WISH
Waste Industry Safety and Health Forum
INFORMATION DOCUMENT

MACHINERY SAFETY INFORMATION BELT CONVEYORS

This WISH information document is aimed at health and safety improvements in the waste management industry. The Health and Safety Executive (HSE) provided support to WISH in producing this guidance. This guidance may go further than the minimum you need to do to comply with the law with regard to health and safety

Contents

Introduction and scope

This is one of a series of information sheets covering specific items of machinery in common use at recycling plants/MRFs. All are available as free downloads from the WISH website (https://www.wishforum.org.uk/information/). General guidance on recycling plant safety is also available (https://www.wishforum.org.uk/wish-guidance/), and on isolation and lock-off (https://www.wishforum.org.uk/wp-content/uploads/2021/10/WISH-WASTE-29-Practical-isolation-and-lock-off-guidance-October-2021.pdf). This sheet does not aim to be comprehensive – you should also seek further guidance, such as that available on the HSE's website, and where required obtain competent advice. This sheet covers conveyors, with an emphasis on belt conveyors as the most common type in use at recycling plants.

Case studies – the case studies in this information document are based on real accidents. However, they have been anonymised by the removal of names, company names, dates etc to prevent any distress to relatives, friends etc of the injured person/s.

Introduction

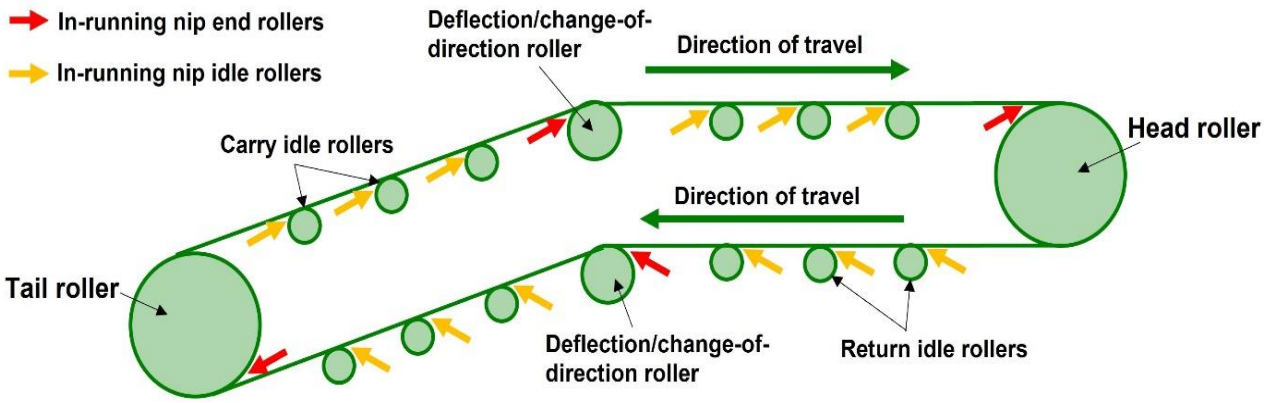
Belt conveyors are among the most common type of process equipment for the movement of materials. Material spillage from a conveyor belt is caused by various issues such as overloading or from a lack of material containment such as inadequate conveyor side walls, either at a transfer point or along the conveyor's route. Spillage can sometimes carry over from the discharge point, returning at the belt underside or get underneath the drive/return rollers, which in turn can affect belt tracking. Rubber conveyor belting itself can wear, stretch, rip, or become embrittled. Ineffective jointing of conveyor belting by stapling or crocodile clips can create additional looseness in the belt tracking. Inconsistent material loading can also affect the belt tension and how the conveyor is driven.

Entanglement in the moving parts of conveyors, such as rollers, has been the cause of multiple serious and fatal accidents at waste recycling plants. The latest HSE statistics available show that machinery safety is the most common cause of fatal accidents at recycling plants (https://www.hse.gov.uk/statistics/industry/waste-recycling.pdf). The safe design, use and maintenance of conveyors is essential if we are to reduce this unacceptable toll of serious, life-changing, and fatal accidents.

