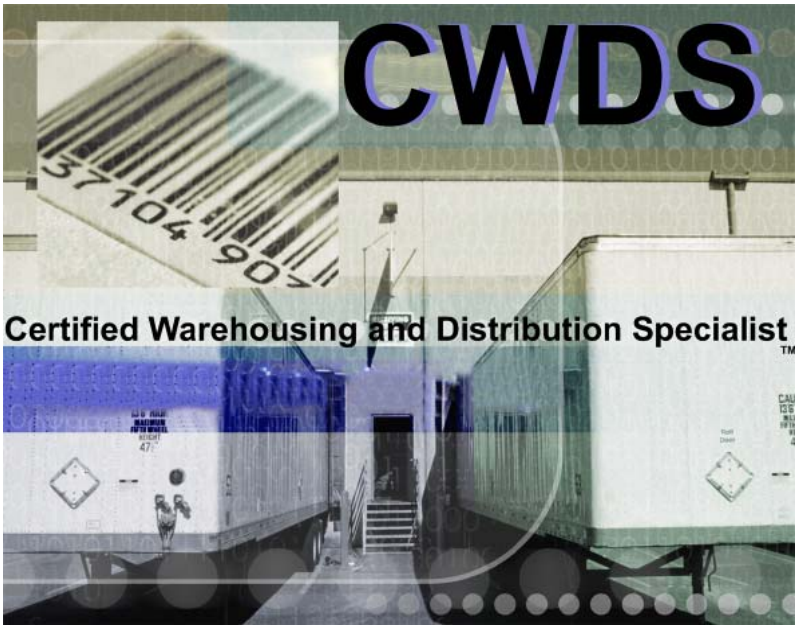

Handling Systems

QUICKSTART®
TECHNICAL COLLEGE SYSTEM OF GEORGIA

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Introduction

Overview

Packaging line conveyors are used to transport the product, empty containers, closures, filled containers, and loaded cases through the various locations of the warehouse.

Conveyors connect the machines or units in a production or packaging line and move the product and containers into position for filling, closing, inspection, coding and marking, case packing, and other functions that may be involved in a particular warehouse operation.

Several different types of conveyors and conveying processes are used in packaging. The equipment that is used can be selected to best fit the size, shape, weight, and specialized handling requirements of the items being transported. These conveyors can provide various conveying surfaces, provisions for product control, and types of movement.

In this unit you will become familiar with different types of conveyors that are used on packaging lines and learn to describe the ways they are used.

In future units, you will learn details of the ways the different types of conveyors are constructed, how they operate, and how they are incorporated into the warehouse system. As a Certified Warehouse and Distribution Technician, you should be familiar with the different types of conveyors, their configurations, and the attachments that they use.

Objectives

The information, activities and practice provided during this unit will enable you to:

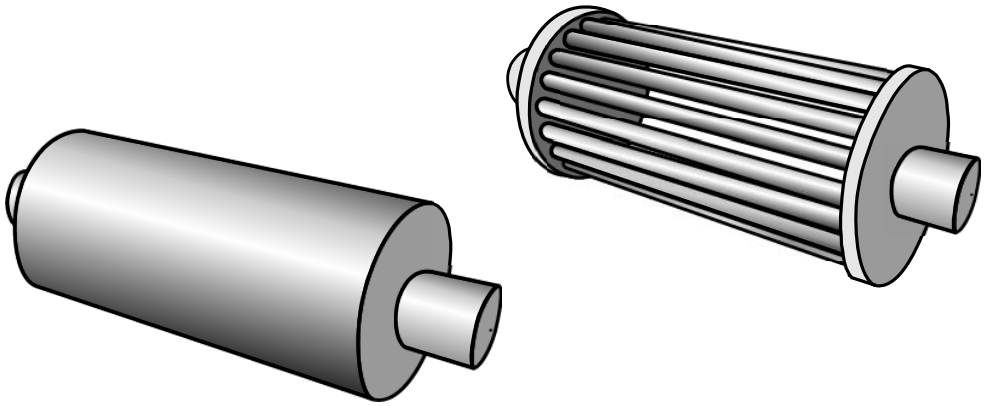
1. Describe the different types of conveyor systems used in warehouses.
2. Identify a conveyor that is appropriate for a particular product and container.
3. Describe how a particular product or container is moved through a warehouse.
4. Specify the type of protection that must be provided for a product while in a conveyor system.

Belt Conveyors

The belt conveyor provides a smooth moving surface that can be used for transporting solid products, containers, packages, and loose product.

Conveyor belts are made of a variety of materials such as combinations of fabric, rubber or plastic, wire mesh, and metal plates. The specific belt that is used on any packaging line will be determined by the characteristics of the product being carried. For example, belts used in bakery ovens must be resistant to heat, those used in chemical plants must resist acid or other corrosive materials, those used to carry plastic bottles should not scratch the plastic, and those carrying sharp objects should not cut easily.

Conveyor belt pulleys are cylindrical and usually have a solid surface. The cage pulley, or self-cleaning pulley, is a special pulley that is used for conveying dirty products that may accumulate on the conveyor belt. The pulley-carrying surface is made of a series of parallel rods. The belt will bend over the rods as it is carried around the cage pulley, and the dirt or other material that has stuck to the belt will fall off.



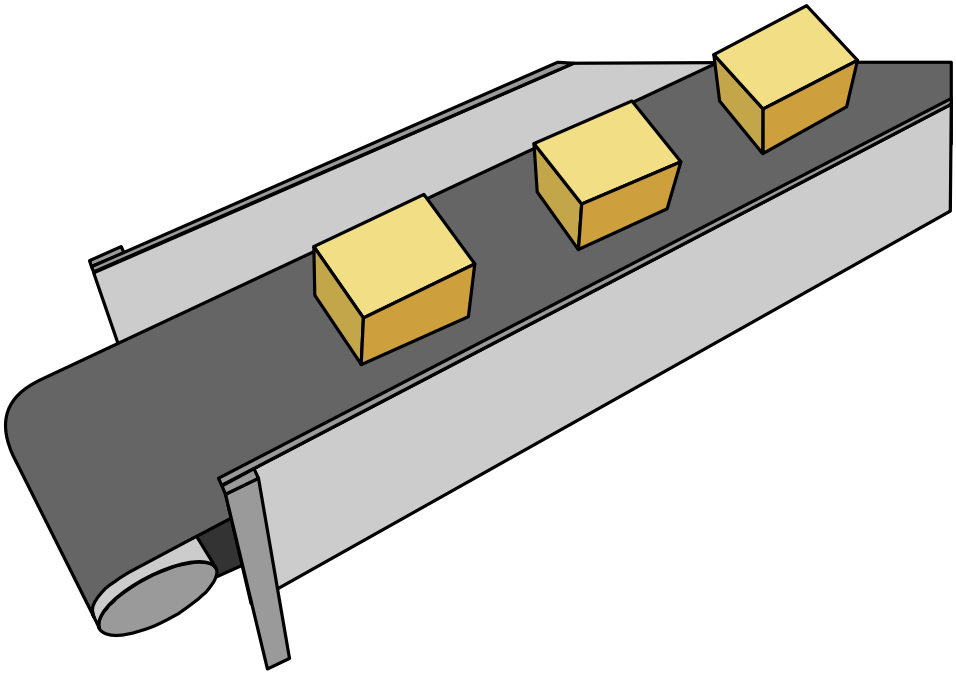
Conveyor Belt Pulleys

The different types of belt conveyors, their components, operations, and ways they are used differs with different types of products and containers. The following descriptions will acquaint you with the specifications that are used to select a flat-belt type conveyor.

Flat Horizontal Belt Conveyor

Flat horizontal belts provide a continuous flat surface on which the product or container can ride. Horizontal flat belt conveyors are generally used for transporting separated individual items, containers, or packages.

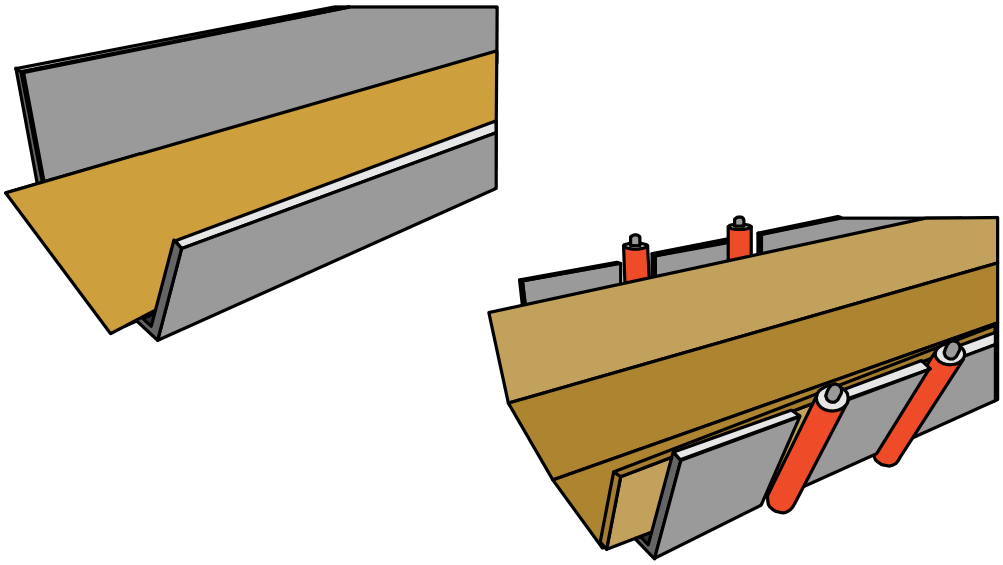
The basic horizontal flat belt conveyor is shown in below. The belt rides over a bed that helps support the weight of the load and two pulleys. The drive pulley usually provides the operating power through a V-belt connected to a motor. The tail pulley supports the back end of the belt and its position may be adjusted to control the amount of slack in the conveyor belt.



Flat Horizontal Belt Conveyor

Trough Type Belt Conveyors

There are three types of trough type belt conveyors as shown in illustrations below. Trough shaped belt conveyors may be used for transporting bulk materials or items and in the packaging lines they can be used for conveying product to the fillers.



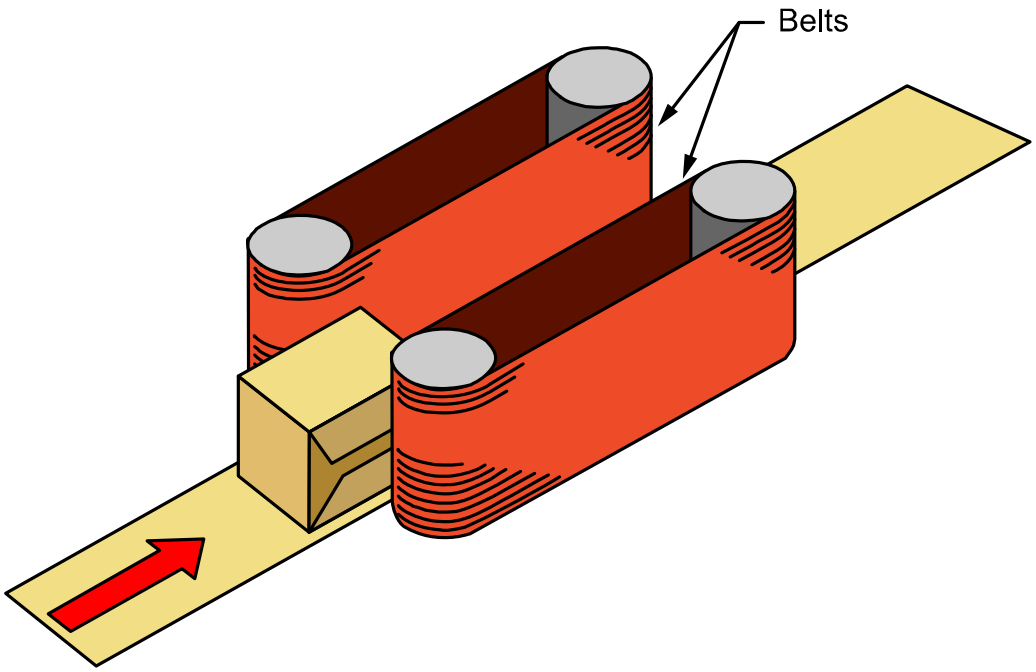
Trough-shaped Horizontal Belt Conveyors

The trough type conveyor on the left has a belt in the bottom and metal sides that form the trough. The one in the center has a belt that folds up the side and rides against the flat metal sides of the trough. The conveyor on the right also has a belt that folds to form the sides of the trough, but it rides against rollers mounted in the sides of the troughs.

Vertical Belt Conveyors

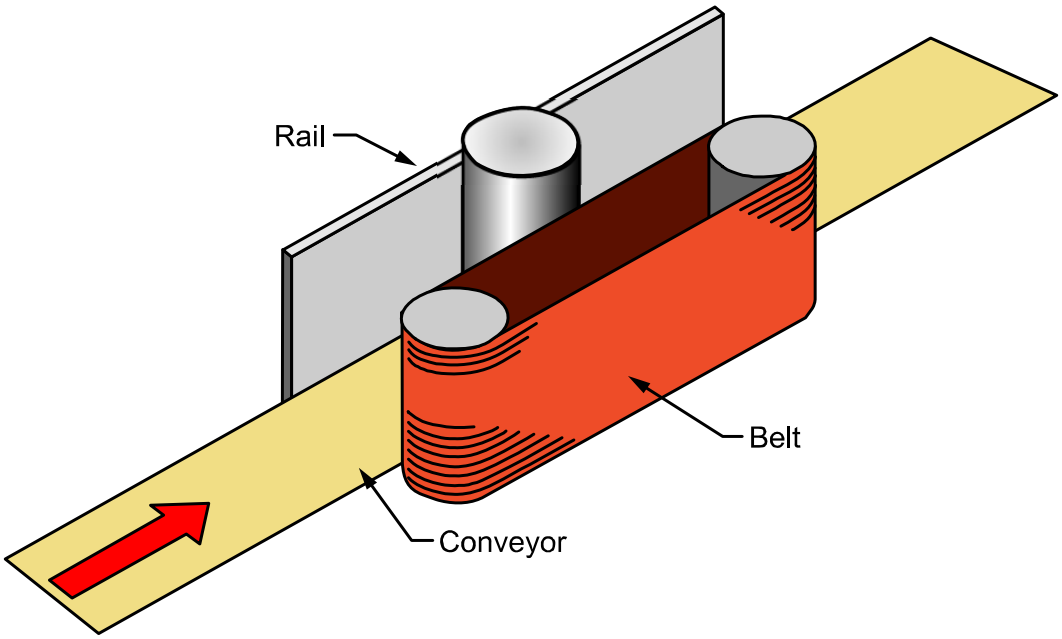
Vertical belt conveyors can be used to hold the containers in position as they are transported, and may be used for elevating them.

