*Advanced Logistic Systems – Theory and Practice, Vol. 17, No. 3 (2023), pp. 43-50.*
*https://doi.org/10.32971/als.2023.022*

# TRANSPORT CHANNELS IN ADVANCED MATERIAL HANDLING SYSTEMS

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***Abstract:*** *To fulfil the increasing requirements of the social and economic environments, the equipment used in material handling processes have to be developed. The machines fitted exactly to certain manufacturing procedures some decades ago, cannot be found in the advanced version, they role are acted by other, earlier rarely used computer-controlled devices. This paper gives an overview about a special group of material handling machines –transport channels -, presented their operation characteristics and application possibilities to cover their usability in advanced handling systems. Statements presented in this paper are the first results of the research to uncover the special parameters and application advantages of these machines, which can show the development directions of them.*

***Key words:*** *material handling, handling machines, transport channels, advanced handling systems.*

## 1. INTRODUCTION

Nowadays, the industrial systems are continuously developing, suited to the increasing requirements of the social and economic environments. Thanks for this factor, technical solutions and devices applied in production and service processes are also changing and evolving.

This is also true for the equipment used in material handling processes. The machines fitted exactly to certain manufacturing procedures some decades ago [1], can not be found in the advanced version, they role are acted by other, earlier rarely used computer-controlled devices.

This paper gives an overview about a special group of material handling machines – transport channels -, presented their operation characteristics and application possibilities to cover their usability in advanced handling systems.

## 2. EQUIPMENT USED IN MATERIAL HANDLING SYSTEMS

During material handling processes, different goods are moving among technology or other objects locating in given places, to fulfil the requirements of any production, service or consumer systems. The goods can be living or lifeless elements, the moving direction can be horizontal, vertical or other simple or complex). The moving process can be realized by human operators or material handling machines.

There are many material handling machines in industrial and economic processes [2], which are significantly different each other, at first sight. However, we look deeper into their detailed structure and functional operation, many similarity can be found, which enables to put them into different types. In the aspect of the main structure and principal operation characteristics, 15-20 main types can be defined (e. g. cranes). The cause of the uncertainty is that some subtypes are taken as individual types into account by different

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experts (e. g. travelling and jib cranes). Fig. 1 presents a possible structure of material handling device types.

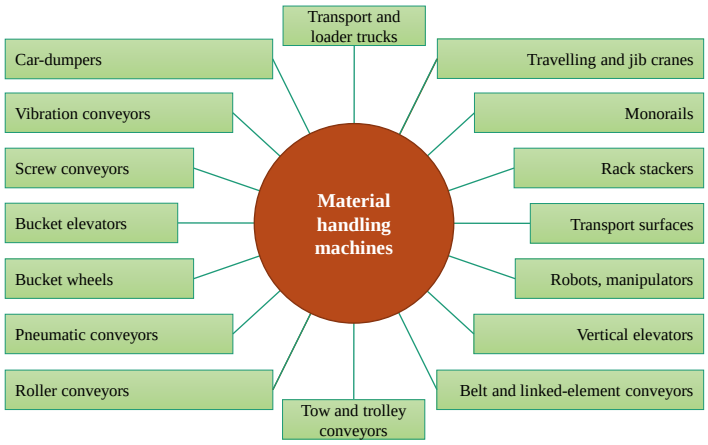


*Figure 1. Main types of material handling machines*

The types shown in Fig. 1 can help to overview the handling machines, but it is possible to make further simplification based on the goods handling methods.

Important question during the material handling process is how the moving of the goods can be realized? The answer is the goods handling method, which principally determines the operation and structure of all handling equipment. There are only four goods handling methods applied in material handling:

- mobile handling units,
- fixed loading arms,
- transport channels,
- moving by towing elements.

The traditional method for the material handling is the using of **mobile handling units**, where the goods are moving on the machines. In this case, the handling characteristics of the goods determined by the machine (speed, acceleration, route, etc.). The uploading and unloading solution of the goods cannot influence the moving. Typical mobile handling units are the lifter trucks, pallet cars, running hoists, travelling cranes, monorails, rack-stackers, etc.

For small distance loading, the simplest solution is the application of **fixed loading arms**. These machines contain an arm system (one or more arm sections), which can be rotated around a fix axle (floor or wall mounted mast or body). The gripping of the goods can be realized by an arm-mounted gripper, or different hoist solutions (fix or mobile). The most important types of this machines the jib cranes and the handling robots.

