\[ F_1 = (0 + (1.97 \cdot (12.95 + 0)) \cdot 0.18) \cdot 2.2 \]
\[ F_1 = (0 + 4.60) \cdot 2.2 \]
\[ F_1 \approx 10,10 \text{ N} \]

ETS SECTION 2

\[ L_2 = \text{Segment length (mtr)} : 1.1\text{ (Straight section)} \]
\[ \mu_k = \text{Friction forces occur in curves : 1.0} \]
\[ \mu_t = \text{Friction coefficient Chain/Slide rail : 0.18} \]
\[ M_i = \text{Total product mass (Kg)} : 25 \text{ Kg} \]

\[ Q_p = \frac{M_i \cdot g}{L} \]
\[ Q_p = 25 \cdot 9,81 \]
\[ Q_p = 267,55 \text{ N/m} \]

Accumulation

\[ Q_p = \frac{M_i \cdot g}{L} \]
\[ Q_p = 25 \cdot 9,81 \]
\[ Q_p = 280,3 \text{ N/m} \]

ETS Section 2

\[ F_1 = [F_c + (L \cdot (Q_k + Q_p) \cdot \mu_i) + Q_p \cdot \mu_t] \cdot \mu_k \]
\[ F_1 = (10,10 + (1.1 \cdot (12.95 + 267,55)) \cdot 0.18 + 280,3 \cdot 0.28) \cdot 1.0 \]
\[ F_1 = (10,10 + 65,54 + 78,48) \cdot 1.0 \]
\[ F_1 \approx 144,12 \text{ N} \]

See engineering online

www.easy-conveyors.com
ETS CONVEYORS

ETS SECTION 3

\[ L_i = \text{Segment length (mtr)} \]
\[ \mu_k = \text{Friction forces occur in curves} \]
\[ \mu_l = \text{Friction coefficient Chain/Slide rail} \]
\[ M_i = \text{Total product mass (Kg)} \]

\[ q_n = M_i \times g / L \]
\[ q_n = 10 \times 9.81 / 1.77 \]
\[ q_n = 58.34 \text{ N/m} \]

\[ M_i = \text{Total product mass (Kg)} \]
\[ M_i = 10 \text{ Kg} \]

ETS Section 3

\[ F_i = F_{1,2} + \{ L_i \left( q_m + q_r \right) \} \times \mu_k \]
\[ F_i = \left[ 144.12 + \left( 1.77 \times \left( 12.19 + 83.14 \right) \times 0.18 \right) \right] \times 2.2 \]
\[ F_i = \left[ 144.12 + 30.61 \right] \times 2.2 \]

\[ F_i = 384.42 \text{ N} \]

ETS SECTION 4

\[ L_i = \text{Segment length (mtr)} \]
\[ L_i = 1.545 \text{ (Drive unit 1.345mtr + 0.2mtr)} \]
\[ \mu_k = \text{Friction forces occur in curves} \]
\[ \mu_l = \text{Friction coefficient Chain/Slide rail} \]
\[ M_i = \text{Total product mass (Kg)} \]

\[ q_n = M_i \times g / L \]
\[ q_n = 5 \times 9.81 / 1.545 \]
\[ q_n = 31.75 \text{ N/m} \]

ETS Section 4

\[ F_i = F_{1,2} + \{ L_i \left( q_m + q_r \right) \} \times \mu_l \]
\[ F_i = \left[ 384.42 + \left( 1.545 \times \left( 12.19 + 31.75 \right) \times 0.6 \right) \right] \times 1.0 \]
\[ F_i = \left[ 384.42 + 41.44 \right] \times 1.0 \]

\[ F_i = 425.86 \text{ N} \]

\[ F_{\text{max}} = F_{\text{max}} \times C_1 \times C_2 \]
\[ F_{\text{max}} = 2591 \times 0.71 \times 0.96 \]

\[ F_{\text{max}} = 1766 \text{ N} \]

System is OK

\[ M_0 = F \times \left( d_u / 2 \right) \]
\[ M_0 = 425.86 \times \left( 147.3 / 2 \right) \]

\[ M_0 = 31.37 \text{ Nm} \]

Run-up Torque

\[ M_0 = M_0 \times C_3 \]
\[ M_0 = 31.37 \times 1.5 \]

\[ M_0 = 47.05 \text{ Nm} \]

\[ P_a = P_a \times \left( 1 - \left( F / F_{\text{max}} \right) \right) \]
\[ P_a = 425.86 \times 0.25 \]

\[ P_a = 0.11 \text{ kW} \]

Conclusion

You can see above that the motor and also the conveyor system are selected because of the input. Also you can see that some values cause a certain overload situation for the system, motor or both.

