WHITEPAPER

SAVE ENERGY
OPERATING BAGGAGE HANDLING SYSTEMS

Siegling – total belting solutions

MOVEMENT SYSTEMS

Foreword

At the initiative of the European council of airport operators (ACI Europe), a global Airport Carbon Accreditation Program (ACAP) was launched in 2009. Its goal is to cut airports' carbon emissions. To date, this program hasn't reflected the energy consumption of baggage handling systems. However, this equipment can cut the carbon footprint of airports quite considerably.

In addition to the factors considered by the ACAP, this paper will also look at the energy consumption of belt conveyors used in baggage handling systems and highlight the potential for improvement in the components involved. The greatest efficiency potential lies in the friction coefficient between the conveyor belt and slider bed. Measurements in the lab and on airport equipment prove that using conveyor belts with low friction coefficients can produce energy savings of over 40% in the conveyor overall. As a result, this approach effectively helps airport operators to achieve their own sustainability goals.

ROI calculations show that the extra costs for the appropriate belt types are more than compensated for by lower energy costs.

Knock-on effects such as longer belt lives and longer conveyors, but where the power transmission is identical, can also cut the costs of the conveyor overall.

Whitepaper
Save energy
operating baggage handling systems · 04/24

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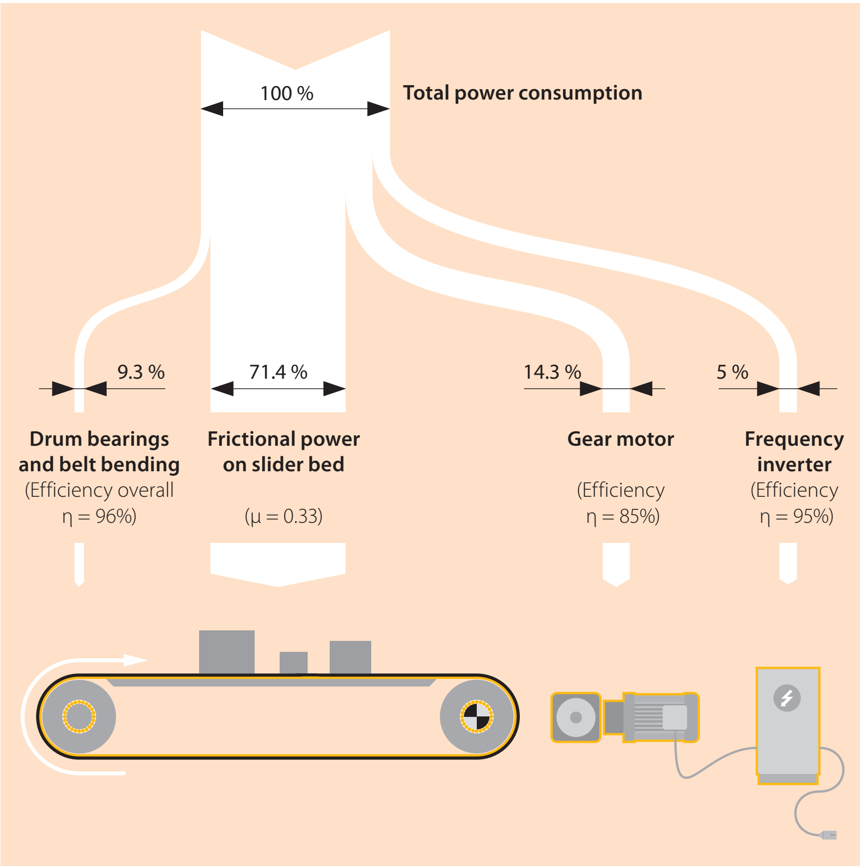
1 The basics of energy consumption in belt conveyors

The total energy consumption of all belt conveyors depends on numerous factors. The quality, design and condition of all mechanical and electrical components play a key role in total energy consumption. It's usually the friction between the slider bed and underside of the conveyor belt that accounts for most of the energy requirements.