Vertically mounted belts may be used singularly or in pairs to contact one or both sides of the containers to turn them into position, compress the seal joints, or to transport them from one point to another. Double or single vertical belts may be used to maintain the orientation of the containers as they are being transported.



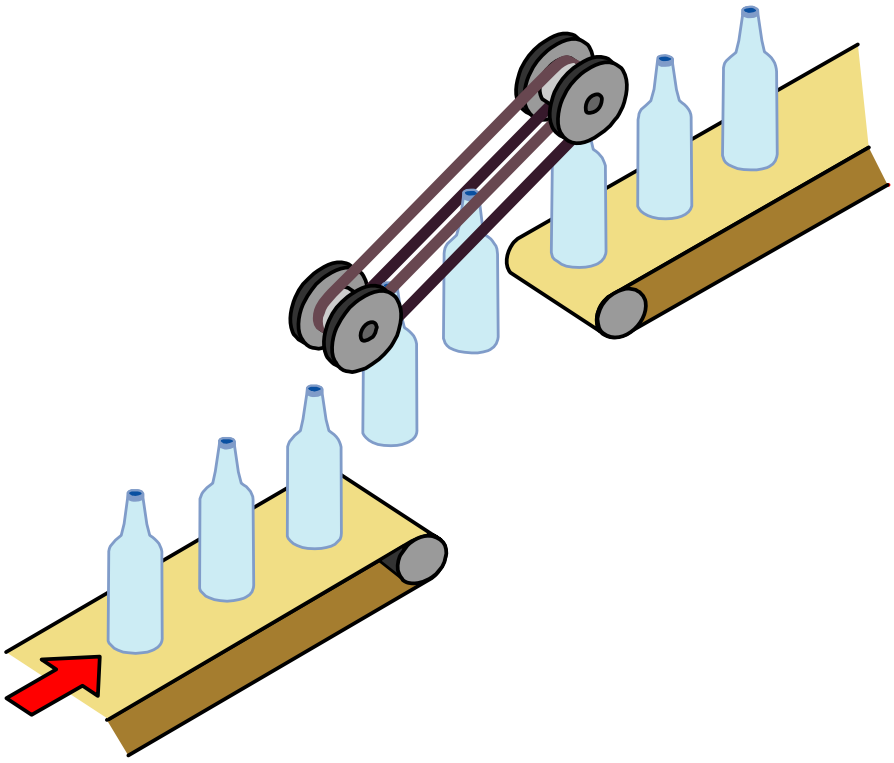
Double Belt Conveyor

A single vertical belt may hold a container against the rail or in position in a labeler as it is carried forward by the conveyor. A pair of vertical belts may move the container forward and maintain a pressure on it while label glue is setting up.



Single Belt Conveyor

Pairs of belts may also be used to hold a suspended container and to transport it from one surface to another. The containers may be moved horizontally or up or down an incline as shown below.



Double Belt Conveyor Holding Suspended Container

Progress Check #1

Circle the letter of the correct answer for each question

1. Conveyor belts may be made from
   a. fabric or rubber
   b. fabric or wire mesh
   c. plastic or metal plates
   d. any of the above

2. The carrying surface of a horizontal conveyor belt is supported by the
   a. bed
   b. edge rails
   c. pulleys

3. The slack in a horizontal conveyor belt is usually adjusted with the
   a. tail pulley
   b. idler
   c. drive pulley

4. A cage pulley will normally be used on a conveyor for products that may
   a. fall off the conveyor
   b. cling to the conveyor belt
   c. cause the belt to slip

5. The carrying surface of a cage pulley is made of

   a. parallel bars

   b. wire mesh

   c. rubber coating

6. Bulk product is most often conveyed

   a. on a flat horizontal belt conveyor

   b. between a set of parallel belts

   c. on a trough style belt conveyor

7. The conveyor that can apply pressure to a glued flap as it transports the carton is

   a. a vertical belt conveyor

   b. pair of vertical belts

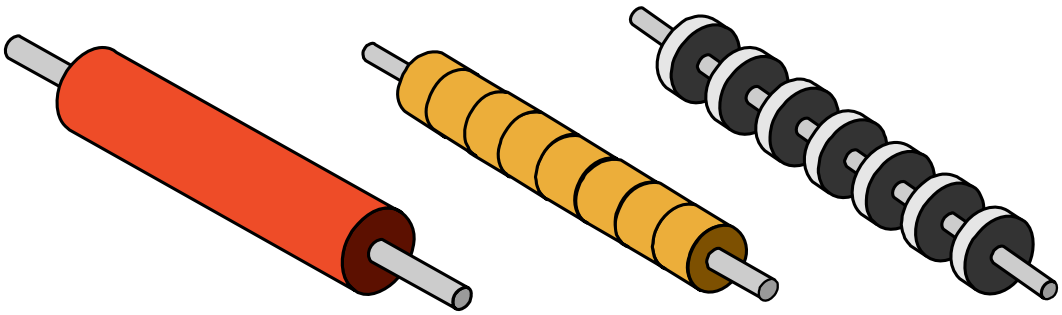
   c. single horizontal belt

Roller Conveyors

Roller type conveyors provide a rotating surface that moves the product or containers. The carrying surface of a roller conveyor is made of a series of rollers that may be operated by gravity or driven by belts or chains. Roller conveyors provide strong dependable moving power that is particularly good for transporting cases and heavy items. Three basic types of roller conveyors include gravity powered rollers and different types of belt and chain driven rollers.

Rollers are made in different sizes, shapes, and designs so that the proper one can be selected for a particular product or application. The illustration below shows solid rollers, segmented rollers, rollers made up of individual wheels, and wheels containing side turning rollers that allow the containers or packages to be moved sideways on the conveyor. The rollers may be firmly attached to the shaft or they may be mounted so that they turn around the shaft when slippage is needed.

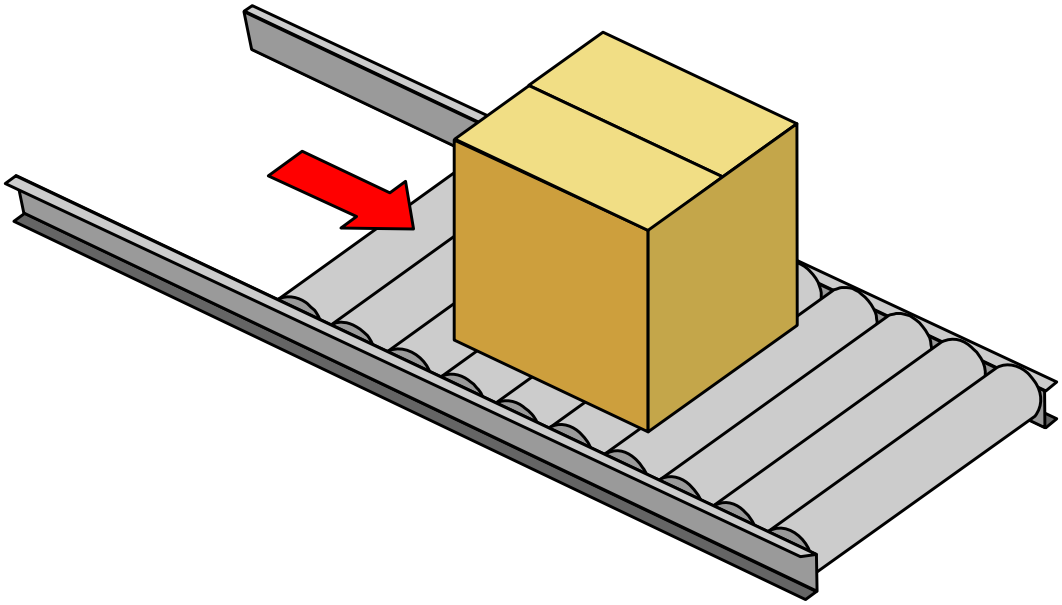
Some rollers are made of stainless steel, and others are made of rubber or plastic materials. The differences of the hardness and flexibility of the materials makes it possible to have a conveying surface that will adequately support load, provide the amount of friction that is needed, and protect particular products. In some cases the rollers must be made of a material that can not be damaged by the weight, sharp surfaces, or chemicals in the objects being conveyed.



Conveyor Rollers

Gravity-powered Roller Conveyors

Cartons or similar items are moved down gravity-powered conveyors by their own weight and the forces of gravity. The bed of the gravity powered roller conveyor is set at a downward angle so that the weight of the items will move them over the rollers. The weight of the case or other container is distributed over several free turning rollers. The momentum with which the case or container moves onto the rollers, its weight, and the downward angle of the conveyor allows gravity to provide the propelling force. The gravity-powered conveyors may operate in straight line or around curves. The roller shafts are mounted in bearings that allow them to turn easily.

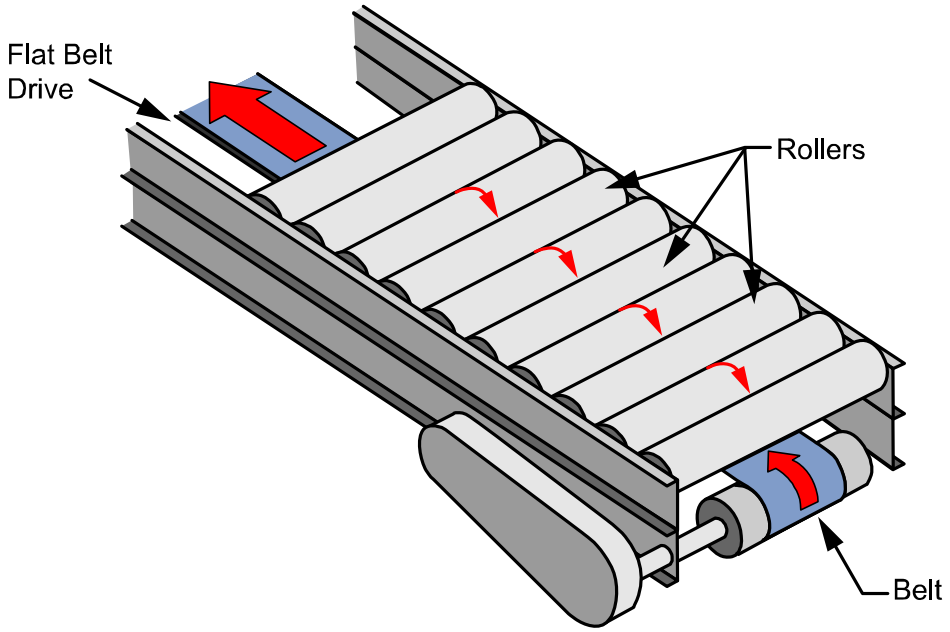


Gravity-powered Roller Conveyor

Belt Driven Roller Conveyors

Flat-belt drives may be used to provide power to roller conveyors. The moving belt turns the rollers as it presses against the bottoms of them. Belts provide the power that is needed but they can slip when backpressure from a jam on the conveyor causes the packages to accumulate on the conveyor. Some systems are designed to allow packages to sit on a slipping conveyor until the next package intentionally pushes them on their way or off the conveyor.

The flat belt mounted under the rollers powers the roller conveyor, shown below. The moving belt rubs against the bottom of the rollers and turns them. The weight of backed-up packages can keep the rollers from turning and the belt can slip under them. This type of belt drive can be used only on straight conveyors.

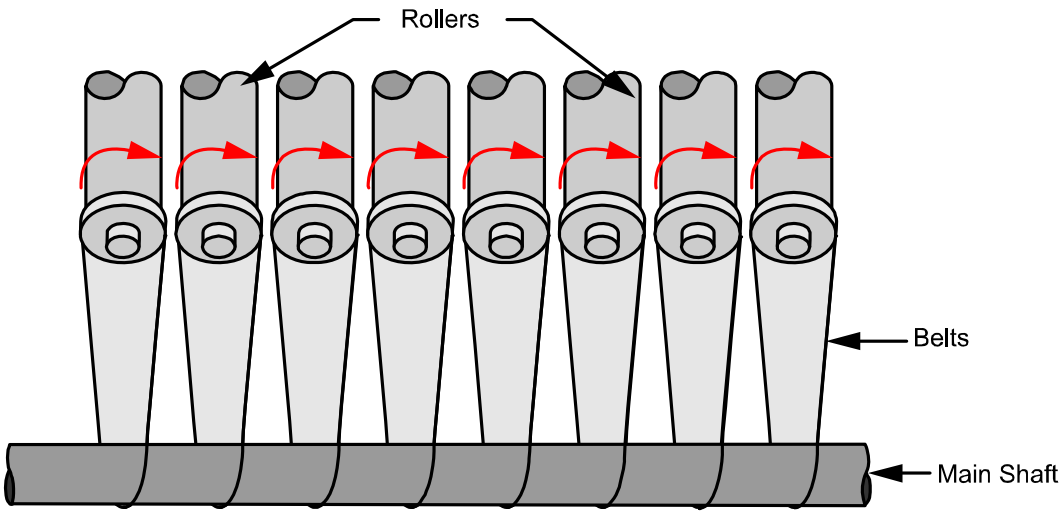


Flat-belt Driven Roller Conveyor

While the flat-belt roller conveyor can move containers in a straight line, the packages must be transferred to another conveyor to make a ninety-degree turn. Curved sections of roller conveyors can be powered by V-belts and a series of sheaves that can carry the belts in a path around the curve.

