syskomp group

white paper - Roller conveyor

the syskomp group

In collaboration with:

ZENTRUM EFFIZIENTE FABRIK SENFTENBERG

b-tu Brandenburgische Technische Universität Cottbus - Senftenberg

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Automatic transportation of goods using the SG© roller conveyor

Foreword

Increasingly interconnected supply chains will demand market-specific logistics solutions. Our roller conveyor has been designed to offer maximum modular flexibility. By expanding our product portfolio with state-of-the-art roller conveyors, we can offer our clients customised solutions to optimise any material flows.

Roller conveyors are found in all areas of modern-logistics material flow systems. With our white paper „Roller Conveyor“, we have compiled a document jointly with the ZENTRUM EFFIZIENTE FABRIK SENFTENBERG and the Brandenburg Technical University Cottbus - Senftenberg, which presents the technology and potential applications of the roller conveyor. This can serve a useful tool to support the decision-making process for choosing a specific roller conveyor system.

Our corporate group can look back on over 50 years of experience. We are a modern company with a focus on workplace design, special machine building and intra-logistics.

Jan-Hendrik Aschmann
Managing Director of the syskomp group

1. Conveyors in corporate logistics

1.1 What is a conveyor?

Conveyors are used to transport goods over short distances. Hence, they are used in internal transport and for transferring goods at the interfaces of the company, incoming goods and outgoing goods sections. They map the company's material flow. Material flow comprises the totality of all transportation, transfer and storage processes. (Griemert 2018, p. 1 f) Intra-company transportation is bridging the space between the transport origin (hereinafter referred to as the source) and the transport destination (hereafter referred to as the sink). Transportation also includes logistics processes such as stacking, buffering, transferring, picking, placing, distributing, collecting and sorting. (Martin 2016, p. 99) Internal means of transport can be subdivided according to different areas:

transport location	• line • area • zone
transport direction	• horizontal • vertical • angled
mobility	• fixed • guided • free
transport goods	• bulk • packaged goods
degree of automation	• manual • mechanised • automated

Figure 1 Breakdown of means of transport (Martin 2016, p. 101)

The basic transportation process does not add any value to the product. However, it is necessary, and thus makes the product more expensive. Depending on the options, the transportation process should be used to complete a work process (e.g., heating up, cooling down, drying) in order to make the entire production process more economical. (Martin 2016, p. 99)

The tumultuous development of material flow in recent decades has been characterised by increasing automation, as well as the desire to avoid heavy physical activity. New developments have led to the awareness that great savings can be achieved with the help of systematic material flow planning, simulations to optimise the material flow or computer-controlled material flow. (Griemert 2018, p. 1)
A material flow-related problem can be described by the three areas of transportation tasks, goods to be conveyed and conveyor machine. They exist independently of each other, but have a reciprocal influence on the problem-solving process (see Figure 2). (Griemert 2018, p. 1 f)

The goods to be conveyed set restrictions for the conveyor equipment due to their weight, dimensions, shape, possible temperature sensitivity and surface properties. Goods to be transported are divided into packaged goods (general cargo or also individual goods) and bulk goods based on their physical properties. Packaged goods are defined as individual loads that can be recorded in terms of number of pieces, and are characterised by relatively large weight and a low quantity. Bulk goods are defined as a large number of small to very small individual goods with relatively small dimensions. Special properties of the bulk goods include the density, the bulk density, the grain size and the angle of slope. The material flow rate for bulk goods is quantified in mass flow rate [kg/h] and in a volume flow rate [m3/h] for packaged goods. (Griemert 2018, p. 7 f) In the following, only general cargo (packaged goods) is considered, whereby it is pointed out that filled bulk goods using loading aids (e.g., container, crate) are also regarded as general cargo.

The transportation task results from the technological and economic demands on the transport. It includes precise definitions of the sources and sinks and also information about the delivery rate, statements on structural and spatial conditions, as well as procurement and operating cost specifications. (Griemert 2018, p. 8) The task of the conveyor machine is to implement the change in location of the conveyed goods according to the transportation task. It must ensure as economical a transportation of the conveyed goods as possible along the transport route by different types of movement. There is no standardised system or specification for the ranking of the sizes. On the contrary, it is based on the specific application. In the case of a new investment, the conveying machine is selected according to the technological properties of the material being conveyed and based on the given conveying task. If the specific application is an extension or expansion, the conveyor machine determines the technological process and also the transport tasks that can be implemented. (Griemert 2018, p. 2 ff)

If a transportation task is solved by multiple conveyor machines, then the totality of the machines in connection with the information of the transport task is called a transportation or conveyor system. The interlinked conveyor machines can be of the same or different types and serve to fulfil a transport task. (Martin 2016, p. 100)