Case study – a deflection/change of direction roller located under a picking cabin at a recycling plant had been deemed 'safe by position' and had not been guarded because it was well above ground level and could not be reached. However, as part of the normal operation of the plant wastes would build-up in the bays/bunkers under the cabin. One day as the result of a puncture the loading shovel used to empty the bays/bunkers was not available and consequently wastes built-up in the bays/bunkers more than would be usual to the extent that the bays/bunkers were becoming full. A worker at the plant attempted to level the wastes in a bay/bunker to allow picking to continue. To do this he climbed-up the pile of wastes under the cabin, so defeating the distance to the deflection roller. He became entangled in the roller and died later in hospital. It is common at recycling plants for wastes to build-up under picking cabins, under the head rollers of output conveyors and similar, or for containers such as skips to be placed in these locations. 'Safe by position' does not work if there is a pile of waste, a waste container or other item placed under conveyor rollers allowing climbing access.

Dangerous parts of conveyors

The most common dangerous parts of belt conveyors involved in recycling plant are the in-running nip-points between the belt and the rollers. The diagram below illustrates these:



Note - the diagram above is simplistic and shows a basic conveyor and is provided for the purposes of illustration only. Yours may be more complicated, such as having a belt tensioner system, multiple deflection rollers at changes of direction etc. Rollers, danger zones etc are often called different names, such as deflection rollers also being called change-of-direction rollers, nip-points being called pinch-points etc. The nomenclature used in this sheet is for the purposes of this sheet only.

Tail and head rollers (end rollers) – generally, belt conveyors are friction drive, such as by being driven by a motor located on the head or tail roller of the conveyor. The tension at these end rollers is significant, often measured in tonnes – if it were not the belt would slip on its driven roller. Entanglement in the in-running nips of end rollers will nearly always result in serious injury or worse.

Deflection rollers (also called change-of-direction rollers) – these rollers are often found at recycling plants where a belt conveyor changes direction, such as where a belt carries waste up to a picking cabin and then ‘changes direction’ to being horizontal to allow picking. Depending on the angle the belt is being forced through, the tension at the in-running nip of deflection rollers can be significant, as shown by the case study above. Experience is that designers can sometimes overlook deflection rollers in their guarding provision – you should be aware of this possibility.

Idle rollers (carry/return rollers) – idle rollers carry the belt: carry-idlers under the load carrying run of the conveyor and return-idlers supporting the empty belt on its return run. Although rollers to the underside of a conveyor belt are not powered, there is still a running nip between the powered movement of the belt and the rollers. Depending on the weight of material/wastes on the belt the risks posed at the in-running nips of carry-idler rollers can be significant. Dependent on the speed of the belt and its empty weight the risks at carry and return idle rollers can also be significant. In general, for return idle rollers if the belt can be deflected by hand pressure by 50mm or more they may not need to be safeguarded, but if in doubt seek competent advice.

Other hazards may also exist, such as nip/entanglement points at the drive mechanism of the belt, traps between slats or protrusions from the belt and fixed structures, at scraper bars and other cleaning and debris removal devices etc. In addition, if the conveyor is reversable (can be run in both directions) then in-running nips will exist on both sides of rollers.

Left to right: tail roller of belt conveyor (guard removed), deflection roller (belt cut to remove injured person), damaged conveyor at and end roller (scene of accident), example in-running nip, second example in-running nip

Safeguarding of belt conveyors

As for any machinery hazard, safeguarding on conveyors should follow the hierarchy given in PUWER (Provision and Use of Work Equipment regulations). In brief, use of close fixed guards should be considered first and if not practical use of interlocked and similar guards, then if also not practical other safeguarding such as perimeter (also called machine) fencing.

Fixed guards – the use of close fixed guards should be the first option. However, close guarding may result in build-up of detritus and/or blockages resulting in a need for frequent access to the dangerous part/s. The use of suitable mesh guards to allow detritus to drop-through or drop-out chutes should be considered if detritus build-up is an issue. Just because a close fixed guard results in detritus build-up does not mean that fixed guarding should be discarded as an option without first considering other designs of fixed guarding. Conveyor side guards may also be required depending on belt speed, any trapping points (such as between perpendicular slats fitted to a conveyor and fixed structures) and the frequency at which personnel are close to the conveyor.