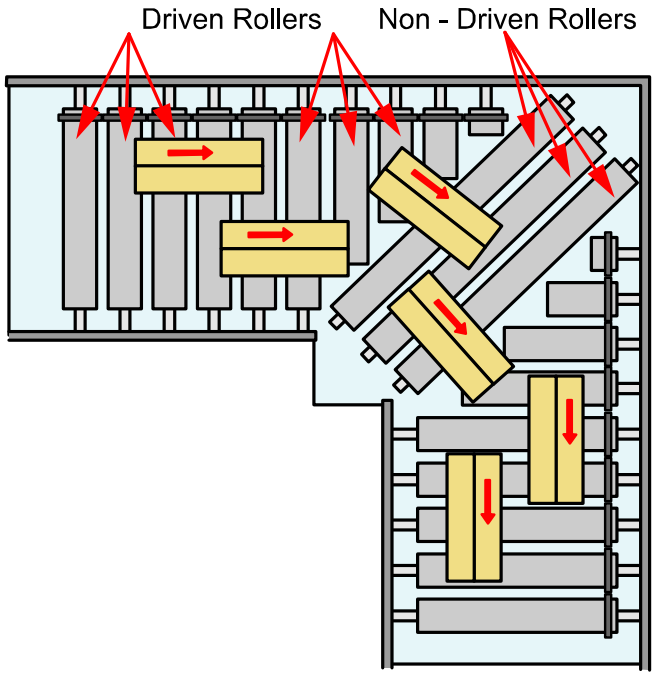
Main Shaft Belt-driven Roller Conveyor

On Main-shaft belt driven conveyors, each roller is connected to the main driveshaft by a separate flexible belt. The driveshaft provides power to the belts that turn each roller separately. When the load on the conveyor is stopped by back pressure the belts can slip on the shafts or the sheaves on the ends of the rollers.



Main Shaft Belt-driven Roller Conveyor

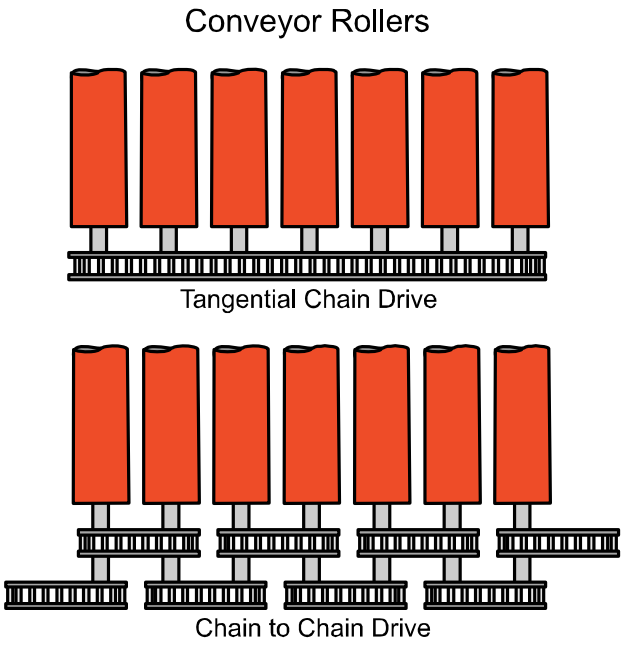
Right angle gearboxes make it possible to turn the driveshafts around ninety degree comers. The illustration below shows how non-driven rollers may be used on a mainshaft belt driven conveyor to carry the conveyed objects around a corner between two sections of individually belt driven rollers.



Ninety Degree Turn Using A Right Angle Gearbox and Non-powered Rollers

Chain Driven Roller Conveyors

The chain driven roller conveyor provides a powerful transporting surface that minimizes slipping. On a chain-to-chain roller conveyor each roller is connected to the rollers on each side of it by short roller chains on the two sprockets on the end of the shaft of each roller. Power applied to the first rollers is transferred to each roller in the line through the chains and sprockets.



Chain Driven Roller Conveyors

A single roller chain that contacts only the top surface of each sprocket and moves them all forward at the same time powers the tangential chain roller conveyor. The chain driven roller conveyors provide positive forward power, and the rollers do not slip when they are exposed to back pressure unless they are equipped with a clutch that will allow slippage.

Progress Check #2

Circle the letter of the correct answer for each question.

1. Roller conveyors may be powered by
   a. gravity
   b. belt or chain drive
   c. gravity or belt or chain drive

2. Conveyor rollers are made of
   a. stainless steel
   b. rubber or plastic
   c. stainless steel, rubber, or plastic

3. Conveyor rollers may be made of corrosive resistant material to protect the
   a. rollers
   b. product
   c. operator

4. The momentum of a container on a gravity conveyor is maintained by the
   a. weight of the container
   b. angle of the conveyor
   c. both the weight of the container and angle of the conveyor

5. A flat belt powers a roller conveyor by
   a. rubbing across the bottom of the rollers
   b. rubbing across the top of the rollers
   c. turning the sheaves on the ends of the rollers

6. Product backup on a belt driven roller conveyor will usually

   a. stop the conveyor

   b. cause the product to fall off the conveyor

   c. cause the product to accumulate on the conveyor

7. On a mainshaft belt driven roller conveyor the rollers are powered by

   a. individual flexible belts

   b. a common long flexible belt

   c. a flat belt

8. A mainshaft belt driven roller conveyor may turn corners by using

   a. non-powered rollers

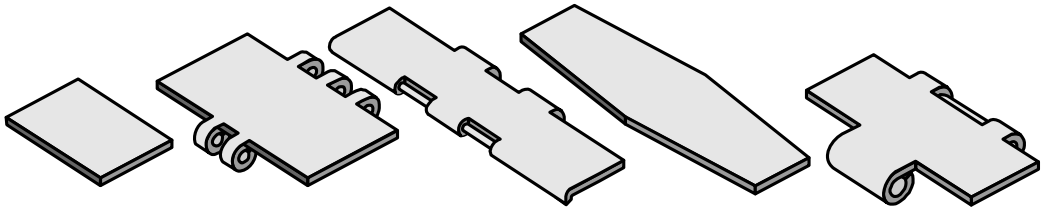
   b. right angle gearbox

   c. non-powered rollers and a right angle gearbox

Chain Driven Conveyors

Chain Conveyors

Chain conveyors are used for transporting product or empty containers to packaging machines and for moving the filled containers and loaded cases away from the packaging machine and through the shipping operations of the plant. Chain conveyors are made with different sizes, shapes, materials, and configurations that make them appropriate for a wide variety of operations. Chain conveyors are made of chain links of many different designs that are is assembled in several configurations. The illustration below shows several chain link plate designs.



Chain Link Plate Designs

Chain link plates are made of many different sizes and shapes. Plate design is determined by the shape of the items to be transported, the support needed for the item, and the direction of movement. Usually strait-line conveyors are made of rectangular plates. Sideflexing conveyors are made of plates that are tapered so that the conveyor chain can flex and travel around corners.

Plate-Top Chain Conveyors

Plate-top chain provides a flat moving surface that acts somewhat like a flat belt conveyor to transport product or a package. Plate-top and mat-top chain conveyors provide a flat conveying surface made of chain links. Clips or hooks may be attached to chains to hold pouches or other items as they are moved. Lugs may be attached to the chain to push the items along.

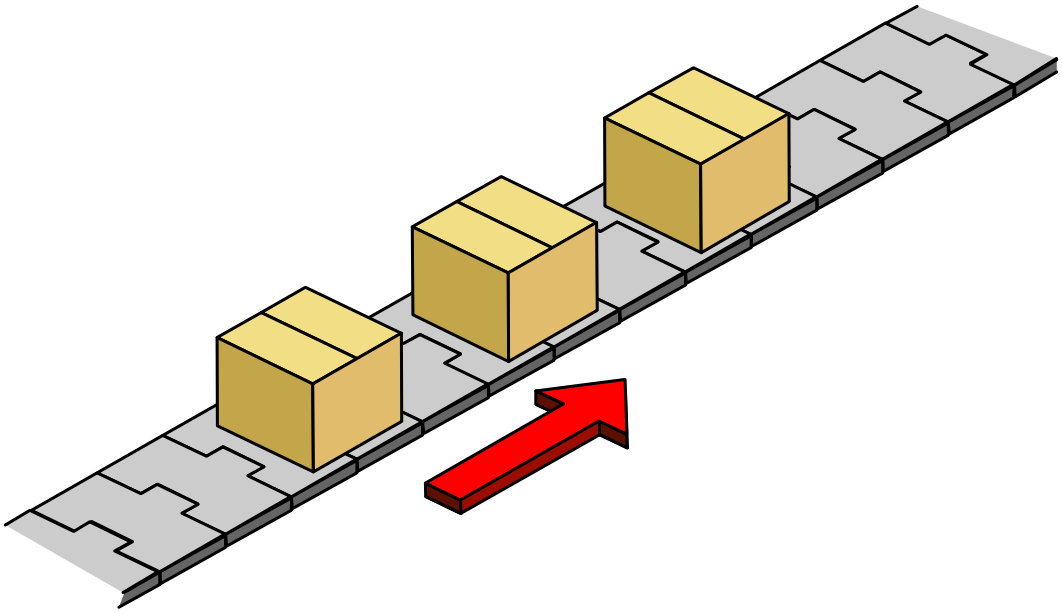


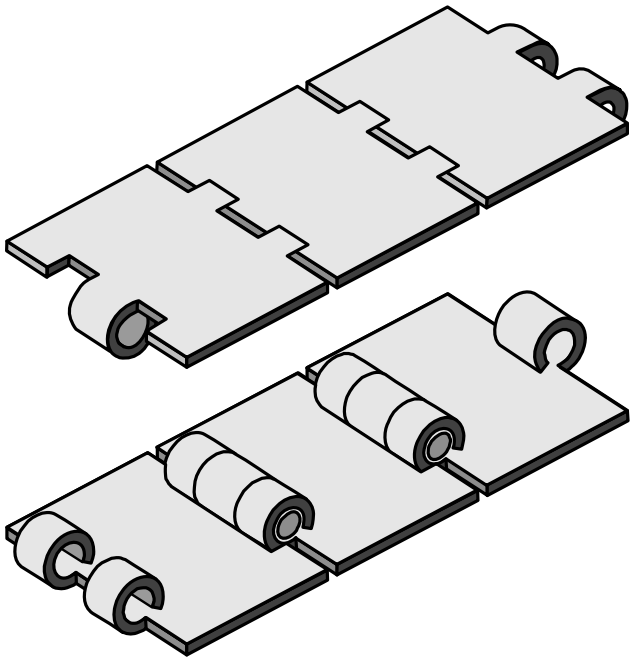
Plate-top Chain Conveyor

The plate-top chain conveyor can be designed to run in a straight line, turn around curves and comers, or move up and down a spiral. Appropriate materials and design can be selected for handling lightweight or heavy items, to operate in wet areas, ovens, freezers and other operations that have special requirements.

The plates and chain components can be made of thermoplastic material, stainless steel, hardened steel, or many other materials. Plate design is determined by the items to be transported, the environmental conditions in which the conveyor will operate, and the directions in which the chain will move. The conveyor chain may be made with a one-piece link or with plates attached to roller chain links.

One-Piece Link Chains

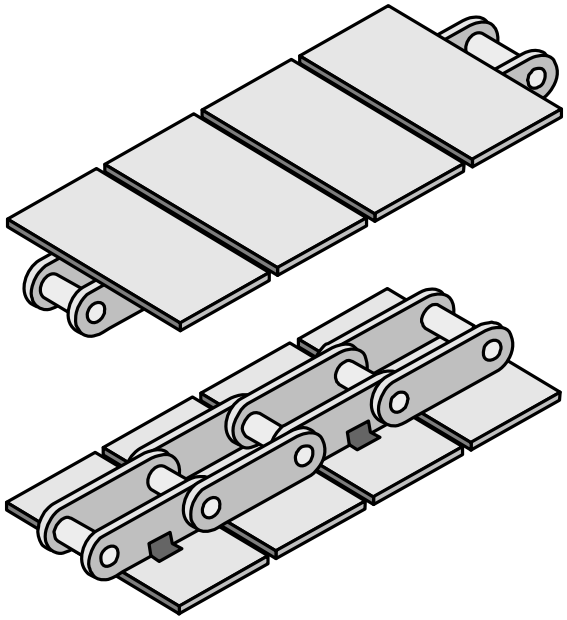
The one-piece link does not have any moving parts. It is formed with the top plate and the chain components all in one piece. It may be made from stainless steel, hardened steel, or thermoplastic material. The links are connected into a chain by pins that pass through the holes in the chain components of each link and hold them together.



One Piece Chain Link

Roller Chain Links

Plate-top conveyor chains are made by attaching the flat plates to the top of roller chain links. The plates may be welded on top of roller chain links or they may be snapped over each link and held in place by the extended ends of the pins in the base chain.



Roller Chain Links

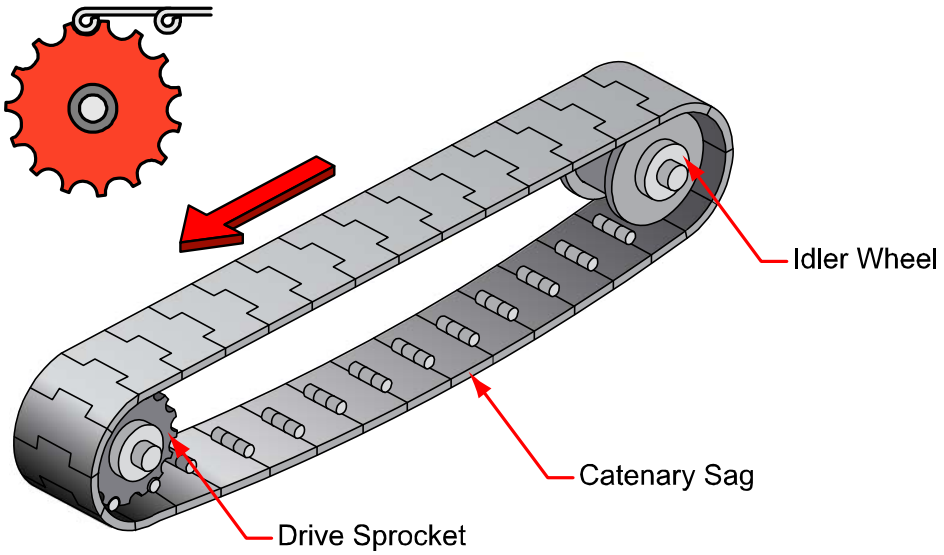
The snap-on plates can be removed from the chain by inserting a screwdriver under the leg of the plate and snapping it off. Damaged plates can be replaced without removing the chain from the conveyor.