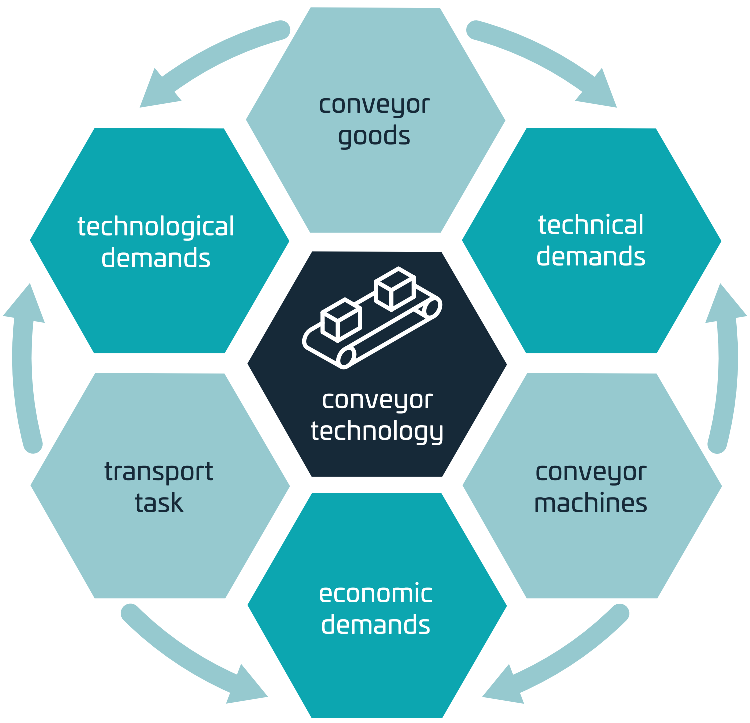


Figure 2 Dependencies of the areas of conveyor equipment (Griemert 2018 p. 2)

1.2 Differentiation

An essential criterion for the classification of the conveyors is the continuity of the conveyance movement. You can distinguish between continuous, virtually continuous and discontinuous conveying processes. Continuous conveyors are characterised by a continuous conveyance movement, whereas virtually continuous conveyors are characterised by a periodic conveyance movement. In the process, the direction of conveyance is always maintained. Continuous and virtually continuous conveyors offer the option of transporting several unit loads at a predetermined or random distance without the load handling device having to return to the starting position between two unit loads against the direction of conveyance. In the following, continuous and virtually continuous conveyors are summarised under the term continuous conveyors. (Schmidt 2019 p. 2)

Continuous conveyors generate a continuous flow of conveyor goods and operate for a longer period of time. If they have a drive, it operates continuously. All supporting elements are driven by the drive. Continuous conveyors are generally used in conjunction with stationary equipment such as lifts or guides. This limits their flexibility. (Hompel 2018 p. 128)

Discontinuous conveyors transport the material to be conveyed discontinuously between the source and sink. The discontinuous transport generally takes place in working cycles, which are characterised by an alternation of load and idle cycles. Moreover, downtimes are necessary for loading and unloading. Loading and unloading can often take place only at defined points. To reach them, connecting journeys often have to be made. Several drives are usually required, which must be designed for intermittent and short-time operation. (Martin 2016 p. 221 f)