There are a few options to prevent an overload.

- Lower the speed
- Lower the amount of product on the conveyor
- Less Start/Stops
- Less Accumulation
- Change type of loading
- Shorten the conveyor
- Choose another conveyor system
- Less running hours per day.
- Choose another transport system. (roller conveyor, mat top conveyor or tabletop conveyor)
## TROUBLESHOOTING

### Chain/belt jumps on sprocket

**Possible causes**
- Chain/belt is elongated e.g. due to wear or overloaded
- Improper catenary sag
- Sprocket is worn
- Wrong sprocket type
- Misaligned sprocket
- Improper sprocket position

**Possible causes**
- Incorrect sprocket dimension or type
- Sticky residue
- Improper catenary sag

**Slip stick operation**

**Possible causes**
- Slip stick
- Return roller diameter too small
- Chain/belt catches the conveyor
- Improper catenary sag

**Damaged chain hinges**

**Possible causes**
- Overloading
- Blocking and obstructions
- Exceeding the minimum backflex radius
- Too small radius far side flexing chain

**Elongation**

**Possible causes**
- Overloading

**Damaged chain hinges**

**Possible causes**
- Overloading

**Wear from dirt in hinges**

**Rapid curve wear**

**Possible causes**
- Overheating
- Embedded abrasives

**Remedy**
- Replace chain/belt and sprocket.
- Check other components as well.
- Eliminate cause of overload.
- Replace sprocket.
- Install correct sprocket.
- Check and adjust position.
- Check and replace sprocket.
- Clean chain/sprocket or renew.
- Check dimensions and adjust.
- Use lubrication.
- Reduce chain/belt tension by shortening the conveyor.
- Install larger rollers.
- Remove obstructions.
- Check return part as well.
- Check dimension and adjust.
- Eliminate cause of overloading.
- Check sprockets and other components.
- Replace chain/belt.
- Replace components if necessary.
- Check the complete conveyor.
- Check conveyor construction.
- Check minimum radius of chain and adjust accordingly.
- Eliminate cause of overloading.
- Check sprockets and other components.
- Replace chain/belt.
- Replace components if necessary.
- Improve cleaning or Use HB pins.
- Eliminate cause of overloading.
- Check sprockets and other components.
- Replace chain/belt.
- Replace components if necessary.
- Improve cleaning or Use HB pins.

### Chain drifts sideways on sprockets

**Possible causes**
- Bad shaft/sprocket alignment
- Conveyors is not level

**Cracked hinge eyes**

**Possible causes**
- Stress-corrosion caused by incompatible chemicals

**Chains for magnetic system releases from curve**

**Possible causes**
- Worn curve
- Improper chamfering of the infeed or other obstructions
- No soft start-up
- Curve not mounted level

**Corroded steel chain**

**Possible causes**
- Incompatible combination of chain material and chemicals
- May occur even with stainless steel

**Excessive chain/belt wear**

**Possible causes**
- Pollution
- Failing lubrication
- Obstructions
- Debris in return part

**Sprockets don’t slide on shaft when belt extends due to temperature increase**

**Possible causes**
- Pollution
- Axial fixing incorrect
- Wrong bore tolerance

**Rapid wear on sprockets**

**Possible causes**
- Abrasive conditions

**Remedy**
- Check chemicals compatibility with chain/belt material
- Use appropriate chemicals
- Install frequency inverter drives.
- Check and adjust.
- Use lubrication.
- Reduce chain/belt tension by shortening the conveyor.
- Install larger rollers.
- Remove obstructions.
- Check return part as well.
- Check dimension and adjust.
- Use ExTRA curve or Nolu-Sy.
- Replace curve.
- Check and adjust/rework.
- Install frequency inverter drives.
- Check and adjust.
- Use only compatible chemicals.
- Consider higher graded material.
- Improve cleaning.
- Re-adjust axial fixing according to temperature situation.
- Replace by sprockets with PLUS tolerance.
- Improve cleaning.
- Use steel sprockets.

Please contact technical support at any time in case of doubt.