Nip/finger guards – these are small, fixed guards located directly at the nip-point to reduce the access gap at the nip-point usually to less than 6mm. These can be effective but may be prone to blockages if waste becomes trapped in the small gap.

Interlocked guards – if access to a dangerous part is required frequently, such as for cleaning, the use of interlocked guards should be considered. However, interlocks are not a replacement for adequate secure isolation and lock-off (see WISH WASTE 29 on lock-off at https://www.wishforum.org.uk/wp-content/uploads/2021/10/WISH-WASTE-29-Practical-isolation-and-lock-off-guidance-October-2021.pdf).

Perimeter/machine fencing – enclosing a dangerous part with perimeter fencing is a popular option at some recycling plants to prevent problems such as detritus build-up and blockages. However, the design of fencing should effectively prevent access, and if frequent access is required the interlocking of access gates in fencing should be considered.

Left to right: mesh fixed guard at tail roller, fixed close guard at tail roller, drop-out chute to reduce detritus build-up, large mesh guard at tail roller, inadequate guarding allowing reaching access, nip/finger guards at head roller

As the case study above illustrates, safeguarding by position should only be considered if there is no risk of access by climbing. It is a common flaw that designers of recycling machinery deem rollers to be safe by position because of their height above floor level. If a waste container is to be placed under a roller, or wastes will accumulate under a roller, or if an easily climbable structure is available the standards relating to reaching-up distances start from the top of these and not from the floor.

Whatever safeguarding approach is taken, guards and similar need to be suitable robust and designed to the required standards. You may need to seek competent advice.

Emergency stop provision

Emergency stops are not considered a means of prevention of danger, but access to emergency stops may mitigate the severity of injury if actuated quickly. Stop buttons or pull-cords (also called pull-wires and tripwires) should be located where they are readily accessible, such as at or near trapping, nip etc points and generally available so that anyone can assist in their activation. Some conveyors are fitted with 'button' type emergency stops. However, more commonly they are fitted with pull-wire emergency stop systems. These either run along the sides or above the conveyor or are suspended on 'goal posts' above the conveyor where access on to the conveyor is possible, such as floor-mounted load conveyors. If such floor-mounted load conveyors lead to a high-risk danger zone, such as a baler or shredder, then goal post type pull-wire systems should be fitted which can be easily accessed by a person laying on the conveyor, for example if they are injured.

- Dependent on the length of the wire, pull-wire emergency stops should have a switch at both ends of the wire or a switch at one end and a spring mounting at the other. They must not have a fixed mounting at one end – pulling directly away from a fixed mounting will not activate the switch at the other end of the wire

Left to right: pull-wire emergency stop above a conveyor (in this case with a non-compliant fixed mounting at one end), typical switch at one end of a pull-wire, load conveyor to a baler fitted with goal post pull-wire emergency stop system above the conveyor, typical tension adjustment window – line between the arrows, pictogram signage for a pull-wire

- Pull-wires need to be checked to ensure they are correctly tensioned (many have a small view window in their switch/es with an arrow and two lines to indicate correct tension – arrow should be between the lines)
- Pull-wires must run freely and be free of obstructions. Items such as ‘soft toys’ or similar scavenged from wastes must not be hung on pull-wires
- As with all emergency stop systems, pull-wire emergency stop should be tested as part of daily/weekly routine checks

Blockages and detritus

In common with other machinery used in recycling plants, belt conveyors can suffer from detritus build-up and blockages.