Plates For Special Applications

Plates topped with small rollers may be used in operations in which it is desirable to reduce the back pressure to protect fragile containers or meet special requirements of the machine. Conveyor chains used in ovens may need to be made of materials that will not expand or be damaged by the heat. Chains in freezers must not contract too much or break in response to the cold and conveyors in wet applications may need slots or openings to allow the water or air to pass through them.

Chain Drives

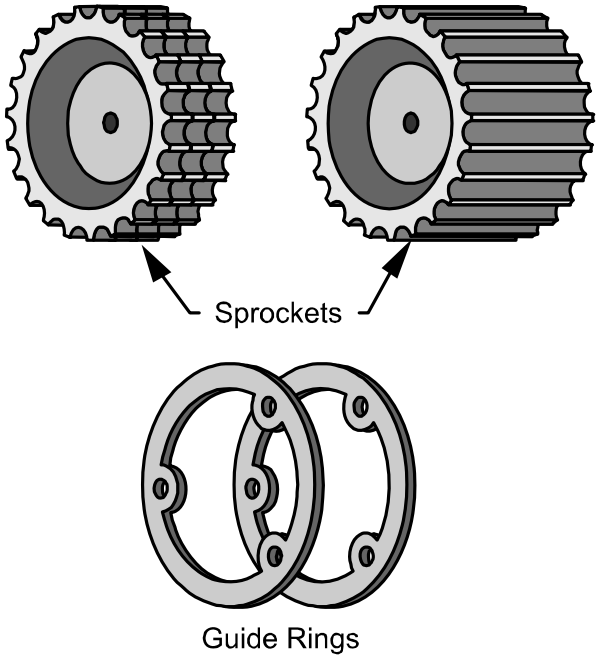
Power to drive a plate-top conveyor is provided from a separate conveyor motor or a connection to the power train of the conveyor line. The power is transmitted to the chain by a sprocket with teeth that mesh with the roller chain links or the projections on the back of the one-piece chain links. The idler wheel in the back end of the chain supports the chain, but it does not provide any power.



Chain Conveyor Belt Drive

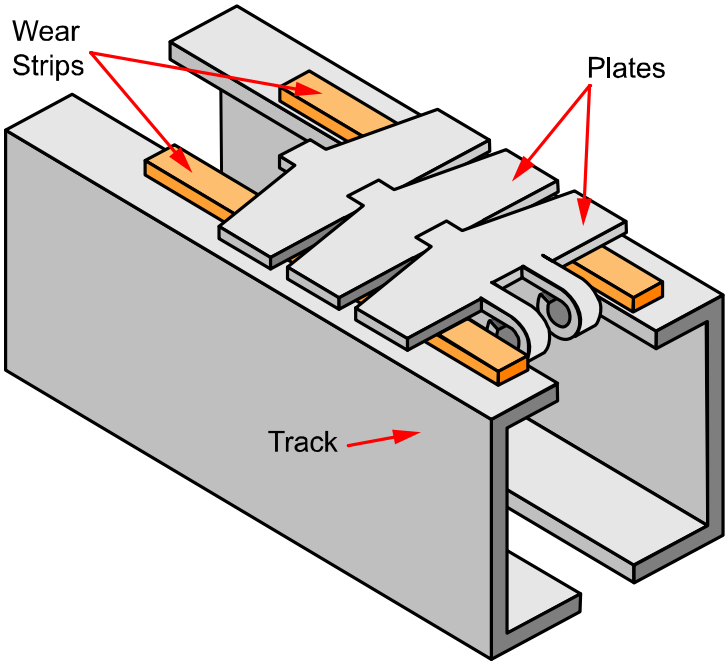
The drive sprocket must be positioned to pull and not push the conveyor chain. Each chain has some slack that will slap the drive sprocket and be difficult to control. Every chain conveyor has a means to adjust and control the slack, called catenary sag, in the return section of the chain between the drive sprocket and the idler wheel. The carrying surface of the chain should always be tight.

The sprockets are shaped for the type of chain on which they will be used. The number of sprockets used in each operation is determined by the width and design of the chain. Roller chains use one sprocket for each chain with closely spaced teeth that fit between the rollers. Sprockets for one-piece link chains are shaped to mesh with the hinge area of the chain. The number of teeth in the sprocket is determined by the spacing of the joints. Some of the sprockets are narrow, some are wide, and some are split. The teeth may be wide or narrow, and they may be close together or far apart. Sometimes guide rings are used to hold the chain on the sprocket and keep it from creeping from side to side.



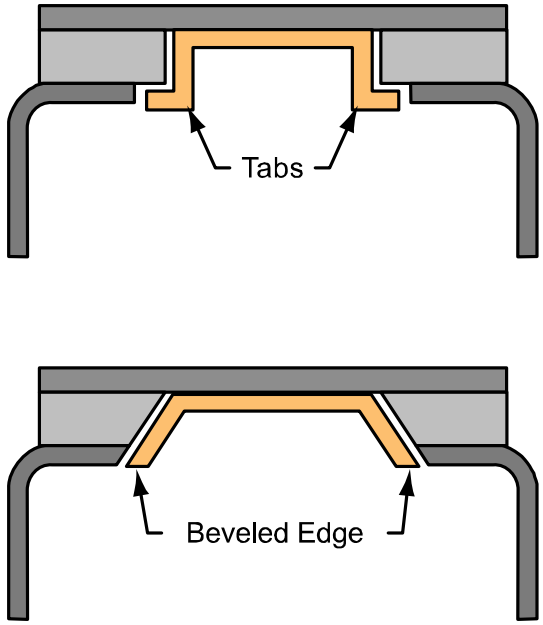
Sprockets For One-piece Link Chain

The moving conveyor chain and its load is supported by the track in the conveyor bed. A replaceable wear strip is mounted between the track and the moving conveyor chain to act as a bearing. The wear strip reduces the friction and prevents excessive wear to the chain and the track. The wear strip is normally made of plastic or soft metal that is easily replaced.



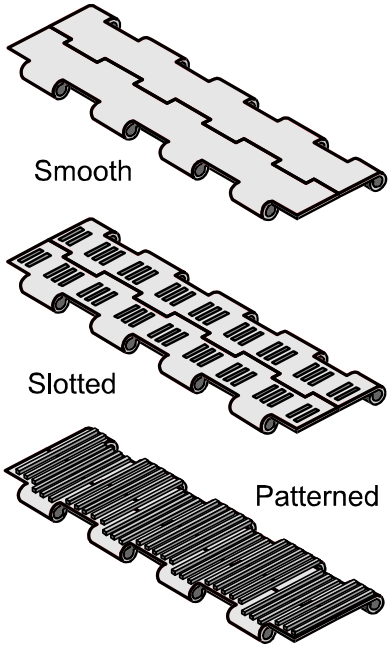
Link Chain Conveyor Wear Strip

Sideflexing conveyor chains can move around curves because the base chains have side flexibility and the corners of the plates have been reduced to allow them to form an arc as they come together. The outside edge of the conveyor chain will rise off the wear strips on the conveyor bed as it makes a turn unless it is restrained. Two of the mechanisms that are used to hold down the conveyor chains in the curves are tabs and bevels. Tabs on the bottoms of the links can ride against the bottom of the wear strips and restrain the rise of the chain in a turn. Matching beveled edges on the wear strips and legs of the chain link are used on some machines to keep the outside edge of the chain from rising as it makes a turn.



Sideflexing Conveyor Chains

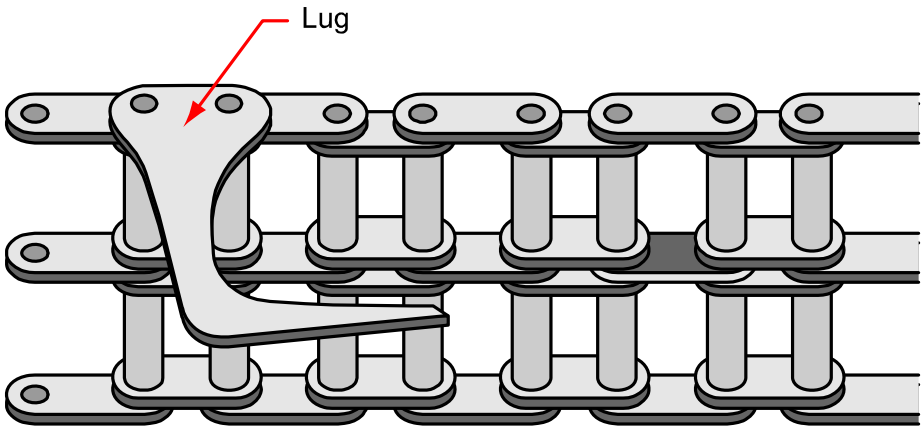
Mat-top conveyor chain plates are made of connected units that provide a wide, continuous, smooth surface for a broad range of conveyor applications. The plates are made in different widths varying from 6 to 72 inches and in lengths up to 10 feet long. They may be made of different materials, different weights of materials, and different surface designs. Special materials may be selected for conveyors to be used with heavy products, long conveyors, high operating speeds, chemical exposure, or extreme temperatures. A solid surface is used for some products while slotted surfaces are used to allow water drainage and air flow. A patterned surface may be used for supporting more unstable products.



Mat-top Conveyor Chain Plates

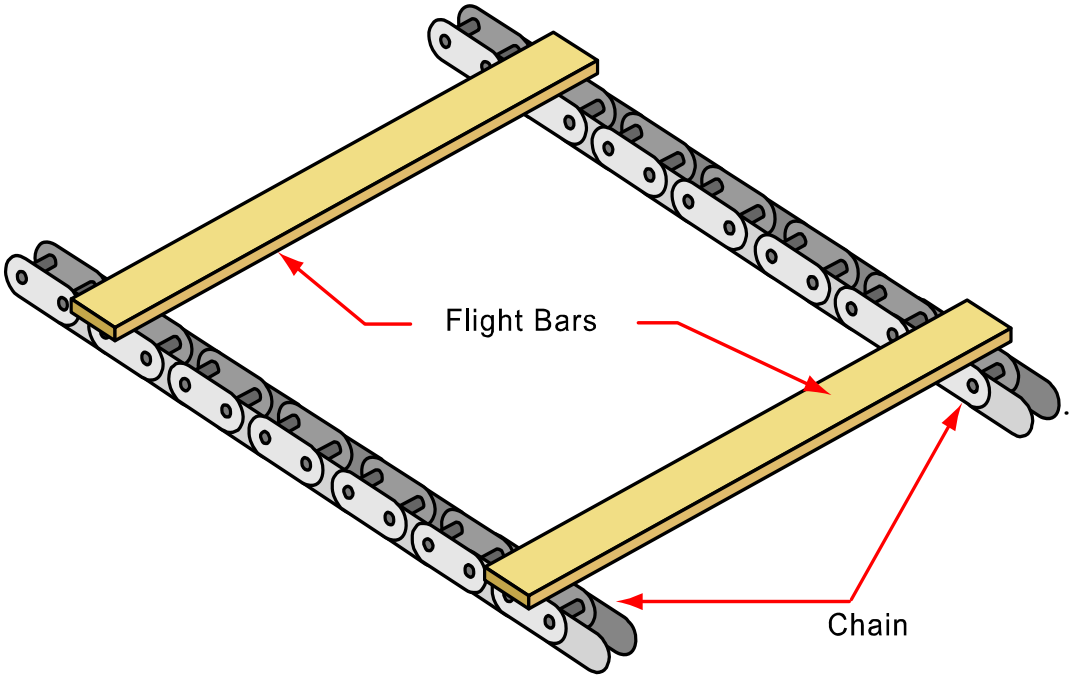
Roller Chain Attachments

Attachments may be added to roller chains to control the movement of product items and containers through a packaging line. Clips may be attached to the chain to carry pouches of product or flexible items into and through a packaging machine. Lugs attached to strands of chain are used to hold boxes and other containers and regular shaped items in position and push them along a conveyor or through a machine.



Clips and Lug Attachments

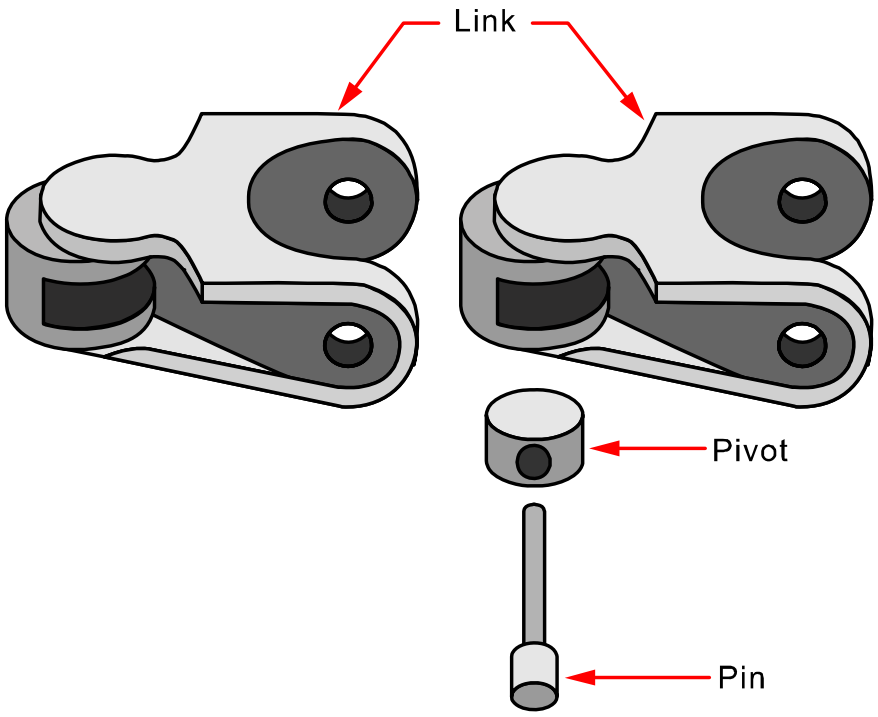
Flight Bars attach two strands of chain by stretching across the width of the conveyor to push the product forward and maintain even spacing between containers.