Energy consumption and energy requirements of each component in a typical belt conveyor configured as follows:

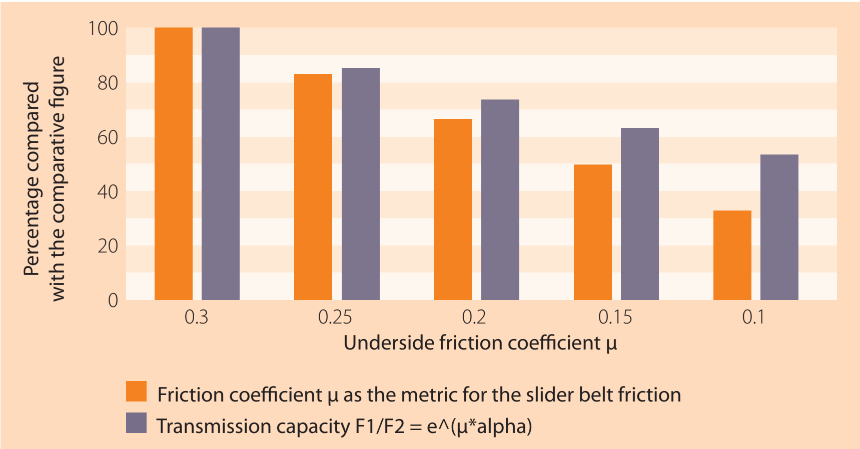
Standard belt type:	E 8/2 U0/V5H
Conveyor length:	10 m
Belt width:	1000 mm
Load:	50 kg/m
Mechanical power drive drum:	1.82 kW
Electrical power (input):	2.3 kW

Drum bearings and belt bending
With an energy requirement of under 10% overall, the potential for improvement is low in this case. The conveyor belt belting is the primary cause of the loss. The roller bearings normally used in the rollers already stand apart for their very low rolling resistance and therefore exceptional efficiency. Theoretically, losses via the belt could be cut by using very flexible belts, but these are not as robust.

Frictional power on the slider bed

The frictional power with the slider bed is determined by the load and the friction coefficient between the underside of the belt and the slider bed. By improving the underside of the belt, the friction coefficient and frictional power overall can be decreased significantly. Therefore, there is huge potential for saving energy easily without making any changes to the conveyor.

By lowering the friction coefficient, the effective pull F_u can also be reduced if the belt is driven via the underside and the pre-tensioning force is constant. At regular pre-tensioning levels, the AmpMiser belt still provides sufficient grip on the drive drum to reliably avoid slippage.



Dependence of the end drum's transmission capacity on the friction coefficient of the belt's underside

The end drum's transmission capacity is maintained reliably.

The potential for energy savings via lower slider bed friction should always be assessed within the limits set by physics.
This applies in particular to:

- Conveyors with low loads, low throughput or long periods of time spent idle
- Rolling support of belts
- Inclined conveying
- Exceptional acceleration or braking forces, e.g. in metering belts

Motors, gears and frequency inverters

Typical drive motors have a degree of efficiency η of 50–90% max., gears 60–90% and frequency inverters 90–96%. In addition to good maintenance and the quality of the components, it's primarily the right design that is crucial to good efficiency. With energy losses of under 20%, the optimization potential is not particularly big in this case and can only be made by investing in the conveyor's technology.

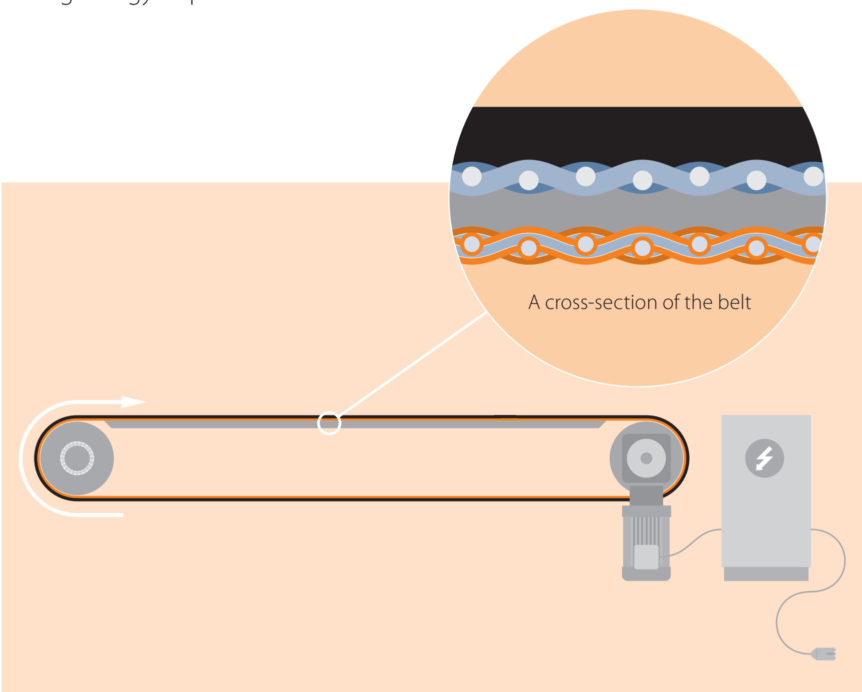
2 Conveyor belts with lower friction coefficients