- If practical the design of the conveyor and its structure should be designed to eliminate or reduce the occurrence of blockages and detritus build-up. For example by close fitting of feed chutes and hoppers to reduce detritus spill, the use of scraper bars and similar to remove detritus without the need for human intervention, use of textured or ribbed belts on inclined conveyors to reduce ‘roll-back’ of detritus towards the tail roller of the belt etc
- Guard design should take account of detritus and blockages. For example, the use of mesh guards through which detritus can fall, use of drop-out chutes etc
- Clearing of blockages and cleaning should be planned in advance and not carried-out on an ad-hoc basis with operatives using improvised tools and methods
- Secure isolation and lock-off must be used where blockage clearance and/or cleaning requires the removal of guards or entry into machine fencing enclosures

Adjustments (tracking)

Belt tracking is a process designed to inspect and align the conveyor belt to the centre of its head drum (also often called a head pulley or roller). If the belt does not run true and skews to one side damage and other problems may occur. Tracking is typically a manual operation where the position of the tail pulley/roller, commonly referred to as the take-up pulley, is adjusted (extended or retracted) using two independently adjusted screw mechanisms on either side of the conveyor frame. Tracking is undertaken with the belt running.

Case study – a maintenance engineer at a recycling plant attempted to track one of the belt conveyors at the site. He was working alone and the guard at the tail roller of the conveyor required removal to access the tracking adjustment mechanism. During tracking his spanner slipped. The engineer instinctively reached-out to try and stop the spanner falling to the floor, as a result his hand became entangled in the nip point of the roller, and he was drawn into the nip point. He sustained multiple fractures to his arm and serious soft tissue and tendon damage requiring the amputation of his arm.

The obvious risk during tracking is contact with the in-running nip point of the tail/head roller being adjusted, as illustrated by the case study above. However, standards allow that where there are also non-powered or low-powered rollers in the work area and these are spaced sufficiently so as not to create nip points, or if the rollers can be stopped by one hand, then no further safeguards are required. But you should still consider the risk of entanglement in such rollers because of the need for close access to carry out tracking, especially where the weight of the belt rests upon these unpowered rollers. Additional safeguarding may be needed if there is a risk present.

- Wherever practical guards should be designed to allow tracking without their removal, such as by profiling around the tracking mechanism so that adjustment nuts can be accessed without the guard being removed
- If not practical, adequate precautions should be in place such as conveyor set at the lowest speed consistent with tracking, two-person task (one doing the task and the second at the nearest emergency stop with a clear view of the work area), competent persons only to carry-out tracking, use of a permit to work system etc

Other maintenance activities should be considered in the same way as above, starting with elimination. For example, the fitting of remote oiling points to eliminate any need to remove guards to oil or grease conveyor roller bearings and similar.

Left to right: fixed guard designed to allow belt tracking without removal, example of a drop-out chute (in this case with an interlocked gate access to clear debris, example scraper bar (guard removed to show detail), example hinged guard at a conveyor tail roller to make cleaning easier for operatives

Brief overview other types of conveyor

Belt conveyors are the most common in use in recycling plants. However, there are other types of conveyor.

Slat and chain drive conveyors – this type of conveyor tends to be used in 'heavy duty' applications such as load conveyors from feed hoppers. They are typically large and powerful items of machinery.

- The chain drive elements should be safeguarded adequately, usually by the fitting of fixed and robust close guards to completely enclose them
- Protrusions from inclined slat conveyors aimed at reducing roll-back of waste materials are common. Where such protrusions pass fixed structures, they should be safeguarded to prevent access to trapping points

Screw conveyors (sometimes called Archimedes screws) – this type of conveyor is rare at recycling plants, but they are used sometimes as part of de-baling systems or bag splitters. The hazards and dangerous parts of screw conveyors are usually obvious and require careful and robust safeguarding. You will likely need competent advice to assist you.

Disclaimer and WISH

This information document has been prepared by health and safety practitioners to assist health and safety improvements in the waste management industry. It is endorsed by the WISH (Waste Industry Safety and Health) Forum. This information document is not formal guidance and represents good practice, which typically goes beyond the strict requirements of health and safety law.

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The Waste Industry Safety and Health (WISH) Forum exists to communicate and consult with key stakeholders, including local and national government bodies, equipment manufacturers, trade associations, professional associations, and trade unions. The aim of WISH is to identify, devise and promote activities to improve industry health and safety performance.

Useful links and further reading

WISH website: www.wishforum.org.uk
HSE waste and recycling webpages: www.hse.gov.uk/waste/index.htm