High-Speed Conveying System

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ABSTRACT Increasingly higher and higher conveyor speeds are driven in industrial manufacturing. This goes along with a significant rise of the sound pressure level in the production lines. The main cause of this is the articulated and multi-articulated construction of standard plastic-slide-chains in conveyor systems. This condition could be significantly improved by the use of a nonarticulated attraction in the form of a transport toothed belt. In addition, the conveying speeds could be significantly increased. Modifications to the belt teeth provide fastening possibilities for plastic support plates.

KEYWORDS conveyor system, high-speed, toothed belt


SCHLAGWÖRTER Förderung, Hochgeschwindigkeit, Zahnräder
HIGH-SPEED CONVEYING SYSTEM -
NEW KIND OF CONVEYOR CHAINS

MOTIVATION
- The noise emission clearly limits the conveyor speed with standard plastic-slide-chains.
- Higher conveying speed
- Less noise
- Reduced polygon effect by using a toothed belt
- Special adapted plastic support plates

DESIGN
- Closed support plates surface in all positions
- Integrated air ducts help to reduce the high sliding friction power by convection cooling
- Radius of the curve is 152.79 mm depend on the toothed belt pitch
- Support plate width of 87 mm conforms to the standard of Bosch Rexroth VF90
- A highly mechanically and chemically stable as well as friction- and wear-optimized acetal homopolymer resin (Delrin 500CL NC010) was selected for the support plate
- Every second tooth is partially milled on the toothed belt
- The support plate is then inserted and fixed with a rivet of PA6

TEST APPLICATION
A test bench for the investigation of all main assemblies was designed in the form of an L-conveyor. All relevant main assemblies such as drive, stretching elements, span unit, deflecting unit and guide system could be implemented in this way.

RESULTS
The system presented here achieves the sound pressure level only at a quadruple conveying speed, a plastic chain conveyor. Maximum tensile forces of 4000 N permit very large conveying lengths. In straight sections goods can be transported at speeds of up to 6 m/s and in the curves up to 1.5 m/s. These points shows the potential in this new support plate conveyor.

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1. Introduction

Increase of the productiveness with concurrent reduction of the energy consumption and improvement of the terms of employment stand worldwide in the focus of the industry in search of a new automation solution for the production process lines. Therefore, increasingly plastic chains are used beside the established steel chains in conveyor systems. Besides, advantages like low weight as well as free of lubrication and poor in servicing are obvious. By the need of even higher conveyor speeds the plastic chains also on boarders to her efficiency. Besides, all chain joints, independently whether of steel or plastic, are always with clearance, so that during the circulation pushes lead it to a high noise issue of nearly 76 dB(A) in the drive station with 60 m/min of conveyor speed [1] as a result of the polygon effect and the clearance in the transitional places. A beginning of a new conveying system with a new kind of conveyor chains is intended to significantly improve these points.

2. Approach

The motivation was to develop a new kind of plastic-slide-chain with less noise and high-speed transport based on a toothed belt. With special packaging of this belt in conjunction with plastic plain plates arise.

On the basis of a special modified toothed belts as a horizontal circumferential traction mechanism and the plastic support plates fastened to it creates a flat and step-free transport path for piece goods, work pieces and work piece carriers.

Besides, the support plates are supported on plastic slide rails. The design of the support plates forms an almost closed surface. Minimal polygonal effect, maintenance-free, high transport speeds, complete lubricant-free and a low noise emission stand for the advantageous qualities of the toothed belt. The join on any length can be welded together by the use of limited transport tooth straps endlessly. Very long conveyor lines with only one drive can be realized by the low mass of the new attraction. Standardized timing belt pulleys are used as drive and deflection. The curve radius are determined by the belt pitch and used toothed belt profile. Therefore this conveyor system is ideally suited for future transportation tasks in the beverage, food and packaging industries.

3. Technical Implementation

3.1. Guiding Concept

Due to the support plate mounting, the toothed belt on the belt pulleys cannot be guided in a classic way over the outside of the flange wheels. A flange wheel arranged centrally in the belt pulley guides the toothed belt via a groove and can thus remove the vertical forces in the region of the toothed belt pulleys (see Figure 1).