Flight Bars

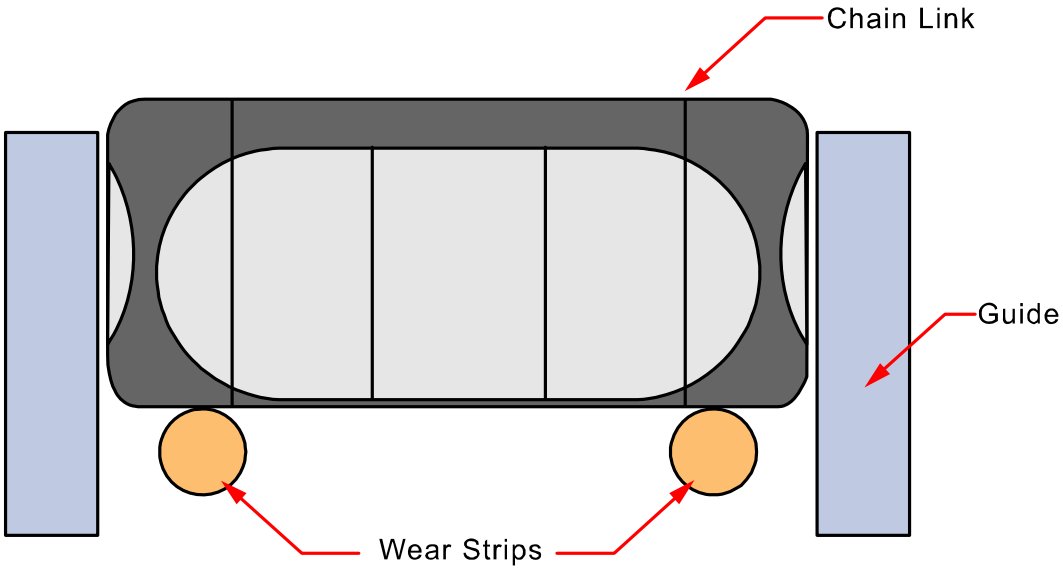
Multiflex Chain

Multiflex chain is made with joints that make them flexible in several directions including side-to-side and up-and-down. The chains are formed with links and pivots that are held together by knurled rivets. The rivets may be removed in order to add or replace links in the chain. The links are made in several sizes and shapes. They have flat tops that can be used to form a conveying surface.



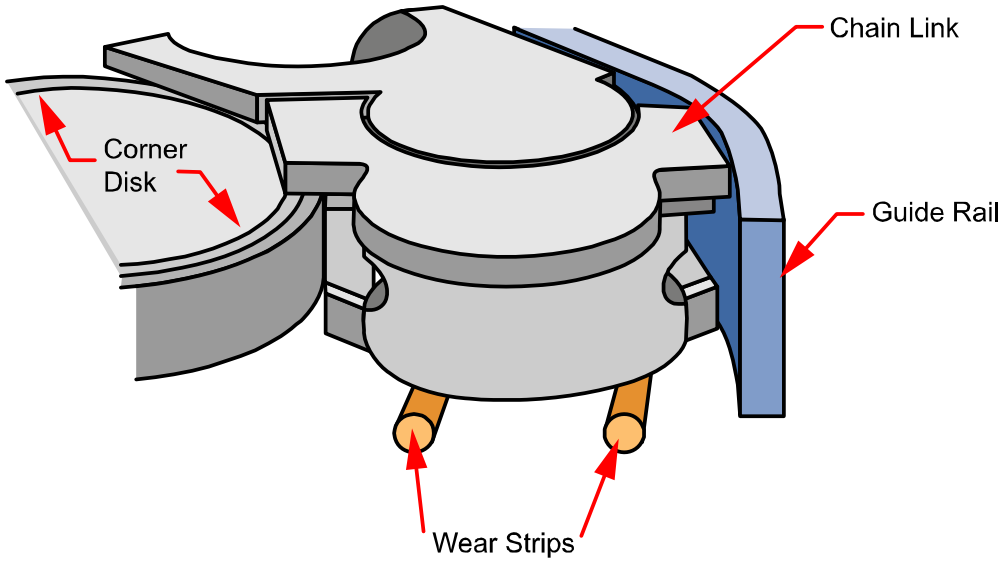
Multiflex Chain

Typically, multiflex chain runs between chain guide rails that are positioned at a level that is below the plate top. This prevents the guide rails from interfering with the movement of products or packages that are wider than the chain links. The chain is supported by the two wear strips that are spaced is varied from side to side to distribute the wear evenly along the bottom of the chain links.



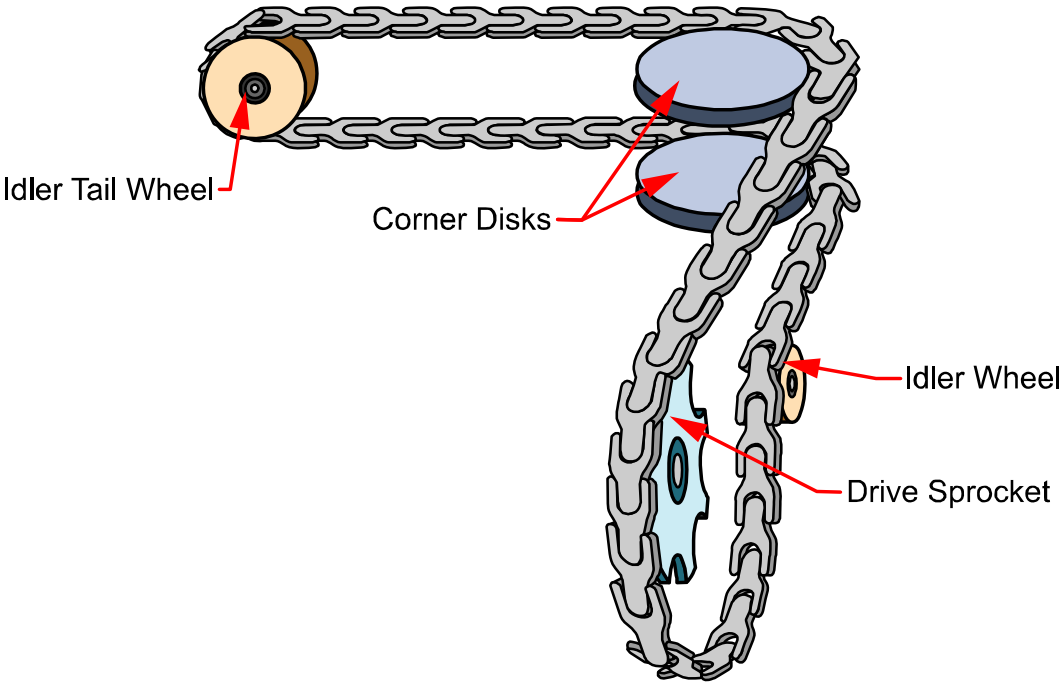
Multiflex Chain Positioned in Guide Rails

Multiflex chain is held down and guided around corners by the corner disk that has an edge shaped to fit into the large grooves in the side of the chain. As the chain passes around a corner the inside edge of each link is meshed with the corner disk and the outside edge is held in place by guide rails. The wear strips continue to support the chain in the turns.



Multiflex Chain Conveyor Rounding a Corner

The illustration below shows multiflex chain that flexes in two directions. The drive sprocket provides power while the back end of the chain is supported by the idler tail wheel. Movement around the corners is controlled by the corner disks and guides, and the catenary sag is controlled by an idler wheel.



Multiflex Conveyor System

Progress Check #3

Circle the letter of the correct answer for each question.

1. Plate-top chains are used on
   a. straight line conveyors
   b. conveyors with curves
   c. both straight line and curved conveyors

2. The links of a one piece link conveyor chain are held together by
   a. roller links
   b. welded joints
   c. pins

3. Snap on plates are attached to
   a. one piece link conveyor chains
   b. roller chain links
   c. both one piece and roller link chains

4. Snap on plates are held on to the chain links by
   a. ends of pins
   b. springs
   c. clips

5. The shape of the conveyor plates is determined by the
   a. weight of items being transported
   b. size of items being transported
   c. curves in conveyor run
   d. all of the above

6. Conveyor chain plates with small rollers on top are used to
   a. increase speed
   b. reduce back pressure
   c. reduce friction

7. Conveyor chain plates may be slotted to allow
   a. air to pass through
   b. water to pass through
   c. either air or water to pass through

8. Conveyor chain sprockets should be positioned to
   a. pull the conveyor chain
   b. push the conveyor chain
   c. pull and push the conveyor chain

9. The back end of a conveyor chain is normally supported by
   a. a sprocket
   b. an idler wheel
   c. wear strips

10. Guide rings may be installed on conveyor sprockets to
    a. adjust the position of the conveyor chain
    b. prevent chain slippage
    c. prevent sideways creeping of the chain

11. Wear strips are used on plate-top chain conveyors to prevent excessive wear of the

    a. chain

    b. track

    c. chain and track

12. Wear strips are normally made of

    a. stainless steel

    b. rubber

    c. soft metal or plastic

13. The wear strips and bottoms of the chain links may be beveled to prevent the

    a. outside of the chain rising in the curves

    b. body of the chain rising at high speeds

    c. chain creeping sideways

14. A section of mat-top conveyor chain is usually several

    a. inches long

    b. feet long

15. Multiflex chains are flexible

    a. only from side to side

    b. only up and down

    c. both from side to side and up and down

16. Multiflex chains ride in guide rails that are
    a. higher than the chain
    b. even with the top of the chain
    c. below the top of the chain

17. Multiflex chain links are made
    a. in one piece
    b. with links and pivots
    c. with roller links and plates

18. Multiflex chains are guided around corners by
    a. corner disks
    b. beveled wear strips
    c. curved tracks

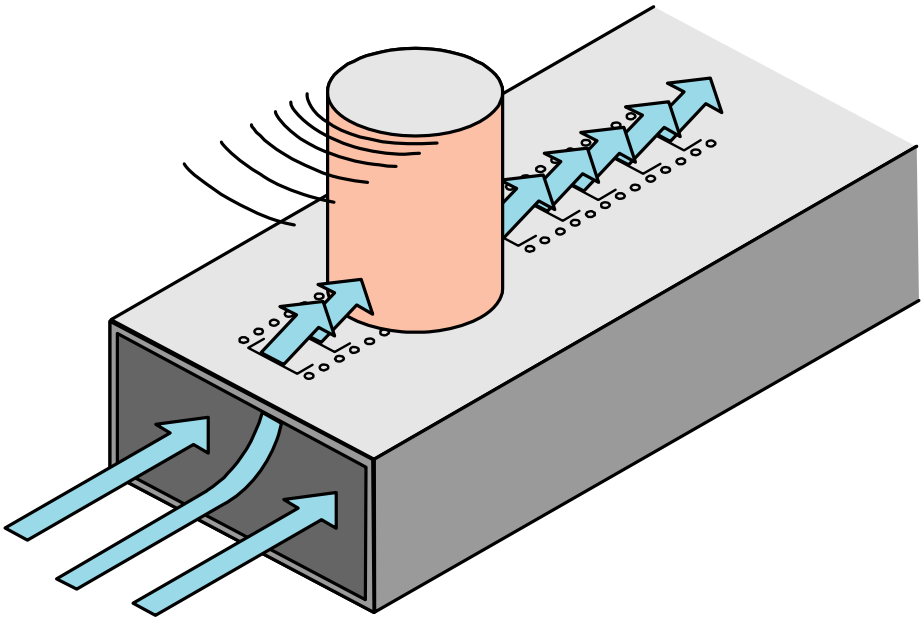
19. A smooth carrying surface is provided on multiflex chains by
    a. the top of the chain
    b. plates snapped onto the chain
    c. plates welded onto the chain

20. The spacing of wear strips for multiflex chains is varied to
    a. evenly distribute the wear on the bottom of the chain
    b. produce a smoother movement
    c. prevent the chain from rising in the turns

Notes:

Air Conveyors

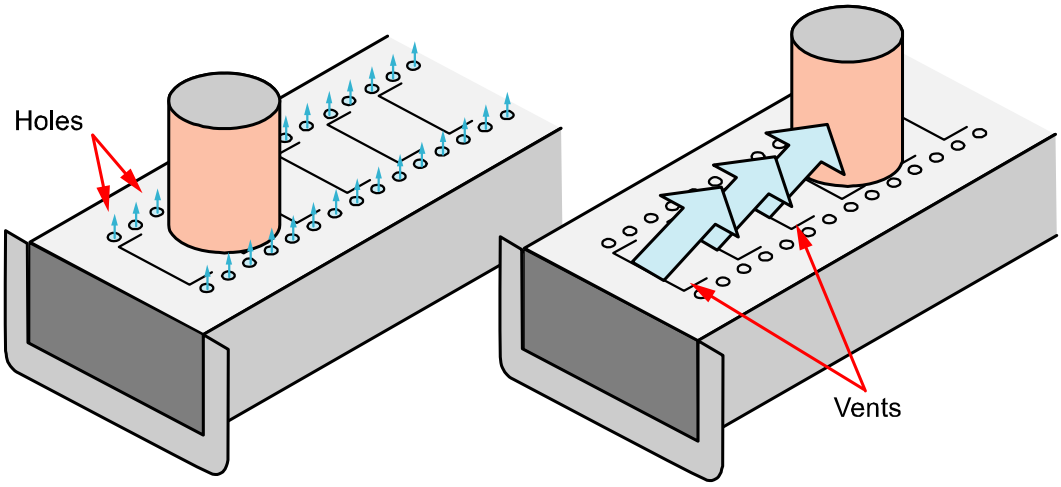
Air conveyors support the items being transported and move them forward on a curtain of moving air. Air conveyors are used to transport empty containers, caps and closures, product items, and lightweight filled containers through packaging lines. The air film moves the conveyed items at high speeds on a frictionless surface. These conveyors can support and transport items that weigh up to five pounds per square foot.



Air Conveyor

When the demand for the product or container is stopped or slowed down in the operating unit following the conveyor, the items on the conveyor will hover slightly above the conveyor deck, and the forward movement will stop until the lead items can be accepted. Air conveyors can operate in straight lines, around corners, and up and down inclines. Bulk materials can be transported on air conveyors. The items float on a film of high speed air that is delivered through vents in the deck of the conveying surface.