The **transport channels** are fixed or moving elements which frame a suitable platform for the transportation of units or bulk solids. The transport line determined by the structure of the device, the uploading and unloading of the goods are realized by other loading machines or self-acting (falling at the end). The best-known types of this handling method are the chutes, the belt conveyors and roller conveyors.

The last goods handling method is the **moving by towing elements**. In this solution, the units or bulk solids are located on/in transport elements (hanger, plate or container) joined to a chain, cable or wheel, which tow them along a given line. The transportation can be realized at floor level or overhead. Tow conveyors, trolley conveyors, elevating conveyors and bucket wheels belong to this group.

## 3. TRANSPORT CHANNELS

The simplest way to realize material handling tasks is the using of different transport channels [3], which can move goods even without additional power (e. g. gravity rollers).

At these machines, the goods are uploaded to a transport surface, which move them along a given line to a downloading point, where they leave the equipment (e. g. fall out). The moving method is depending on the operation principal of the device (e. g. driven belt).

The types applying this method are differing mainly in the driving method and the structure of the transport surface (see Fig. 2).

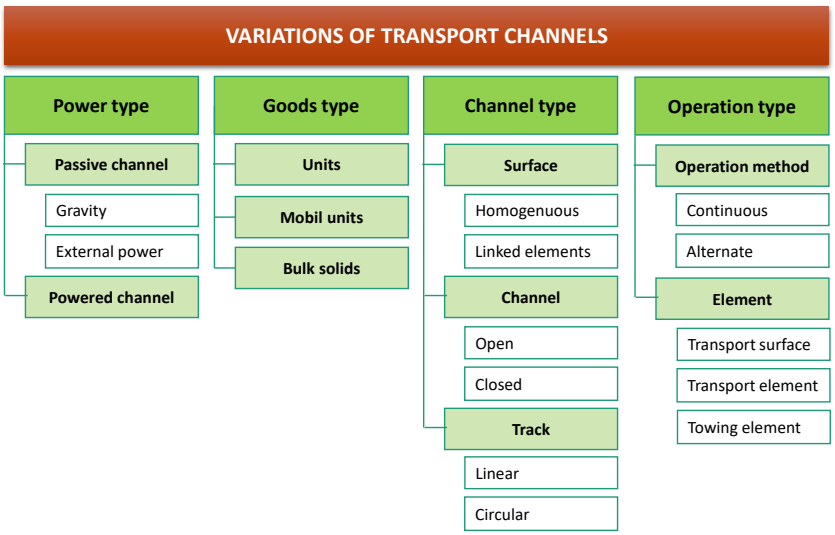


*Figure 2. Versions of the transport channels*

In the aspect of the driving method, there are three different solutions: gravity drive, powered drive and moving element.

Gravity channels use the gravity force to transport goods (units, bulk solids or mobile units), where the transport surface is always tilted (Fig. 3). Different chutes and gravity rollers belong to this category.

Powered transport channels contain continuously moving driven elements (e. g. belt), which transport the goods along the line structure (Fig. 4). The transport elements can be homogeneous surfaces (plates, belts, strips), linked elements (chains, linked cars, etc.), or rollers. This group contains the rotary tables, belt conveyors, slat conveyors, car conveyors, pan conveyors, apron conveyors, vibration conveyors, transport chains and roller conveyors.

*Figure 3. Example for gravity transport channel, source: [4]*

*Figure 4. Example for driven transport channel, source: [5]*

Equipment in the third group of the transport channels consist of a channel and an independent moving element, which moves the goods in the channel (Fig. 5). The moving element of the machines can be manual force, high pressure air, rotation screw or pushing plate. Pneumatic conveyors, screw conveyors, haulage conveyors and en masse conveyors

*Figure 5. Example for moving element in transport channel, source: [6]*

The most important advantages of transport channels are the simple moving process, the complex transport line and simple structure. Disadvantages can be the fix uploading and downloading points and the inflexible structure (hard to change).

## 4. APPLICATION OF TRANSPORT CHANNELS IN ADVANCED LOGISTIC SYSTEMS

Based on the different structure and characteristics, the application fields of the transport channels are also different. In advanced industrial systems, the most often used versions are the roller conveyors and belt conveyors [7]. In the next part of the paper the operation, characteristics and application possibilities of the most often used types will be presented.