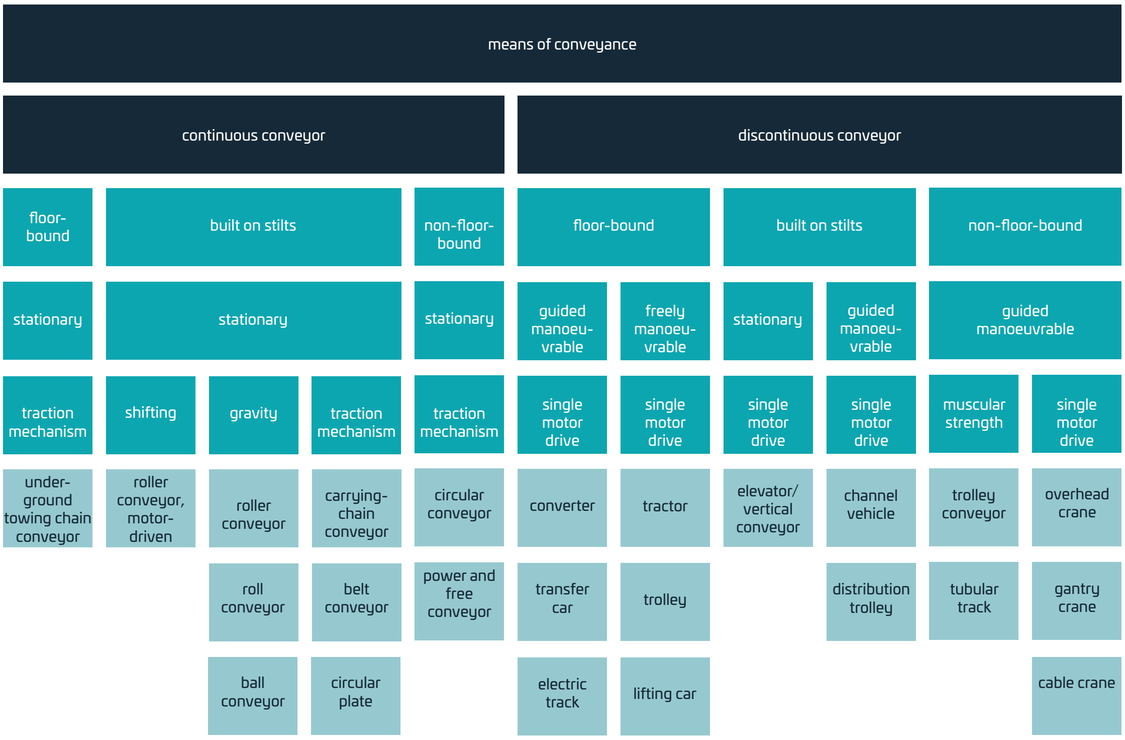


Figure 3 Classification of conveyor for transporting package goods according to Hompel (Hompel 2018 p.129)

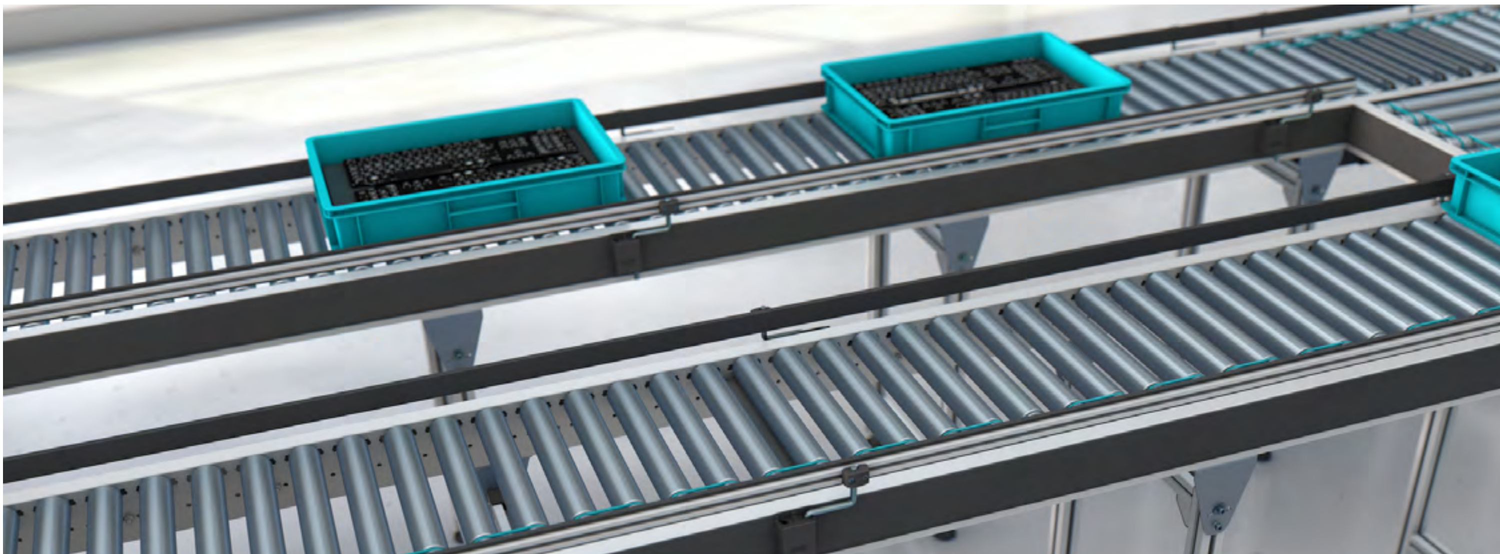
Continuous conveyors are more economical in direct comparison. Assuming the same dead weight, they can transport larger flow rates with a lower energy requirement. (Griemert 2018, p. 7) Due to the continuous operation of the drive and avoidance of constant start-up and shut-down of a motor, continuous conveyors are more energy-efficient during operation than discontinuous conveyors. (Hompel 2018 p. 128) Despite a lower conveyance speed than that of discontinuous conveyors, continuous conveyors have a significantly higher throughput. This is due to the steady flow of material compared to the alternation of load and idle play on the discontinuous conveyor. (Schmidt 2019 p. 2) However, for each investment in a conveyor, it must be checked on the basis of the objective regarding the type of conveyor that solves the transportation task at hand most economically.

