Conveyor Belt Cleaning

Basic Methods, Integration and Economy

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Due to high cost pressure and reduced personnel capacity, belt cleaning systems have become more and more important. The integration of cleaning systems into the conveyor structure requests technical understanding and detailed knowledge of the complete installation.

Efficient belt cleaning devices are indispensable in most conveyor installations. At a time when the number of operatives employed on such conveyors is being reduced, even greater demands are placed on the cleaning efficiency of these systems. Yet this is possible only if the scrapers employed operate in harmony with the remaining plant components. In addition to belt cleaning basics, this article therefore considers the integration of such systems as an important component of the conveyor installation, as well as the economy that can be achieved.

1 Basic Methods and Equipment

Belt conveyors tend to accumulate carryback material on the return strand, as the conveyed material is being scraped by other components of the installation and therefore enters the conveyor line. To prevent or reduce the accumulation of carryback to acceptable levels, each belt must be cleaned after the discharge point. A variety of procedures and methods is available to perform this task (Fig. 2). Fig. 3 shows the most usual belt cleaning systems.

In practice, most companies employ scrapers fitted with blocks, blades or modules to clean their conveyor belts. These scrapers can be classified according to various characteristics, the most important being the cleaning tip material and the position of the blades against the belt. Cleaning tips can be made out of rubber, plastic, ceramics, steel or tungsten carbide. Especially tungsten carbide is characterised by a long service life.

Regarding the position of the blades against the belt, the market nowadays offers numerous scraper systems with a great variety of different designs: paint scraper principle, bar principle or

Pictures: Hosch

Fig. 1: Efficient belt cleaning is indispensable in most conveyor installations.

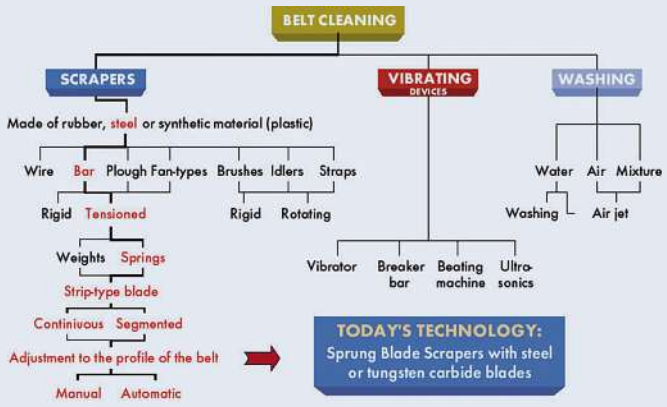

Fig. 2: Overview of different belt cleaning systems [1].

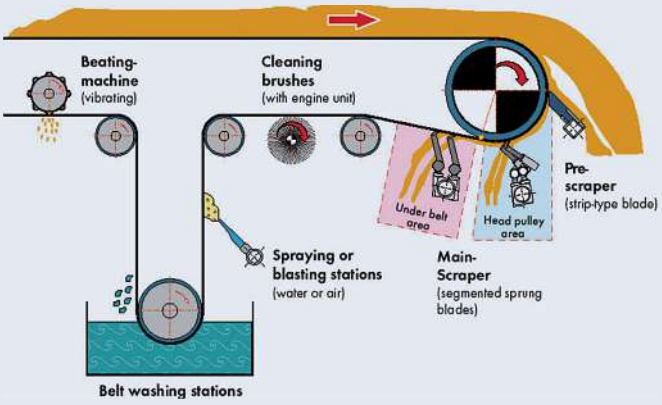

Fig. 3: Positioning of conveyor belt cleaning systems.

negative angle principle (Fig. 4). Other factors which influence the cleaning efficiency include the position of blade to belt travelling direction, the tension of the blade, and the shaping and wear resistance of the blade tip.

All types of scrapers are used, but the best cleaning results are reached with scrapers using the paint scraper principle.

Cleaning Blade Designs

Single-row scrapers with a strip-type cleaning blade made out of rubber, plastic or steel show a so-called continuous line layout. Modern, high efficient belt scrapers however show a split line layout, i.e. individual spring-loaded cleaning elements pressed against the belt. Such scrapers are available in single-row execution – with discharge of scrapings against the belt travel direction – or double-row execution with discharge of scrapings in the belt travel direction (Figs. 5 and 6).