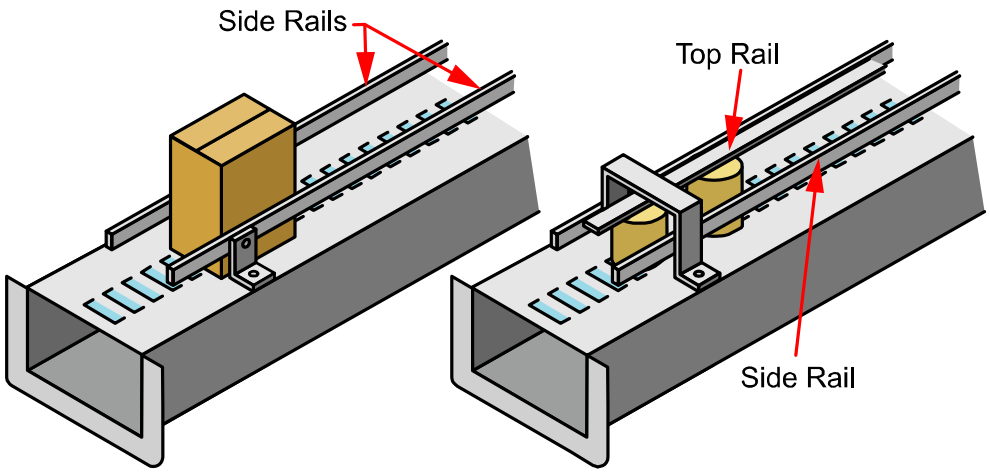
The only moving parts of the air conveyor are the fan and the air. A fan drives a volume of air into the ducts, or plenums. The air forms a moving film or cushion of high speed air as it escapes through the vents and holes in the deck of the conveyor. The air that rises straight up through the holes will support the items above the bed of the conveyor and allow them to hover slightly above the conveyor deck. The air that passes through the directional vents strikes the items at an angle and moves them forward. The size and shape of the vents and the pattern of vents and holes that is used is determined by the size, shape, and weight of the items that are to be transported. The deck may have only vents in on-feed points, discharge points, inclines, and other areas in which greater drive is required. There may be a mixture of vents and holes in areas in which there is need for less drive and more flotation, and there may be only holes in declines and other areas in which there is a need for flotation but not for drive.



Air Conveyor Deck

The amount of air that is consumed is controlled by the number and size of the openings in the deck and the operating pressure. The operating pressure is usually significantly less than one pound per square inch (psi). The air consumption is measured in cubic feet per minute (cfm). For a given deck design, the air consumption increases as the air pressure increases.

Side guide rails may be sufficient for filled cartons and other stable objects, but top guide rails may also be needed for items that are light enough to float off the conveyor. The tolerances between the guide rails and the items on the conveyor must be set to permit the object to float along on the air film, but they must be close enough to keep it under control and in the proper orientation. Guide rails may be made of polyethylene or stainless steel.



Air Conveyor Guide Rails

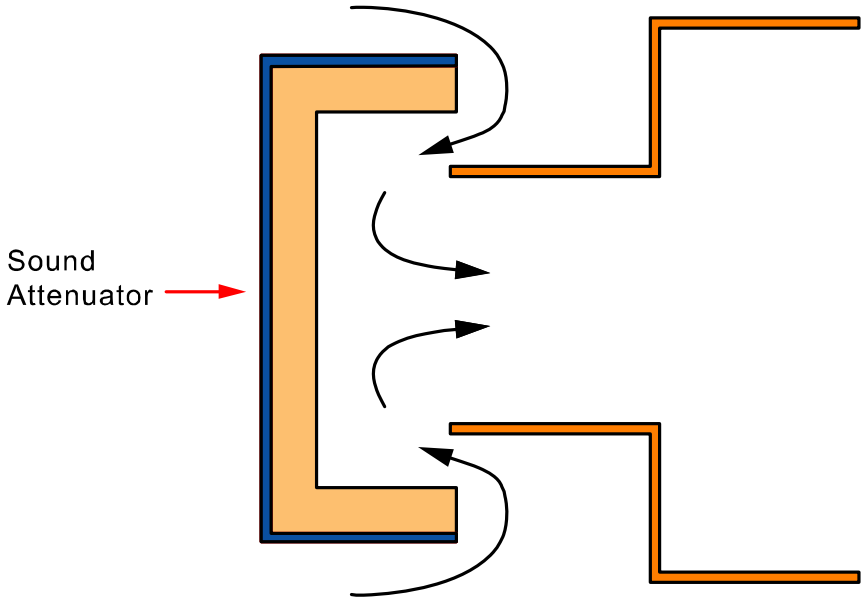
Air Ducts

The ducts, or plenums, carry the air from the fans to the ports in the decks. The size of the ducts is selected to provide the constant operating pressure and air velocity that is needed inside the ducts. The fan is most efficient when it is located near the midpoint of the zone it powers because half of the air goes in one direction and half in the other. The shape of the vents in the deck directs all the air in the same direction as it moves onto the deck surface of the conveyor. The operating pressure of the system can be adjusted with dampers that are installed in the air ducts. The volume of air flow and the air pressure can be decreased by partially closing the dampers and restricting the area through which the air will pass. Dampers are normally located near the fan, but they can also be located at any point in the conveyor duct where pressure adjustment is required.

Pressurized air is supplied to the air conveyors by one or more fans connected to the ducts. A single large fan may operate a complete air conveyor system or smaller fans may be installed at isolated sections. The fans may be positioned below, beside, or above the conveyor, and they may be located in another room. The volume of air that is moved and the amount of air pressure that fan produces is affected by the design of the blades and the speed of the motor. Centrifugal fans with backwardly curved blades are frequently used in systems that require large volumes of low-pressure air. Centrifugal fans with flat blades are used in systems that require smaller volumes of air at fairly high pressures. Flexible connections are used to attach the fans to the air ducts to isolate vibrations from the motor from the duct.

Sound Attenuators

Sound attenuators may be attached to the air inlet of the fan to dampen the sound generated by the fan. The sound attenuators are cylindrical caps that are lined with sound absorbing material. The air makes two 180-degree turns around the sound absorbing material as it passes through the cap and enters the fan. The sound attenuator can reduce the noise produced at the fan inlet by approximately fifty percent.

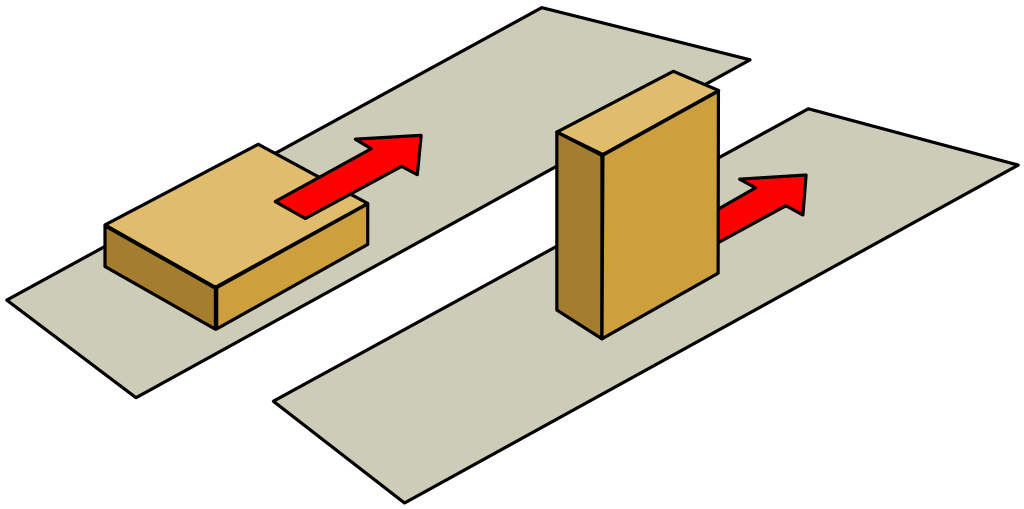


Sound Attenuators

Air filters may be attached to the inlet of the fan to prevent particles that are in the air from entering the conveyor. The filter housing is attached to the inlet of the fan to hold the filters. Disposable furnace filters normally provide sufficient protection but more sophisticated filtration devices are used in special situations. The filters and the dust they collect tend to restrict air flow so the fan must have the capacity to compensate for this reduction in air flow. The filters must also be replaced or cleaned frequently enough to prevent the accumulation of dust and dirt from interfering with conveyor operation.

The amount of air pressure that is needed in an air conveyor is affected by the weight of the conveyed items, the shape of the container bottom, and the orientation of the items. The amount of air pressure required increases as the weight of the item increases. The air conveyor can normally transport items that weigh up to five pounds per square foot. The shape of the bottom affects the distance that the conveyed item must be raised above the deck. For example, a convex or uneven container bottom must be floated higher above the deck before it will move. The container with a flat bottom will move at a lower level using lower air pressure.

Container orientation also has a big effect on the conveying requirements because of the amount of surface that makes contact with the air. The item turned or flat side in the illustration below has the weight distributed over a larger conveying area than it does when it is turned on its end.



Container Orientation

Since air conveyors are limited to containers that weigh 5 pounds per square foot or less, it is better to expose the largest possible container area to the deck and divide the total weight by the greatest area.

Progress Check #4

Circle the letter of the correct answer for each question.

1. The moving parts of an air conveyor are the
   a. deck and compressor
   b. air and fan
   c. rollers and fan

2. Air moving through round holes in the deck of an air conveyor
   a. support the item
   b. move the item forward
   c. both support the item and move it forward

3. Air moving through vents in the deck of an air conveyor
   a. support the item
   b. move the item forward
   c. both support the item and move it forward

4. Top rails are needed on air conveyors carrying
   a. any item
   b. heavy items
   c. light items

5. The fan on an air conveyor is most efficient when it is connected to the

   a. leading end of the a conveyor duct

   b. center of the conveyor duct

   c. trailing end of the conveyor duct

6. The volume of air that is produced by a fan is affected by the

   a. shape of the blades

   b. speed of the motor

   c. shape of the blades and speed of the motor

7. Backward curved fan blades are used on fans that produce

   a. large volumes of low pressure air

   b. small volumes of high pressure air

   c. large volumes of high pressure air

8. Flexible connections are used between the fan and ducts to

   a. prevent transmission of vibration

   b. reduce intake noise

   c. permit easy adjustment

9. Sound attenuators are used on air conveyors to reduce noise produced

   a. at the fan blades

   b. by the fan intake

   c. by air passing through the deck vents

10. Transporting a flat bottom box on an air conveyor requires

    a. less air pressure than a convex bottom box

    b. the same air pressure as a convex bottom box

    c. air pressure than a convex bottom box

11. A box is more easily conveyed on an air conveyor when it is turned with

    a. the smallest side down

    b. the largest side down

    c. the largest side against the guide rail

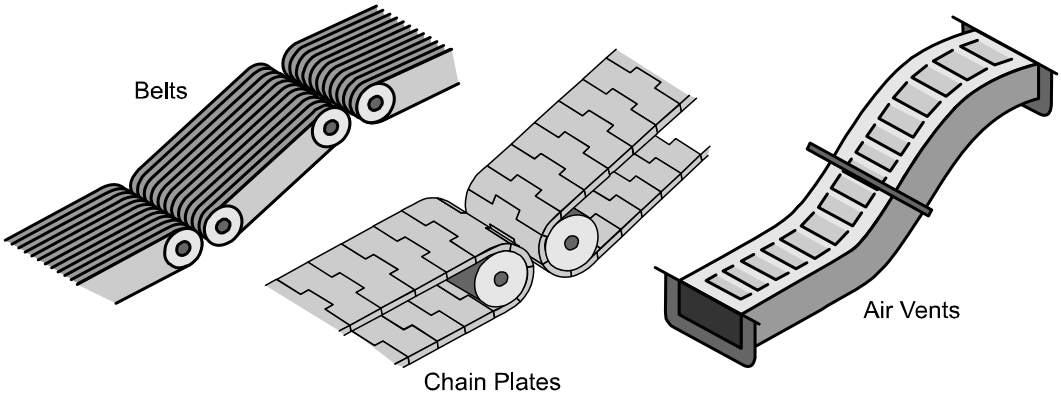
Notes:

Elevating Conveyors

Elevating conveyors can be used when conveying operations require containers to be moved from one level to another. Elevating conveyors may be used to deliver product into the packaging machine and to transport it to the height of the filler input area as well as to deliver the empty containers into the machine and carry filled containers away from the packaging area and into the delivery area of the plant. The different types of elevating conveyors include inclines, spiral conveyors, vertical belts, bucket conveyors, and elevators.

Incline Conveyors

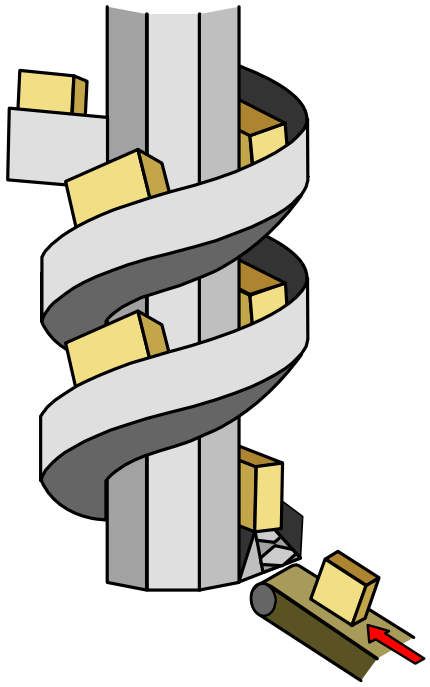
Flat belt, chain, and air conveyors can be operated on an inclined angle to carry the product or containers to a higher level. The angle of the incline is restricted to the angles at which the conveyed items will move forward and not slide backward on the conveyor. Some incline conveyors are equipped with tabs or flight bars that hold the product or containers in place and prevent slipping.