Forbo's R&D team has long been looking at developing conveyor belt undersides that cut the friction coefficients with standard slider bed materials and therefore minimize the energy consumption of the conveyor and any carbon emissions that might result.

Thanks to its Amp Miser conveyor belts, Forbo has a series of belts today that meet development goals:

- A consistent reduction in the friction coefficient over the belt's whole lifecycle
- Suitability for use on the standard slider bed materials, steel, galvanized steel and wood
- Outstanding energy savings
- Exceptional resilience to chemicals, such as kerosene vapor
- Long belt lives

Thanks to the addition of patented Texglide to the underside fabric, Amp Miser belts have a sliding layer that consistently acts like a dry lubricant, therefore minimizing energy requirements.

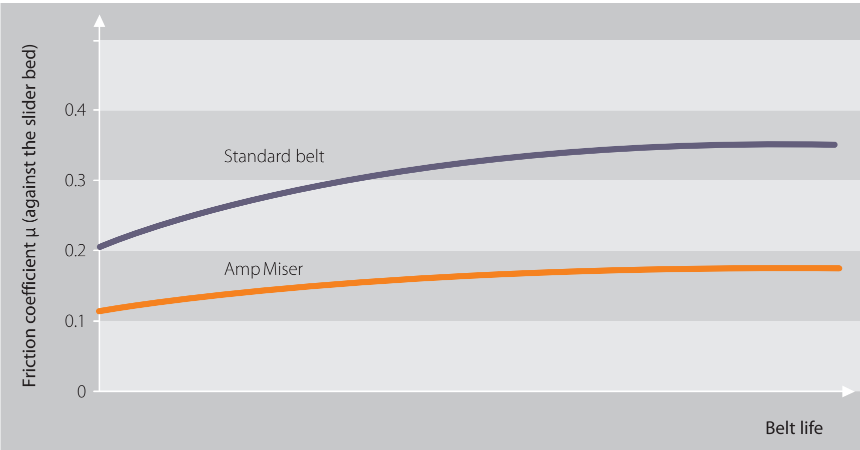


Patented
Texglide finish

Superior energy savings can be expected in the following cases if Amp Miser are used:

- On long conveyors
- With heavy loads (see graphic below)
- Where speeds are fast and constant
- Horizontal conveying

Which is why the benefits of Amp Miser conveyor belts are particularly visible when products are conveyed continually and lots of belts are required, for instance in airports, logistics- or fulfilment-centers.



Change in the friction coefficient μ during the belt's service life (drawing showing the principle)

How conveyor operators benefit

Simply switching belt types with standard undersides for ones with Amp Miser can produce the following results on long conveyors and where loads are heavy, but without the need to make changes to the conveyor:

- Energy savings of up to 45% are possible
- Faster belt velocities can increase throughput
- Unit weight can be increased

Calculate the savings potential at www.ampmiser.com online.

Link to the online calculation of the savings potential

The benefits to OEMs

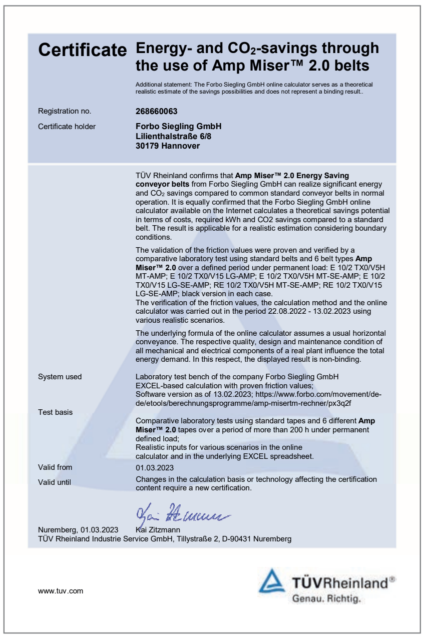
OEMs benefit from lower system costs due to design changes. Amp Miser belts, which cut slider-bed friction by 50%, enable the following design changes to the conveyor:

- Smaller motors but the conveyor belt stays the same length
- Longer conveyor belts but the power requirements are the same: Using one long instead of two short conveyor belts means a reduction in the number of motors
- Heavier loads, but the drive power is the same

Patents and certification

In the EU and US and other industrial nations, Amp Miser is patent protected.