Cleaning Principles

There are two categories of scrapers: the pre-scrapers and the main scrapers. Pre-scrapers are installed on conveyors where the working conditions lead to an overload of the main scraper. They reduce the product layer sticking to the belt surface so that the main scraper can achieve an optimal cleaning efficiency. If one considers the main scrapers, the sprung blade scraper with split line layout prevails as the most important scraper type. The cleaning elements are generally fitted with tungsten carbide tips.

Pre-scrapers show either a single line or a split line layout and are generally equipped with single plastic cleaning blocks (Fig. 7). However, ceramics and tungsten carbide can also be used.

Scrapers are used practically everywhere in the extraction, transportation and processing of bulk materials. Each application has its own special requirements, but it is almost always possible to find a viable concept.

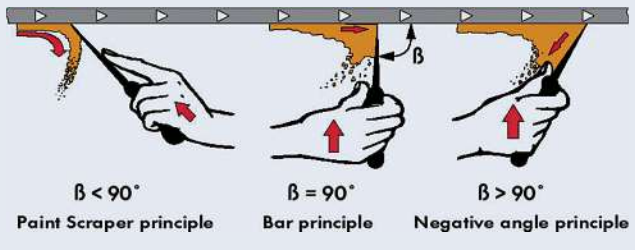

Fig. 4: Position of cleaning blades against the belt.

2 Integration into the Conveyor Structure

The basic pre-requisites for a good cleaning are, on the one hand, the principle behind the scraper system but also, on the other hand, the underlying technical conditions encountered in the facility as a whole and the properties of the conveyed material. The scraper is in permanent interaction with the other belt conveyor components. It is therefore only as good as the conveyor allows.

When discussing the use of scrapers, we generally distinguish between the pulley and the return strand (Fig. 8). The boundary between the two areas is marked by the discharge point. Cleaning is highly efficient in both areas.

On a reversible belt, each discharge point must be equipped with a cleaning system. In this place, scrapers are generally installed 90° to the conveyor belt. In case a high cleaning efficiency is requested on the pulley, cleaning systems using the paint scraper principle can also be installed. Depending on the belt travel direction, these scrapers must be disengaged and re-engaged. The requested disengaging devices can be steered electrically, pneumatically or hydraulically.

To obtain the best possible results, the following principles should be noticed:

- Availability of sufficient space for arrangement of the scrapers according to the installation and operation instructions.
- Where conveyed material sticks to the belt in thick layers there should be enough space for a pre- and a main scraper.
- After the scraper there should be enough space up to the rear chute wall to prevent caking of material on the chute.
- The rear wall of the chute should exhibit an angle appropriate for the discharge behaviour of the material.
- The rear wall of the chute should be closed as high a possible to prevent scrapings being thrown behind the chute.
- The scraper should be easily accessible to permit ease of mounting, maintenance and cleaning.

Chutes that are built extremely small and narrow prevent optimal cleaning for the entire life of the plant, also creating extra costs. Each cleaning facility should therefore be carefully selected at an early stage in consultation with the plant constructor, the plant operators and the scraper manufacturer, in order to achieve the best possible cleaning efficiency.

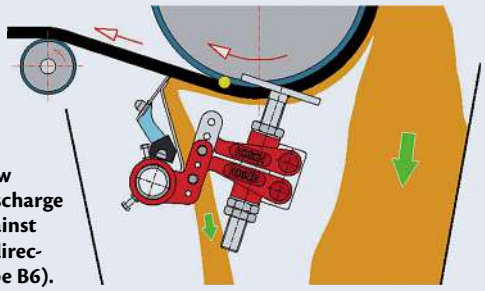

Fig. 5: Single-row scraper with discharge of scrapings against the belt travel direction (Hosch Type B6).

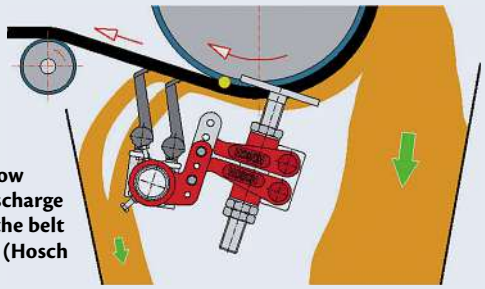

Fig. 6: Double-row scraper with discharge of scrapings in the belt travel direction (Hosch Type C6).