Incline Conveyors

Spiral Conveyors

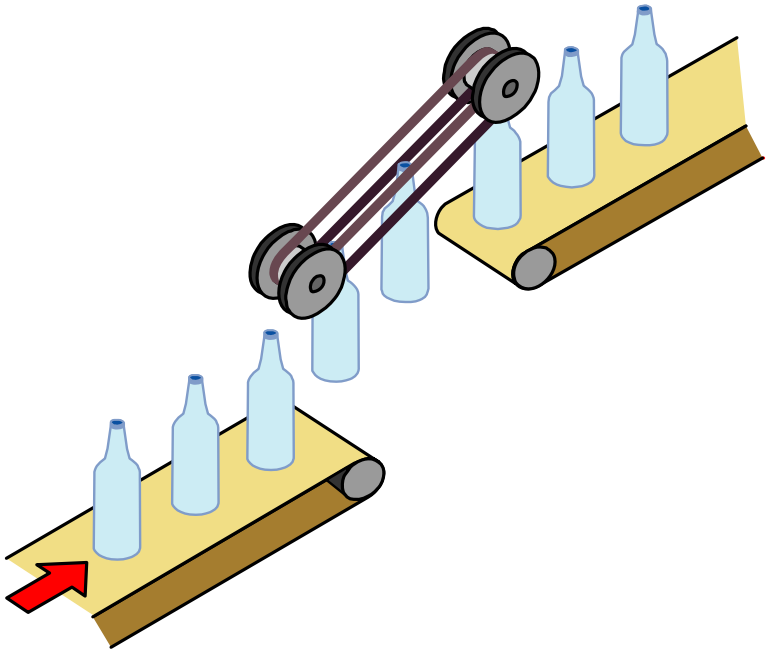
Spiral conveyors and other types of elevators may be used to carry containers and packages over aisles and to other work areas. Plate-top chain conveyors may be turned in a spiral to carry the conveyed items up to the desired level. Spiral conveyors turn in a spiral that slowly climbs up to a higher level where the containers are transferred to another type of conveyor system.



Spiral Conveyor

Vertical Belt Conveyors

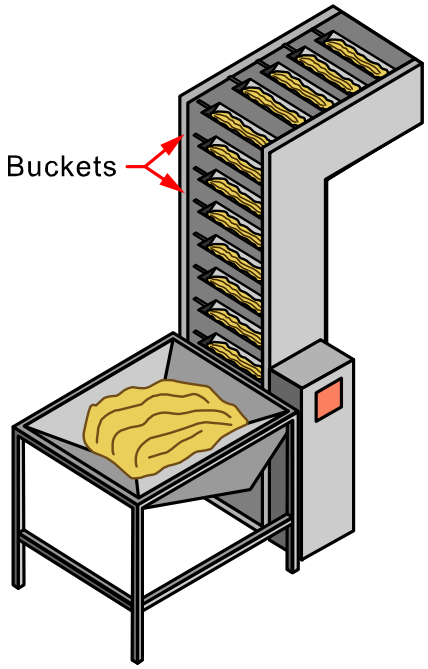
Pairs of horizontal belts may be used to elevate some types of containers. Bottles, cans, and similarly shaped items can be conveyed between two vertical belts while being held in place by friction. The size and design of the belt vary with the size, shape, and weight of the conveyed items.



Vertical Belt Conveyor

Bucket Conveyors

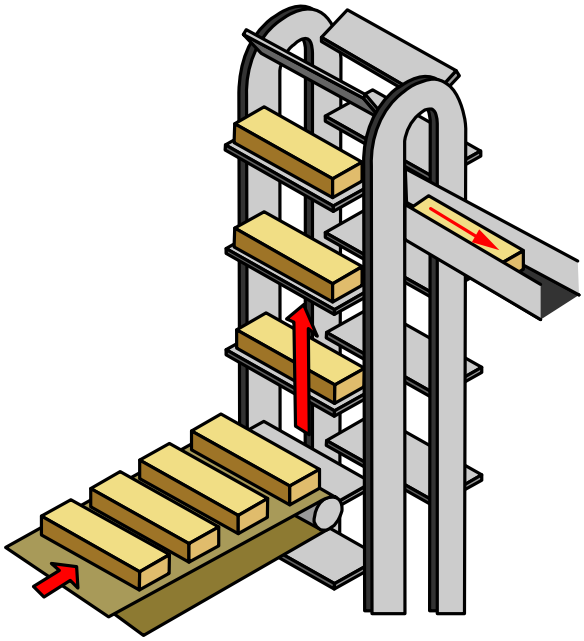
Bucket conveyors are used to raise the product to a higher level that may be needed to deliver it into the filler or other elevated machine unit. Bucket conveyors are used to transport dry product or solid objects from a low level infeed conveyor up to the top of a hopper where the product is dumped. The material or items are loaded into the buckets by the infeed conveyor, and the buckets are carried to the top of the conveyor by two sprocket driven chains. The load is dumped from each bucket as it is passed over the top of the conveyor and starts down the back to return for another load.



Bucket Conveyor

Elevators

Elevators carry individual items upward in a manner that is similar to the bucket conveyors. The conveyed items are set on shelves or held by clamps as they are carried upward. Usually the items are then normally transferred to another conveyor that will carry them forward as they cross the top of the elevator.



Elevator

Progress Check #5

Circle the letter of the correct answer for each question.

1. Long-necked bottles are elevated by
   a. vertical belts
   b. bucket conveyors
   c. elevators

2. The surface of a spiral conveyor is normally made of a
   a. flat belt
   b. plate-top chain
   c. rollers

3. The primary use of loops on vertical conveyor belts are to
   a. make the belt stronger
   b. make the belt more rigid
   c. hold the product more firmly

4. Granulated product would be elevated to the filler hopper with a(n)
   a. elevator
   b. bucket conveyor
   c. spiral conveyor

5. Flight bars are used on inclined flat belt conveyors to
   a. support the belt
   b. keep the product from falling off the side
   c. keep the product from slipping

Accumulators

Accumulators are installed at various points along a line to maintain an even flow by gathering excess product that is produced by one unit and holding it until it is needed by the next unit in the line. Accumulators are used in packaging lines to provide temporary storage of excess product. Using accumulators evens the flow of product through each of the machine units and minimizes the interruptions that may be caused by malfunctions or machine shutdowns for clearing jams and making minor adjustments. Accumulators are used on packaging lines to provide time cushions that will give the operator an opportunity to clear a jam or make an adjustment without having to stop the entire line. If an upstream unit is stopped briefly, the packages in the accumulator are fed into the line to keep the downstream units operating. If a downstream unit is stopped or the inspection station falls behind the accumulator temporarily stores the packages and prevents the necessity of stopping the upstream units. The length of the time cushion is determined by the capacity of the accumulator and the speed of the packaging line.

Accumulators are used to hold the packages in position in the line to allow time for drying or other operations that may have a time requirement. Accumulators may also be used to gather the completed packages for case packing, bundling, or other staging for shipping.

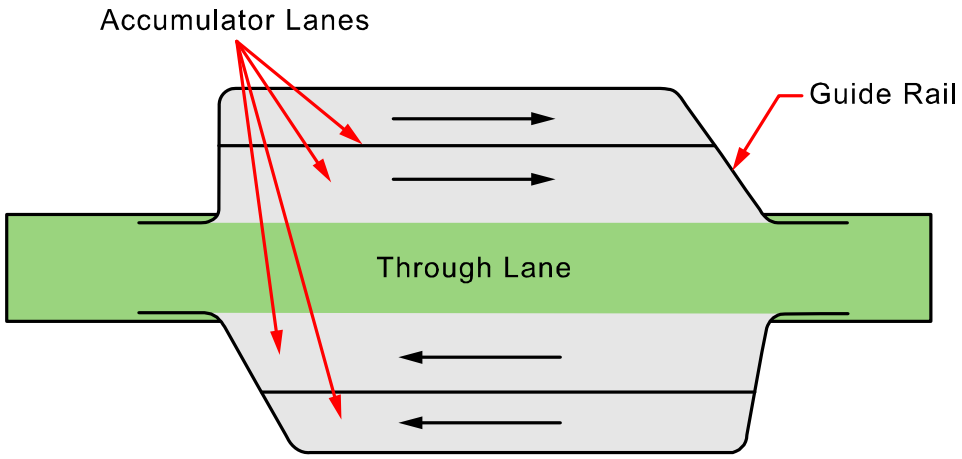
Accumulators may be installed in-line or off-line. The in-line accumulators provide storage that is integrated directly into the packaging line while off-line accumulators divert the excess product into accumulator areas that are used only when product is backing up on the line.

The order in which the product is fed back into the line can be an important consideration on some operations. Some accumulator designs provide a first-in, first-out operation in which the items leave the accumulator in the same order in which they entered. Other accumulators operate on a last-in, last-out sequence in which the first items remain longer than the later ones. Enmasse accumulation moves the product in the accumulating area so that they do not maintain the position in which they enter the accumulator and the items are fed back into the line more or less randomly.

Four basic types of accumulators are accumulator tables, rotary accumulators, serpentine accumulators, and multi-lane accumulators.

Accumulator Tables

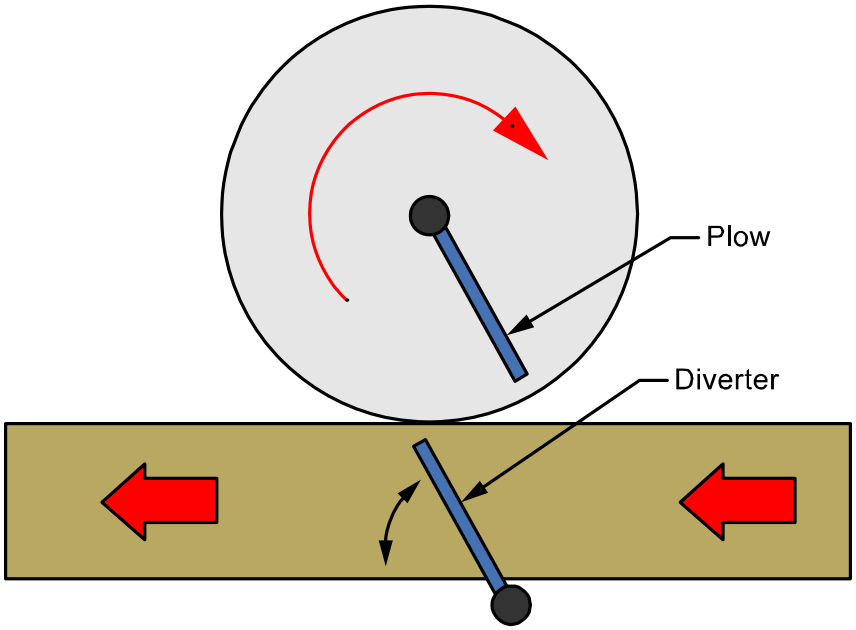
Off-line intermittent motion accumulator tables can be installed alongside the conveyor where it can be operated to receive excess product when a problem occurs downstream and the product backs up. When a backup is detected by the sensors, the table is activated and the product is carried onto the table as it is pushed off the line by the back pressure. The table motion is stopped when a limit switch or sensor indicates that the table is full or when the photoelectric cell or another sensor indicates that the product is no longer moving from the line onto the table. When the downstream jam has been cleared, the flow on the conveyor will resume. Limit switches or other sensors will detect openings in the line and operate the table to feed the product back onto the conveyor as space becomes available. The same type of table can be used for unscrambling and feeding empty containers into the packaging line.



Accumulator Table

Rotary Accumulators

Rotary disk accumulators are used for off-line and in-line accumulating. Rotary accumulators are rotating disk tabletops that store excess product or containers and release them into the conveyor stream when they are needed. Rotary accumulators are normally used with cylindrical items that are under five inches in diameter. When a rotary accumulator is used off-line, a downstream product or container backup caused by a stopped unit activates a switch to move a diverter across the conveyor to direct the incoming product or containers onto the rotating disk. As the product or containers accumulate on the disk they are held in position by the plow which is a spring steel arm attached at the center of the disk. When the product or containers are needed in the downstream units, the diverter is opened, and the conveyor carries the items past the accumulator and into the downstream units. The items on the rotary accumulator disk are guided back onto the conveyor by the plow as space becomes available in the line. The rotary accumulators store all the items together so there is no specific order in which they are returned into the conveying line.



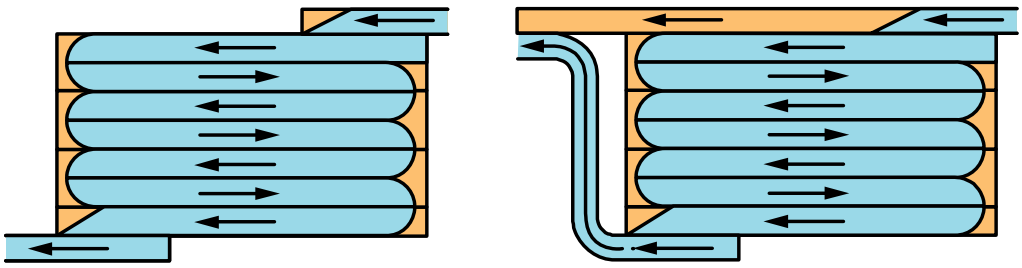
Rotary Accumulator

When the upstream units are expected to have some downtime the accumulator can be loaded with product that can be used to feed the downstream units while the upstream units are not operating.

In the normal operation of an in-line rotary accumulator, each product item will pass from the conveyor onto the disk and move around the outside edge and back onto the conveyor. Items that cannot be accepted immediately by the downstream units are collected on the disk and held until they are needed. The position and movement of the items on the disk is controlled by the plow.

Serpentine Accumulators

Serpentine accumulators store the conveyed items in a series of turns in the conveyor. These accumulators can be used with rectangular, square, and irregularly shaped items that may be difficult to handle in other types of accumulators. The in-line serpentine accumulator provides all its storage in the main line of the conveyor. It can be used to hold the product or package for a time period needed for drying or other operations and it allows an accumulation of product or containers to compensate for surges or short downtimes in the operation of the machines in the line. The first items in are always the first items out and all the items have to pass through the accumulator in sequence.