Independent German inspection body TÜV Rheinland tested the characteristics of Amp Miser on a range of belt types. The accuracy of the online calculator at www.ampmiser.com, absolute carbon dioxide savings and savings potential were confirmed and certified in the process.



Certificate **Energy- and CO_2-savings through the use of Amp Miser™ 2.0 belts**

Additional statement: The Forbo Siegling GmbH online calculator serves as a theoretical realistic estimate of the savings possibilities and does not represent a binding result..

Registration no.	**268660063**
Certificate holder	**Forbo Siegling GmbH** **Lilienthalstraße 6/8** **30179 Hannover**
	TÜV Rheinland confirms that **Amp Miser™ 2.0 Energy Saving conveyor belts** from Forbo Siegling GmbH can realize significant energy and CO_2 savings compared to common standard conveyor belts in normal operation. It is equally confirmed that the Forbo Siegling GmbH online calculator available on the Internet calculates a theoretical savings potential in terms of costs, required kWh and CO2 savings compared to a standard belt. The result is applicable for a realistic estimation considering boundary conditions. The validation of the friction values were proven and verified by a comparative laboratory test using standard belts and 6 belt types **Amp Miser™ 2.0** over a defined period under permanent load: E 10/2 TX0/V5H MT-AMP; E 10/2 TX0/V15 LG-AMP; E 10/2 TX0/V5H MT-SE-AMP; E 10/2 TX0/V15 LG-SE-AMP; RE 10/2 TX0/V5H MT-SE-AMP; RE 10/2 TX0/V15 LG-SE-AMP; black version in each case. The verification of the friction values, the calculation method and the online calculator was carried out in the period 22.08.2022 - 13.02.2023 using various realistic scenarios. The underlying formula of the online calculator assumes a usual horizontal conveyance. The respective quality, design and maintenance condition of all mechanical and electrical components of a real plant influence the total energy demand. In this respect, the displayed result is non-binding.
System used	Laboratory test bench of the company Forbo Siegling GmbH EXCEL-based calculation with proven friction values; Software version as of 13.02.2023; https://www.forbo.com/movement/de-de/etools/berechnungsprogramme/amp-misertm-rechner/px3q2f
Test basis	Comparative laboratory tests using standard tapes and 6 different **Amp Miser™ 2.0** tapes over a period of more than 200 h under permanent defined load; Realistic inputs for various scenarios in the online calculator and in the underlying EXCEL spreadsheet.
Valid from	01.03.2023
Valid until	Changes in the calculation basis or technology affecting the certification content require a new certification.

Nuremberg, 01.03.2023 Kai Zitzmann
TÜV Rheinland Industrie Service GmbH, Tillystraße 2, D-90431 Nuremberg

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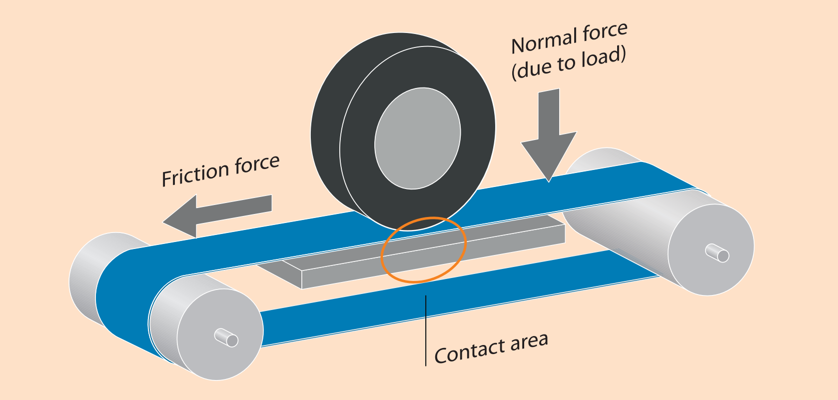
3 Dynamic friction lab measurements

Dynamic friction tests in the physical lab looked at the friction between the underside of the belt and slider bed.