Optimum Belt Surface Quality

The surface quality of the conveyor belt, of course, also has considerable influence on the cleaning effect. A furrowed or worn belt does not permit efficient cleaning, as the scraper cannot fully contact the conveyed material. Also cover plate hardness of 60 to 75° Shore-A is favourable and the junction and patched areas in the belt must be level and undamaged.

The properties of the belt surface should be adapted to the operating conditions, i.e. the belt should be heat and oil resistant etc. If these requirements are not met, the covering plate of the belt may suffer from alterations likely to impede the cleaning or even make it impossible. Belt joints should be rendered in compliance with existing standards and directives. This is especially indispensable for an optimal function of pre-tensioned cleaning systems that the cover plate hardness in the junction area does not deviate from the undisturbed section by more than +/- 5° Shore-A.

If the cover plate hardness in the junction deviates from the undisturbed section, the junction must show a gradual, terrace-like edge. The edge of a textile belt junction should be gradual, terrace-like, so that the scraper hits the undisturbed section of the belt after passing the junction, and does not run against the overlap.

It is indispensable to check the compatibility of mechanical belt splices with the scraper. In some cases, it may be necessary to use special cleaning elements showing a lower cleaning efficiency. This is also the case in case of highly damaged belt surface, patches and grooves.

Excessive belt mistracking in the scraper area may cause the pre-tensioned cleaning elements to lose contact to the belt and damage the belt edges. In order to stabilise the belt in the scraper area, the installation of support idlers on the return strand may be requested.

Also the head pulley is very important. In case a scraper is to be installed on the head pulley, it is indispensable to check the scraper's compatibility with the pulley lagging and the pulley design. The conveyor design should ensure that no material is caught between the belt and the pulley, since this could damage the belt (deflector), and especially in the winter time, the formation of ice should be avoided on the pulley.

It should also be noted that scrapers increase the requirement of energy of a conveyor belt. It may be necessary to check the required power of short belt conveyors.

All in all it is apparent that a variety of factors must be taken into account when selecting equipment and designing the plant. Yet unfortunately in practice it is often clear that too little attention is paid to belt cleaning systems, thus preventing optimum selection and arrangement.

By investing slightly more in the configuration of material transfer facilities for example, plant owners are guaranteed satisfactory operation for the entire life of the plant. Each cleaning facility should therefore be carefully selected at an early stage in consultation with the plant constructors and operators, taking into account the conditions of service as well as the relevant standards and directives.

Scraper systems are components that are situated in the product flow and therefore exposed to high dynamic and static stress. These operating conditions, combined with the requirements of high and steady cleaning efficiency, request a regular maintenance of the devices.

Scraper Maintenance

In order to schedule maintenance intervals and requirements on spare parts it is recommended to run statistics.

Table 1: Belt cleaning investment and operating costs for model calculation.

Costs of investment
Belt cleaning system
Installation of cleaning system and modification of conveyor structure
Operating costs
Spare parts for cleaning system
Maintenance of the cleaning system
Costs for cleaning up carryback
Costs of material loss
Costs of increased wear of other conveyor components
Costs owing to conveyor failure
Costs of energy, air, water etc.

Table 2: Belt cleaning feasibility analysis for two scrapers of different efficiency.

Pos.	Unit	Cleaner Type - A	Cleaner Type - B
1.	Volume of carryback per year [m³]	700	350
2.	Costs of investment		
2.1	Cleaning system incl. installation [EUR]	1500	2000
3.	Operating costs per year [EUR]		
3.1	Spare parts for cleaning system [EUR]	750	1000
3.2	Maintenance of cleaning system	250	250
3.3	Cleaning labour costs [15 EUR/m³]	10500	5250
3.4	Costs of material loss [5 EUR/m³]	3500	1750
3.5	Total costs for first year [EUR]	16500	10250
4.	Potential cost saving for first year [EUR]		6250

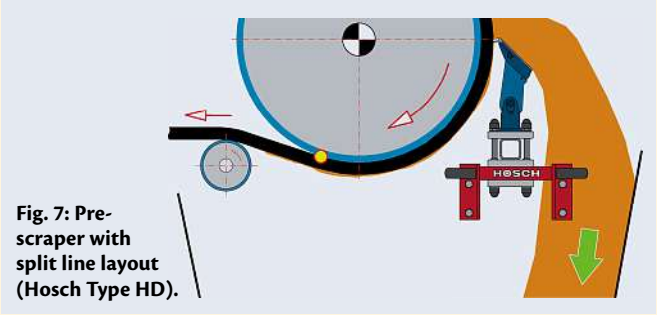

Fig. 7: Pre-scraper with split line layout (Hosch Type HD).