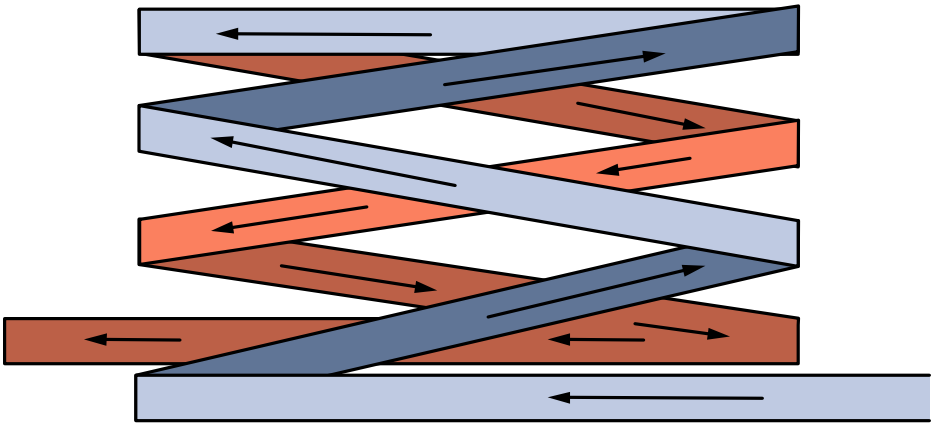


Serpentine Accumulator

The off-line serpentine accumulator takes excess items from the line and stores them off-line until they are needed. This is a first-in, first-out operation for the items that enter the accumulator, but all the items in the line do not go through the accumulator.

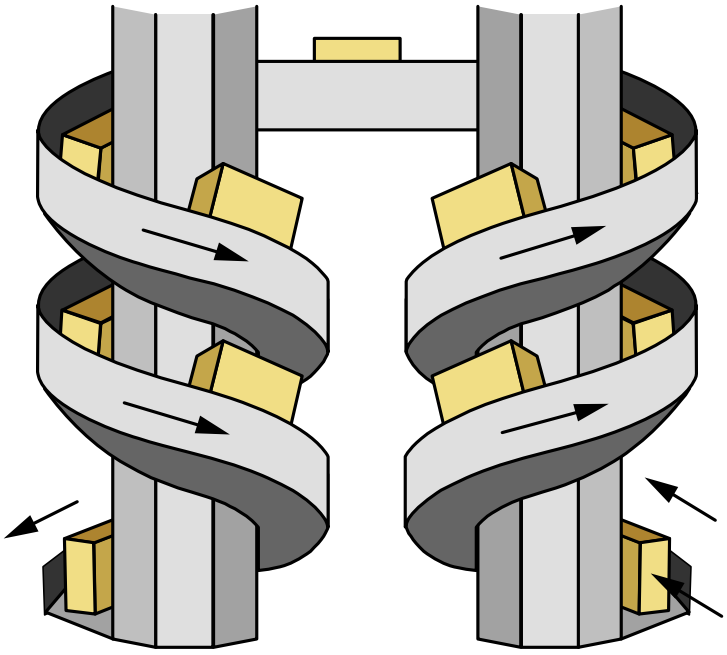
The serpentine sections of the conveyor may be on a flat surface or they may form a stack that carries the product or containers up and down a series of inclines.

The stack accumulator increases the storage capacity in a limited floor space.



Stack Accumulator

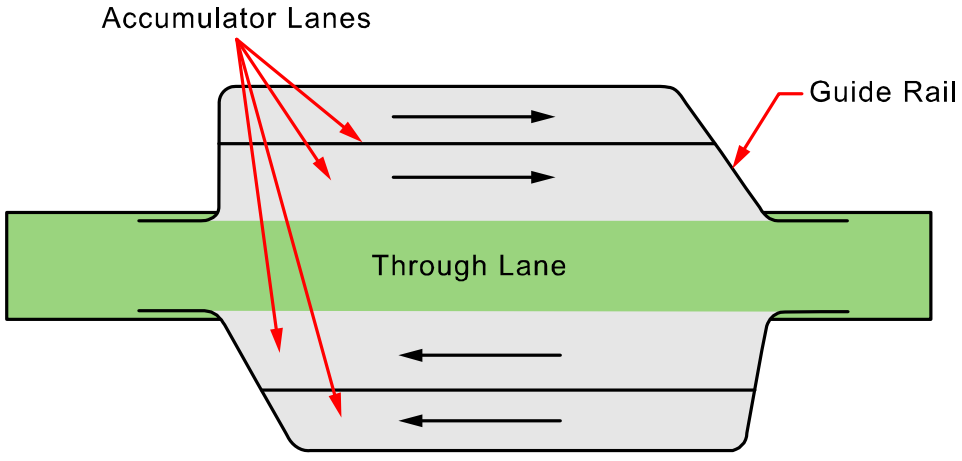
The spiral accumulators operate in the same manner as the stacked serpentine accumulators except they carry the items up and down in a spiral pattern.



Spiral Accumulator

Multi-lane Accumulators

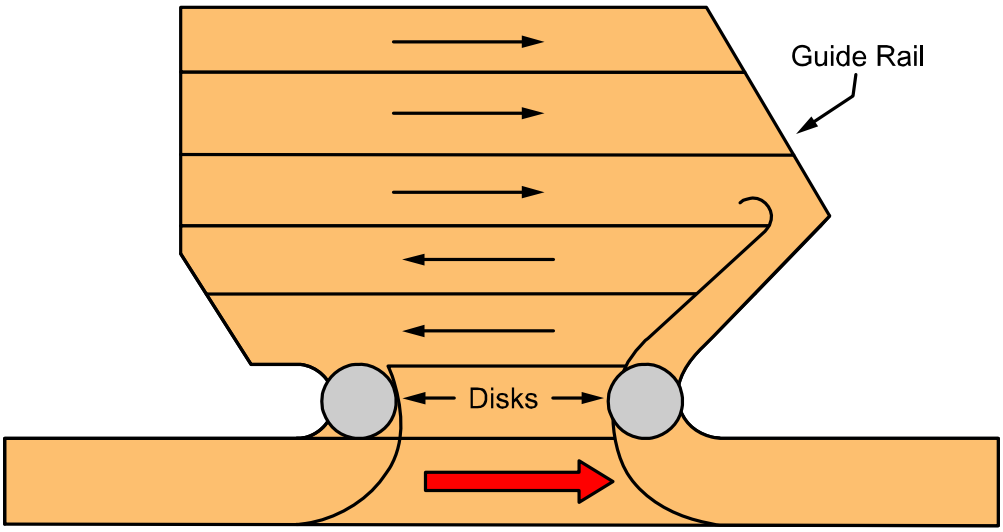
Multi-lane accumulators provide a straight-through path for product flow under normal conditions and provides temporary storage on parallel lanes when a jam-up occurs. Multi-lane accumulators operate best with cylindrical items but they may also be used with rectangular or square shapes. They can be used on high-speed lines. The number and length of lanes that are used is determined by the speed and storage requirements of each application. The accumulator shown below has a through lane and two accumulator lanes in each direction. When a jam-up occurs the items on the conveyor back up on the through lane and the back pressure diverts some of them onto the adjacent lane that is moving in the opposite direction. Guide rails direct the flow during the accumulation so that it is continuously circulating on the lanes. If the reverse direction lanes are filled before the jam-up is cleared the back pressure pushes the items on the accumulator lanes through the line on the through lane and onto the accumulator lanes that are moving in the same direction as the through lane.



Multi-lane Accumulator

Once the jam-up is relieved the through traffic resumes, and the accumulated items are guided back into the line as space becomes available on the through line conveyor. The multi-lane accumulator fills and empties automatically without the use of sensors or control devices. All the accumulated items are stored together and kept constantly circulating so that they are fed back onto the through lane in an irregular order without regard to the order in which they came into the accumulator.

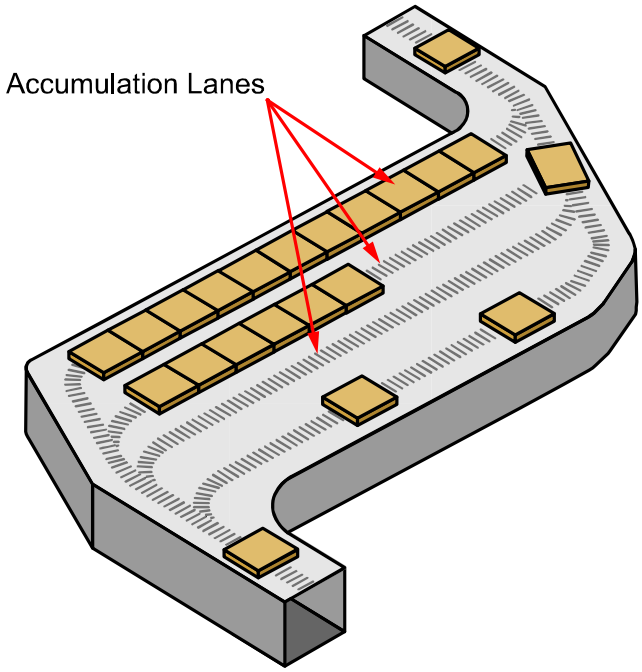
The multi-lane conveyor can also be configured as an off-line conveyor. The illustration below shows a multi-lane accumulator installed alongside the through conveyor lane. Revolving disks transfer the items from the conveyor onto the accumulator and back onto the conveyor. The rails and bidirectional movement of the lanes keep the items circulating and directs them back onto the conveyor as needed.



Off-line Multi-lane Accumulator

Air Accumulators

Air accumulators are designed to operate on air conveyors to store containers and packages. Air accumulators store the items slightly above the conveyor surface and moves them forward on jets of air. Back pressure on the items in the air conveyor shown below will operate gates that stop the flow of containers on the through conveyor and divert the items into the accumulating lanes. The items hover on jets of air while they are being stored. When the jam is cleared the back pressure is relieved and the gates open to allow items in the accumulator lane to return into the through lane as they are needed.

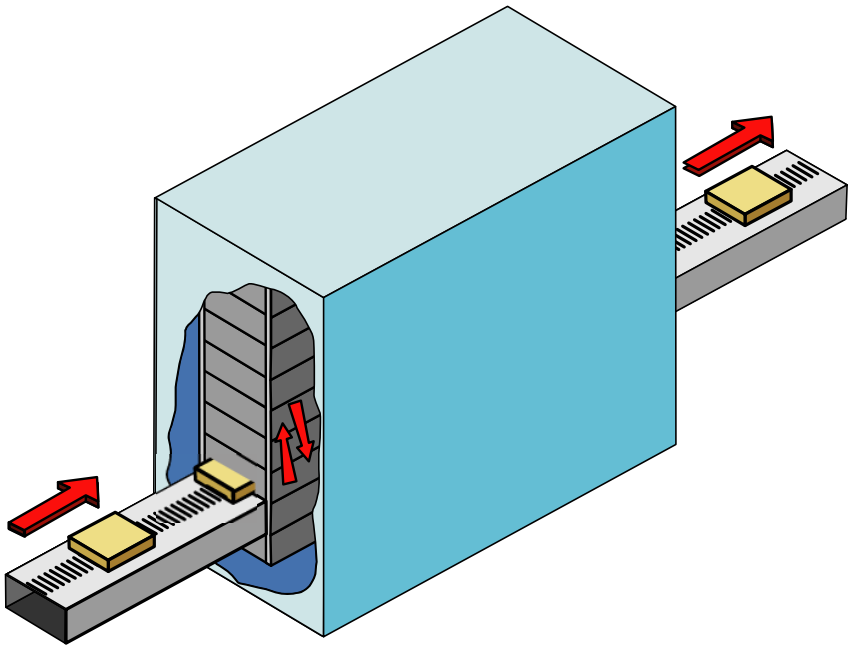


Air Accumulator

The items on an air conveyor can also be accumulated in a stacker which stores several layers of items in the space above the conveyor.

Stacker

The stacker is operated when a downstream jam stops the flow in the conveyor as shown below. Clamps hold the items together and a hydraulic lift raises the layer up one position in the stack. When the conveyor section is refilled the lift operates again and raises both layers. The operation is repeated until the stacker is filled or the jam is cleared and the conveyor resumes normal operation. As space becomes available in line, each layer is lowered, and the items are released into the line.



Stacker

Progress Check #6

Circle the letter of the correct answer for each question.

1. Interruptions in the flow of a packaging line caused by clearing jams are minimized by
   a. adjusting the conveyor speed
   b. clearing the jam with the machine running
   c. using accumulators

2. Items stored on a rotary disk accumulator are returned to the packaging line conveyor in a(n)
   a. first-in, first-out sequence
   b. last-in, first-out sequence
   c. irregular sequence

3. Off-line accumulator tables operate with
   a. continuous motion
   b. intermittent motion

4. Conveyed items are fed onto the off-line accumulator table
   a. continuously
   b. by back pressure
   c. by sensors and switches

5. Rotary accumulators are normally used with
   a. round items
   b. square and rectangular items
   c. either round or square and rectangular items

6. On an in-line rotary accumulator
   a. all of the items pass through the accumulator
   b. some of the items pass through the accumulator

7. On an off-line rotary accumulator the items are returned to the conveyor in
   a. first-in, first-out sequence
   b. last-in, first-out sequence
   c. irregular sequence

8. The containers on an off-line rotary accumulator are held in position by
   a. centrifugal motion
   b. the plow
   c. guide rails

9. Square or irregular shaped items can be stored more easily on a
   a. serpentine accumulator
   b. table accumulator
   c. rotary accumulator

10. Spiral accumulators are most similar to
    a. rotary accumulators
    b. multi-lane accumulators
    c. serpentine accumulators

11. On an in-line serpentine accumulator

    a. all the items pass through the accumulator

    b. some of the items pass through the accumulator

12. Serpentine accumulators are on

    a. flat surfaces

    b. inclined surfaces

    c. either flat or inclined surfaces

13. Packages on a multi-lane conveyor are pushed onto the accumulating lanes by

    a. back pressure

    b. diverters

    c. guide raids

14. When a jam-up occurs the first packages pushed off the multi-lane conveyor are pushed onto an accumulator lane moving in

    a. the opposite direction

    b. the same direction

    c. circles

15. On a multi-lane accumulator, the lanes on the two sides of the through lane move

    a. in the same direction

    b. in opposite direction

    c. in both directions

16. The operation of a multi-lane accumulator is controlled by

    a. back-pressure of the items

    b. limit switches

    c. photoelectric sensors

17. In a multi-lane air accumulator the stored items rest on

    a. chains

    b. belts

    c. jets of air

Notes:

Summary

Conveyor systems are extremely important in use to move product and containers throughout the warehouse. Various types of conveyors have been designed to handle almost any commodity that can be transported. Whether the product needs to simply be transported in a straight line or if it needs to be elevated, turned or otherwise positioned, the conveyor for the job has probably been designed and built. Beyond simply transporting goods, the conveyor accumulator helps keep the packaging line run consistently when part of the line are down or running faster than downstream units.