3.1 Test rig

The endless belt is tensioned at a constant weight-based pretension of 80 kg and driven at a constant speed of 0.5 m/s. With a load of 40 kg, simulated by rotating tires, normal force is applied to the belt. A movable linear carriage, which the slider bed material is attached to, is set in motion due to the friction force now generated between the belt and the slider bed and presses against the fixed load cell. This friction force is recorded for at least 300 h. A thermocouple is fitted to the contact area under the slider belt material, which records and monitors the temperature in the contact surface. The contact area is approx. 4 x 7 cm (28 cm^2) in size.

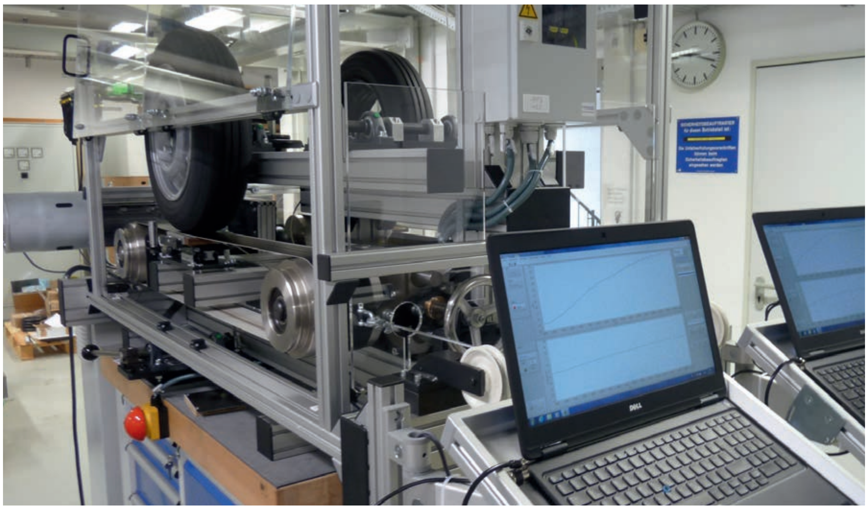
Sketch drawing dynamic friction testing in Forbo's lab



Testing parameters

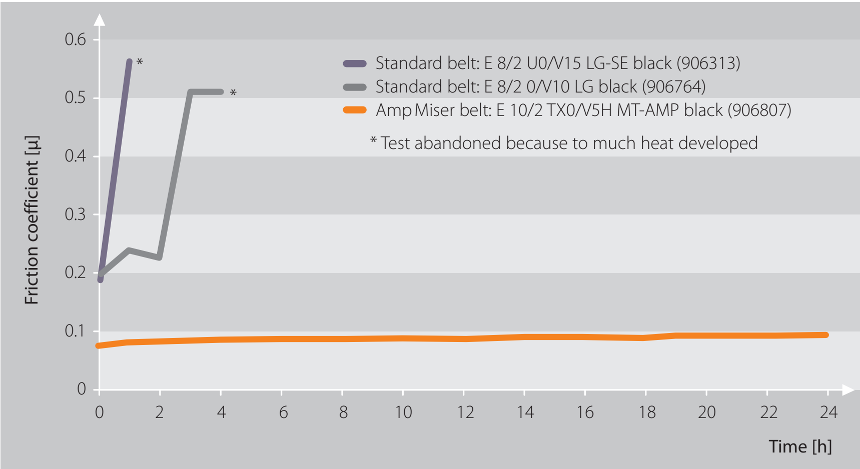
Dimensions of the test belt:	3000 x 100 mm
Belt running speed:	0.5 m/s
Load/vertical force:	40 kg
Belt pretensioning force:	80 kg
Test duration:	min. 300 h
Slider bed material:	Steel or galvanized steel
Surface pressure:	4 x 7 cm = 28 cm^2 ≙ 1.43 kg/cm^2

The parameters for this test were selected so that the temperature in the contact area is not too high. Running the tests at increased surface pressure levels shortens the testing times required.