2. The roller conveyor

2.1 Description and state of the art

The roller conveyor belongs to the group of elevated continuous conveyors. It consists of many rollers arranged in a row behind one another. These rotate freely or are driven by a motor. The rollers are mounted between two profiles and must have an axial distance that is less than half the length of the goods to be transported so that at least two rollers always serve as a support. Roller conveyors can be divided into two classes regarding the unit load weight to be transported. On the one hand, there are roller conveyors for heavy-duty applications with a maximum unit load weight of approx. one tonne. On the other hand, there are roller conveyors for industry and trade for lighter unit loads of up to 50 kg. (In the following, the consideration of heavy duty roller conveyors is ignored.)

Due to its installation, the roller conveyor is generally stationary and thus forms an obstacle for other transportation vehicles and employees. However, there are individual applications where the roller conveyors are not stationary, in which they are mounted on a chassis or AGV and can be positioned as desired. The roller conveyors are usually driven by drum motors inside the rollers. The trend here is for only a few rollers to be driven by the motor and for these to transmit their rotation via belts to a large number of driven rollers. This design reduces the cost and effort required for cabling, lowers costs and enables an accumulation function. To implement the desired conveyance route, conical rollers are used for curves. Their shape compensates for the different speeds between the track on the inside and outside of the curve. Various diverting, transfer and lifting devices are used to pick up and discharge the goods being conveyed. (Hompel 2018, p. 131 et. seq.)



2.2 Parameters for approximate design

- Mass flow: $\dot{m} = \frac{m}{la} \times v \left[z.B.in\ \frac{kg}{s}\right]$ (Griemert 2018, S. 214)
- Piece flow: $\dot{m}_{st} = \frac{v}{la} \left[z.B.in\ \frac{Stück}{s}\right]$ (Griemert 2018, S. 214)
  m = Mass of the individual item to be conveyed in kg
  l_a = Distance (pitch) of the individual items the conveyor flowin m
  v = Circumferential speed of the rollers in $\frac{m}{s}$
- maximum conveying speed at a given load and nominal drive power:

  $v = \frac{P_n}{F_w}$ in $\frac{m}{s}$(Griemert 2018, S. 214)
  P_n = Drive power of the motor in W
  F_w = Total resistance in N
- Total resistance:
  $F_w = \mu_{ges} \times l \times g \times ({}^{m}/_{F} + {}^{m}/_{G}) \pm {}^{m}/_{G} \times m \times g \times h$ (Griemert 2018, S. 228)
  „+" upward conveyance
  „-" for downward conveyance
- $\mu_{ges} \approx$ 0,03…0,06 (smaller value for steel rollers, larger value for rubberised rollers) (Griemert 2018, S. 285)
  l = Conveyance length, g = Acceleration due to gravity
  h = Conveyance height difference between material inward and outward transfer
  ${}^{m}/_{G} = \frac{\dot{m}}{v}$ = Material load related to unit of length (Griemert 2018, S. 285)
  ${}^{m}/_{F}$ = Dead load of rotating roller parts related to unit of length, including loads due to drive system

With the given formulas, it is possible to determine approximately how large the load is for the conveyor system at a given pitch. From this, the maximum speed of the conveyor route can be calculated for a given drive power. If the formulas are converted accordingly, you can calculate the required motor power for a given conveyance speed and pitch between the conveyed goods. This allows an approximate overview of the equipment necessary.

2.3 Task and area of application

The roller conveyor is used for transport tasks with a high volume flow rate due to its high level of throughput. The roller conveyors are often used as a means of interlinking different or similar processes of series production and mass manufacture. They ensure a high degree of linkage of the individual work steps. The degree of linkage rises again with increasing automation and lower stowage capacities.

The roller conveyor is well suited for deployment in automated transportation and storage processes. Another feature of the roller conveyor that influences its field of application is the constant or steady conveyance speed. It ensures a constant flow of material and thus a constant supply of material. Moreover, transportation processes with an identical transport route all the time encourage the use of the roller conveyor, just as transportation systems with standardised loading aids.

Roller conveyors can be deployed in almost all branches of industry and commerce. The integration of technological processes such as cooling, painting or drying into the transport process opens up other areas of application and, at the same time, leads to a reduction in manufacturing costs. Roller conveyors are not suitable for a transport task that requires positioning of the transported goods at the end of the conveyor route with one (tenth) millimetre accuracy. (Hompel 2018 p. 128 f)