A significant influence on the wear behavior of the system Support Plate / Slide Rail results from the surface pressure as a function of the speed. The higher the surface pressure, the lower the conveying speed can be driven [2]. One approach is based on the reduction of the real contact surfaces in the form of microstructures on the surface. As a result, friction can be significantly reduced and wear can be counteracted [3]. In the straight line areas of the conveyor section, the
vertical load is removed proportionally by means of grooved ball bearings which are located below the transport toothed belt. Sliding rails are arranged at a slight distance from the support plate ends, which prevent torsion and lateral striking of the belt. In terms of percentage vertical forces about the support plates are also put down on the sliding rails (see Figure 1 und 2).

At the sliding surfaces of the support plates, integrated air ducts help to derive the resulting heat permanently due to the high sliding friction power by convection cooling (Figure 3). A melting of the support plate material as well as of the sliding rail material even at high transport speeds can be counteracted so successfully. This design reduces the heat generation between the support plate and the sliding rail to a minimum.
3.2. New Kind of Conveyor Chain

The support plates overlap, so that they also form a closed surface in curves (see Figure 4). The radius of the curve of 152.79 mm results from the toothed belt pitch. A support plate width of 87 mm conforms to the standard of Bosch Rexroth VF90 (see Figure 5).

A subsequent load analysis shows that the support plate with a wall thickness of 4 mm can withstand all required loads. For the required vertical load of 100 N, this is achieved with a safety factor of 4.5.

As a material for the support plate, a highly mechanically and chemically stable as well as friction- and wear-optimized acetal homopolymer resin (Delrin 500CL NC010) was selected. This material is also a good choice as a friction partner for sliding rails made of PE-UHMW.

As a result, the support plates can be exchanged quickly and without a special tool in the event of damage. To fasten the support plates to the toothed belt, every second tooth is partially milled. So that the support plate is then inserted and fixed with a rivet of PA6. This allows easy and fast assembly of the support plates (see Figure 6 and 7).
4. Test Device Application

A test bench for the investigation of all main assemblies was designed in the form of an L-conveyor. All relevant main assemblies such as drive, stretching elements, span unit, deflecting unit and guide system could be implemented in this way (see Figure 8). Currently the endurance run with mass pieces as a mass piece substitute (see Figure 9).

In the next step are examined a turnout system to the good change for branch lines and the connection between speed, surface pressure and friction capacity are investigated in order to derive maximum loads.

![Figure 8: Test bench High-Speed-Conveyor](image1)

![Figure 9: Prototype Test](image2)

5. Results

A high noise emission clearly limits the conveyor speed with standard chain conveyor systems. The use of Whisper Chains promises to reduce the noise level. These chain conveyors achieve a reduction in the sound pressure level of 3 to 4 dB(A) compared to standard plastic-slide-chains by the use of elastomer springs [4]. The new system presented here achieves the sound pressure level only at a quadruple conveyor speed of a standard plastic-slide-chain conveyor (see Figure 10).

For dimensioning the new high-speed conveyor system not all methods described in [5] for chain conveyor systems can be applied. Results from the still running tests and dimensioning bases of transport toothed belts form the basis here and form a new calculation basis.

Maximum tensile forces of 4000 N permit very large conveying lengths. In straight sections goods can be transported at speeds of up to 6 m/s and in the curves up to 1.5 m/s. It depends on the high flow forces in curves. Alone these points shows the potential in this new support plate conveyor.
6. Summary

Using a transport toothed belt as traction mechanism instead of plastic chain links for a new support plastic plate conveyor. The conveyor speed could be significantly increased compared to standard plastic-sliding-chain conveyors and the sound pressure level reduced by 14%. A horizontally circulating toothed belt traction drive, which is equipped with closed plastic support plates, forms the basis for this. Rolling vertical support of the toothed belt in the straight sections and specially ventilated sliding zones on the support plates bottom provide the improved properties.

References