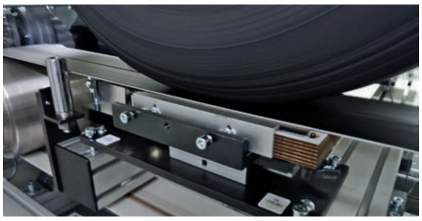
3.2 Measurement results

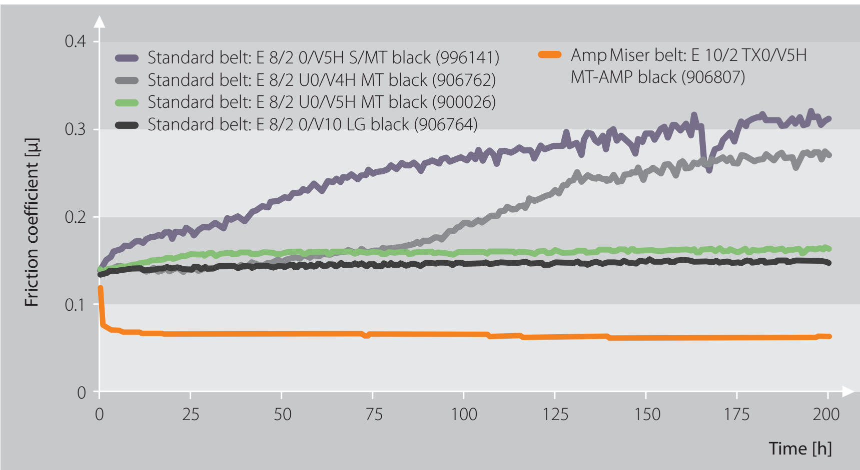
The friction coefficient of various friction pairs was measured on the test rig shown.



Friction coefficients on galvanized slider beds
Comparison with standard conveyor belts and Amp Miser types over a period of 24 hours.

Belt velocity v:	2 m/s
Pre-tensioning force on the tensioning roller:	800 N
Normal force:	400 N
Conveyor belt dimensions:	3000 mm x 100 mm





Friction coefficient on slider beds made of melamine-coated plywood
Comparison with standard conveyor belts and Amp Miser types over a period of 200 hours

Belt velocity v:	0.6 m/s
Pre-tensioning force on the tensioning roller:	800 N
Normal force:	400 N
Conveyor belt dimensions:	3000 mm x 100 mm

With the testing parameters outlined, the frictional power by Amp Miser belts was reduced by more than 50% compared with standard belts.

4 Field measurements with lower-friction belts

To verify dynamic friction measurements in the lab, Forbo Siegling started measuring the power of baggage handling conveyors at airports back in 2012. The belt drives' active power was recorded and analyzed over a long period of time.

4.1 Measurement planning

In agreement with the operators, we decided to test baggage handling systems at consistently high load levels (with few idle phases).
Where two identical conveyors are in a line, an Amp Miser belt was refitted to one and both belts were measured at the same time. In the other cases, just one conveyor was chosen, whose drive power was measured at least once a week to start with, and to which a standard belt had been fitted. Once the belt had been swapped for an Amp Miser, the drive power was then recorded over a long period of time. We compared the maximum power consumption phases of both installations without having to evaluate the average load on the belt.
The long-term impact is confirmed by comparable measurements. Some conveyors have had Amp Miser belts for several years and are repeatedly tested.

4.2 Conducting the measurements

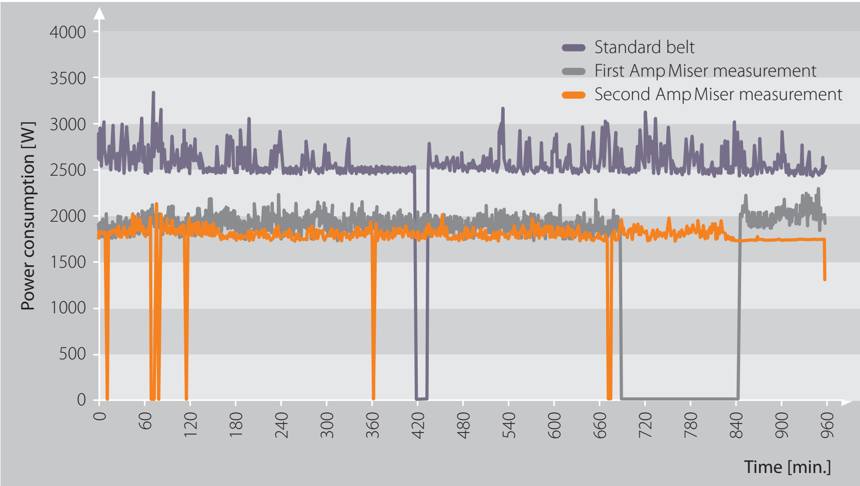
The active power of all three current phases was recorded directly on the three-phase motors. A measurement of this type is beneficial for the following reasons:

- Losses in the converters don't affect the measurement result
- Asymmetrical grid loads are recorded
- The power factor cos φ of the motors is taken into account.