The simplest transport channels are **chutes** (linear or curved), which use only the gravity force to move goods in on tilted surface or channel (Fig. 6). In advanced logistic systems, it can be used for short distance transfer of units (e. g. package handling), or in different phases of bulk solids handling (uploading to conveyors, silo discharging, uploading and downloading of transport machines, etc.). Their main advantages are the simple structure and the powerless operation.

*a) Package handling, source: [8]* *b) Bulk solids handling, source: [9]*

*Figure 6. Examples for chutes*

**Rotary tables** are also simple machines (Fig. 7), containing a circular plate rotated by a driving motor. It can be used for moving of different units placed to its surface for transporting or feeding. The application of these devices is usually as technology feeders in advanced logistic systems [10].

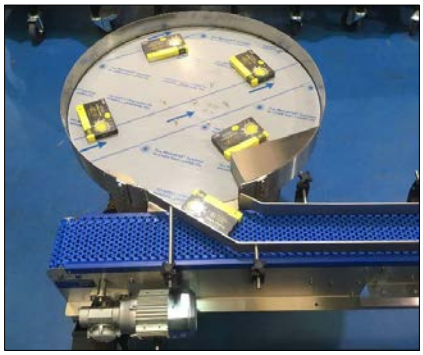

*Figure 7. Example for rotary table, source: [11]*

**Belt conveyors** are continuous transport machines of units and bulk solids, containing a belt circulating between two drums, along a linear line (Fig. 8). Goods are placed to the surface of the transport element, which can be a composite belt or linked elements (e. g. chain). They have many application possibilities in advanced logistic systems, e. g. short distance (in manufacturing procedures) or long distance (external raw material transport) transport of bulk materials, or rather continuous transport of units for different production process elements (e. g. postal mail and package handling) [12].

*Figure 8. Example for postal belt conveyor, source: [13]*

**Roller conveyors** consist of different rows of rotating rollers for moving individual pieces (Fig. 9). Units can be transported along only a sloping line on gravity rollers, powered rollers offer wider transport possibilities, but with more complex building structure (depend on the driving solution). In advanced logistic systems, they are used mainly for complex continuous transport of interoperation units within production and packaging processes [14]. Another important application field of roller conveyors are the unit handling in warehouses.

*Figure 9. Example for roller conveyors in stores, source: [15]*

During **pneumatic conveying**, bulk solids are transported in a closed channel (pipe) using high pressure air as a power (Fig. 10). At the source point, the bulk material is mixed with the air and transported as a gaseous material. There are two main types of these machine; high density and low density transport. In advanced logistic systems, firstly the low density versions are used for transportation and distribution of certain bulk solids (filling of teabags, transportation of plastic granulates, etc.).

*Figure 10. Example for pneumatic conveyor systems, source: [16]*

**Vibration conveyors** are swinging chutes, which can transport bulk solids based on the inertness of the bodies (Fig. 11). During the swinging motion, the particles of the material are jumping along the chute suited to the special moving characteristics of the machine. In advanced logistic systems, they are used for feeding processes (e. g. silo discharging) and complex, short distance transport and transfer of bulk materials (e. g. food processing).

*Figure 11. Example for vibration conveyors, source: [17]*

**Screw conveyors** consist of a transport channel and a rotating shaft with screw leaves (Fig. 12). The bulk materials are filled into the channel and the screw transports it to a leaving point. In advanced logistic systems, they are used for feeding processes (e. g. silo discharging) or rather loading of grains (e. g. loading of ships) and inhomogeneous materials (e. g. waste materials).

*Figure 12. Example for feeder screw, source: [18]*

## 5. SUMMARY

To fulfil the increasing requirements of the social and economic environments, the equipment used in material handling processes have to be developed. The machines fitted exactly to certain manufacturing procedures some decades ago, cannot be found in the advanced version, they role are acted by other, earlier rarely used computer-controlled devices.

This paper gave an overview about a special group of material handling machines – transport channels -, to uncover their application possibilities in advanced industrial systems.

As there are large differences among the various types of transport channels, their application characteristics and possibilities are also very different. In advanced logistic systems the using of the roller and belt conveyors are the most prevalent, but many other

types can be efficiently applied in special handling cases. Only one or two types cannot be suited to the requirements of the advanced technologies (e. g. en masse conveyors), but in the future it can be changed.

Next phase of this research will be the uncovering of the special parameters and application advantages of these machines, which can show the development directions of the transport channels.

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