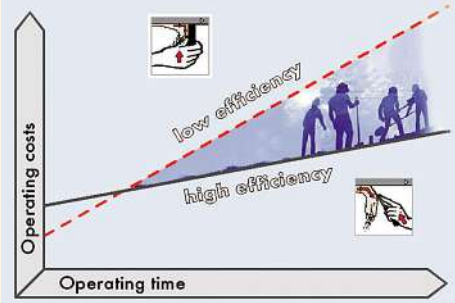

Fig. 8: Operating cost of belt cleaning depending on cleaning efficiency.

Scraper maintenance consists of different steps:

- Regular visit and inspection of the scrapers and control of their efficiency.
- Regular cleaning of all scraper components and functional check of all components.
- Replacement of worn-out or damaged parts by original parts.

The intervals for follow-up inspections are variable and mainly depend on the material conveyed and the operating conditions of the scraper. Intervals for follow-up can vary from once a month up to once a week. A good example for a high maintenance frequency is a wet ash application in an incineration plant for domestic refuse. Metal components lodged between the blade and the belt, as wires for example, lead to a deterioration of the belt surface if they are not regularly removed.

3 Economy of Belt Cleaning

Conveyed material sticking to the belt can lead to substantial plant operating costs:

- Personnel costs incurred due to the cleaning work required.
- Loss of conveyed material, depending on the material, generates not unsubstantial costs.
- Material sticking to the belt impacts on the plant, e.g. the idlers carrying the return strand, and leads to increased wear.
- If the material becomes clogged on the return idlers or piles up underneath the return strand the belt can start to skew dangerously. This can result in damage to the belt, the steel structure and, in the worst case, to a total failure of the plant.

If we consider the economic viability of a belt cleaning system, we need to compare investment and operating costs (Table 1).

A model cost statement gives a clearer picture, Table 2 shows that by halving total contamination levels, i.e. by duplication of the efficiency of the cleaning system, significant cost savings can be achieved. The economic consequences of inadequate belt cleaning are still underestimated by many companies (Fig. 8).

Hosch has therefore developed a practical assessment method and offers operators an analysis of the effect of existing or newly installed systems. In the course of this measuring, a carryback gauge, consisting of a steel blade and a collecting vessel for the removed material are installed behind a belt cleaning system for a limited period of time to measure the quantity of carryback. The quantity of carryback can be measured in two different ways, either volumetrically in litres or by weighing the collected material. Afterwards, the data ascertained is extrapolated to one year taking into consideration the respective operating times, and the economic viability of the system is evaluated.

In relation to the costs of investment in a full conveyor the costs of a scraper system is only of minor importance. When considering the overall cost of running a plant later on, they then become of great significance. Scraper systems should therefore be taken into consideration and specified when planning a new installation and concepts should be developed in accord with the whole plant.

4 Summary

At a time of high cost pressure and reduced personnel capacity, belt cleaning systems have become more and more important. The integration of cleaning systems into the conveyor structure requests a considerable technical understanding and a detailed knowledge of the complete installation. Optimal system configuration significantly reduces the operating costs of belt conveyors. ■

References

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[2] Hell, E.: *Bulk material handling technology 2003 - Performance assessment of belt cleaning systems*. Aufbereitungstechnik 45, (2004), Heft 1-2, pp. 25-31.

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Following his studies of Mechanical Engineering and his graduation as a qualified engineer (Dipl.-Ing.), Eckhard Hell worked at Deutsche Babcock Werke from 1982 to 1985. From 1986 to August 1998 he was employed at Veba as a Project Manager for large-scale power stations. In September 1998 he took the position of General Manager of Hosch in Germany and he is now Managing Director of the international Hosch Group.

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