Therefore, the active power metric also includes the mechanical losses in the gearmotor and in the conveyor's deflection rollers, which are assumed to be constant in the comparison, as the belt tensioning forces were not changed either. Fundamental changes in the active power can therefore be directly attributed to the different slider bed friction coefficient after replacing a belt.

4.3 Measurement results

On-site measurements indicate a clear difference between the old standard belt and an Amp Miser belt during longer operating times at full load: power consumption with a load is reduced by up to 44%.



Energy savings field measurement Yodel (UK)
Comparison of a standard conveyor belt with the E 10/2 TX0/V5H MT black (906807) Amp Miser belt

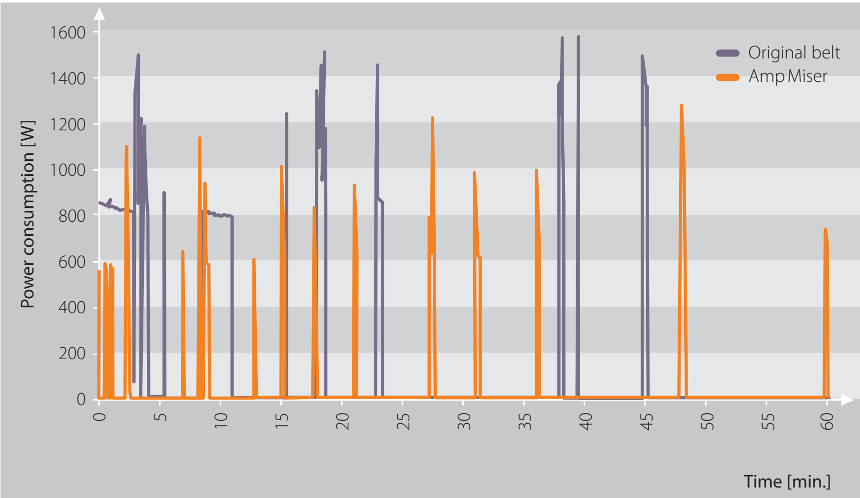
Measurement duration: 16 h

Average power consumption

Standard belt: 2736 W

First measurement
Amp Miser belt: 1987 W
energy saving = 27.4 %

Second measurement
Amp Miser belt: 1794 W
Energy saving = 34.0%



Energy savings field measurement Madrid Airport (ES)
Comparison of a standard conveyor belt with the E 10/2 TX0/V15 LG-SE-AMP black (906673) Amp Miser belt

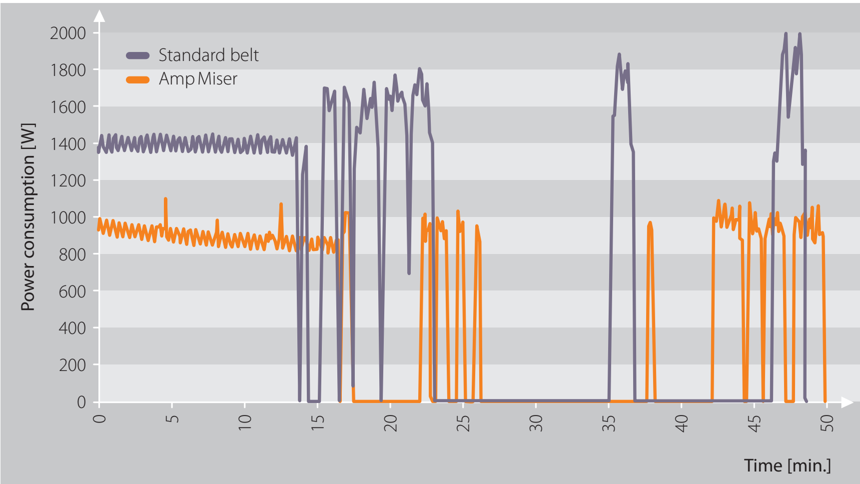
Measurement duration: approx. 1 h
Center distance: 31.7 m (inclined conveyor)

Average power consumption

Original belt: Idle 820 W
with load 1195 W

Amp Miser belt: Idle 572 W
with load 785 W

Energy saving: Idle 30.2%
With load 34.4%



Energy savings field measurement Schiphol Airport (NL)
Comparison of a standard conveyor belt with the E 10/2 TX0/V15 LG-SE-AMP black (906673) Amp Miser belt

Measurement duration: 50 min

Average power consumption

Standard belt: Idle 1394 W
with load 1684 W

Amp Miser belt: Idle 854 W
with load 941 W

Energy saving: Idle 39%
With load 44%

5 ROI

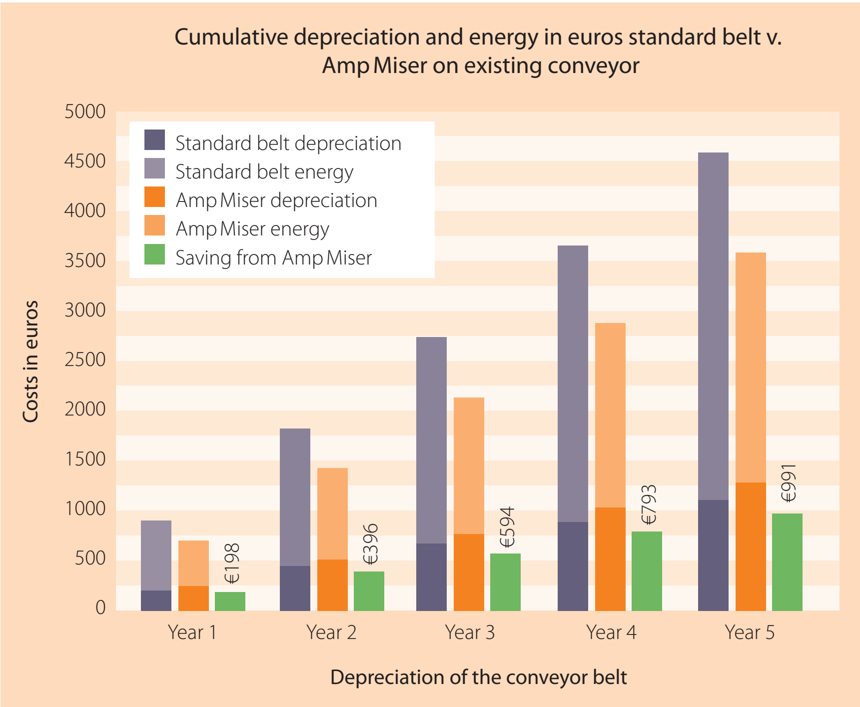
When customers invest in lower-friction belts, they often ask how much they save. Although these belts cost a little more, lower expenditure on electricity usually means savings are made.

We use the following variables to calculate the costs:

Share in costs	Assumption for the calculation	Comment
Electricity costs	€0.21/kWh	Electricity price foritems consuming a lot of electricity 2023
Operating period full load	1000 h	i.e. approx. 4 hours per working day on 250 working days
Example calculation conveyor belt	€1,120 standard belt €1,300 Amp Miser belt	16% extra costs for the Amp Miser belt
Depreciation period for conveyor belt	5 years	

Conveyor info

Conveyor length:	14 m
Belt width:	0.8 m
Specific belt load:	45 kg/m
Drive efficiency:	0.8



Over the depreciation period of the belt, the example conveyor saves € 991. This calculation is for demonstrative purposes only. Forbo can provide a calculation tool to work out the savings in your case.

6 Conclusion

The energy requirements of conveyors can be decreased if conveyor components are designed well, very efficient motors, gears and frequency inverters are used and preventative maintenance is applied.

The biggest savings potential is possible when conveyor belts with lower friction coefficients run against standard slider bed materials such as steel, galvanized steel and wood. Both lab tests and field measurements verify outstanding savings in this case. When Forbo Amp Miser belts are used, the friction coefficient can be cut by up to 50%. This results in over 40% less energy required if the conveyor's capacity and efficiency of the drives is high (in addition to a high conveying load close to the rated load, this also includes avoiding long idle periods).

Experience and example calculations show that the extra costs for Amp Miser belts very quickly pay for themselves due to the energy costs saved. In baggage handling systems, the savings of each conveyor add up to considerable amounts. By the same token, conveyor operators save carbon emissions and improve their own sustainability performance.

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