

Figure 16.1

A belt in good condition that is center loaded on a well-engineered and –maintained conveyor structure should not wander but stay in perfect alignment.

Chapter 16

BELT ALIGNMENT

Keeping the Belt in Alignment 253

Basic Belt Behavior 254

Causes of Mistracking 256

Investigating the Problem: The Survey..... 260

Training the Belt..... 261

Hardware for Training the Belt 265

Installation of Belt-Training Devices..... 273

Safety Concerns 274

System Maintenance 274

Typical Specifications..... 275

Advanced Topics..... 275

Belts in the Real World..... 277

In this Chapter...

In this chapter, we focus on belt alignment and its relationship to fugitive materials: causes of mistracking as well as techniques to train the belt. We also discuss uses of belt-training hardware and installation of devices for belt training. Finally, equations used to calculate power consumption for belt-trainers are provided.

In an ideal world, a belt would be in good condition and center loaded and the conveyor structure would be well-engineered and -maintained; under those conditions, the belt would not wander but stay in perfect alignment (**Figure 16.1**).

However, belts that wander from the desired path are an everyday fact of life in many bulk-materials handling operations. A conveyor belt that wanders can cause material spillage, component failure, and costly damage to the belt and structures (**Figure 16.2**). A belt that runs to one side of the structure can greatly reduce its service-life, because it abrades one or both edges, becomes stretched, or folds over on itself (**Figure 16.3**). A wandering belt can run against steel chutes and structural members until the belt, other components, and steel structures are damaged, often beyond repair (**Figure 16.4**). Worse yet, belt-wander problems have contributed to fatalities.

In many ways, proper belt alignment is a precursor to, and a fundamental requirement for, resolving many of the fugitive-material problems discussed in this book. In this chapter, we will discuss many of the problems that cause a belt to wander and suggest solutions.

KEEPING THE BELT IN ALIGNMENT

Many terms are used when discussing the topic of belt wander. The terms tracking and training are often used interchangeably, as are their counterparts wander and misalignment. Here, training is defined as a procedure to make the conveyor belt track (or travel) on the centerline of the conveyor

structure, both empty and fully loaded. Wander and mistracking can be defined as the tendency of the belt centerline to move from the conveyor structure's centerline, and misalignment is the amount that the belt wanders.

Belt tracking must be controlled before spillage can be eliminated; if the belt wanders to one side, or back and forth, as it passes through the loading zone, material is more readily released under the skirtboard seal on either (or both) sides (**Figure 16.5**). Belt mistracking is managed by “training



Figure 16.2

A conveyor belt that wanders out from underneath the sealing system can cause material spillage, component failure, and costly damage to its belt and structures.

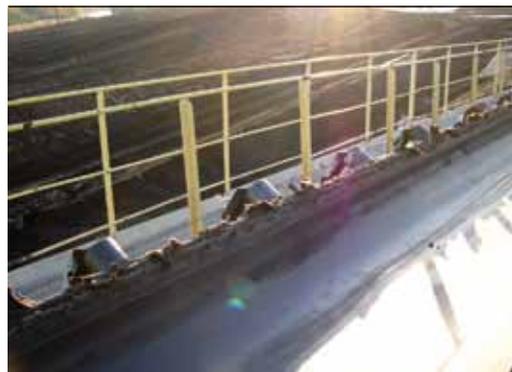


Figure 16.3

A belt that runs to one side of the structure can greatly reduce its service-life, because it abrades one or both edges, becomes stretched, or folds over on itself.



Figure 16.4

A wandering belt can run against steel chutes and structural members until the belt, other components, and steel structures are damaged, often beyond repair.

the belt” and by installing components designed to limit or correct wander.

When a belt mistracks, it can cause large amounts of material spillage. These spillage piles can cause trip hazards. If an overhead conveyor mistracks, it can rain material of any size down on workers. The potential for worker injury and all of the associated

costs would indicate that it is in an operation’s best interest to solve the problem of mistracking belts (**Figure 16.6**).

BASIC BELT BEHAVIOR

Despite all of its various causes, mistracking is still unnecessary. It is a problem that can be controlled or, better yet, corrected. Understanding the basic patterns of belt behavior and undertaking a set of procedures to carefully align the conveyor’s structure and components to correct fluctuations in the belt’s path can, in most cases, prevent belt wander.

Belt behavior is based on simple principles. These serve as the guidelines for belt training, which is the process of adjusting conveyor structure, rolling components, and load conditions to correct any tendency for the belt to run off-center.

The fundamental rule of conveyor belt tracking is this: The belt will move toward the side that has more friction, or the side that reaches the friction first (**Figure 16.7**). When a side of the belt encounters that friction, that side of the belt moves slower. The belt’s other side moves faster; a force imbalance occurs, which pivots the belt toward the slower moving side.

For example, if an idler set is installed at an angle across the stringers, the belt will move toward the side it reaches first. If one end of the idler set is higher than the other, the belt will climb to the higher side (because, as the belt is laid down on top of the idlers, it touches the higher side first).

Figure 16.5

Belt tracking must be controlled before spillage can be eliminated.



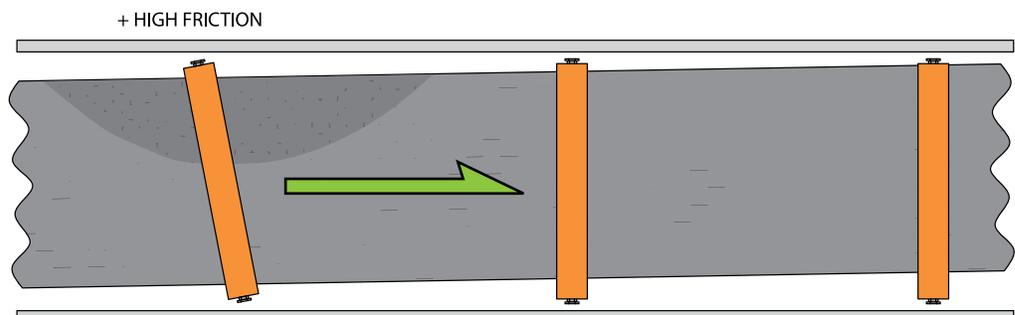
Figure 16.6

When a belt mistracks, it can cause large amounts of material spillage.



Figure 16.7

The fundamental rule of conveyor belt tracking is that the belt moves toward the high-friction side of the belt.



This can be demonstrated very simply by laying a round pencil on a flat surface, such as a table. If a book is laid across the pencil and gently pushed away from the experimenter, the book will shift to the left or right depending upon which end of the pencil is closer to the person doing the pushing; that is, the end the book is contacting first (**Figure 16.8**). This basic rule is true for both flat idlers and troughed idler sets.

In addition, troughed idlers exert a powerful tracking force. With their troughed configuration, a portion of each belt edge is held aloft. A gravitational force is exerted on that raised portion. If the belt is not centered in the set of rollers, the force on the higher edge will be greater than the force on the other side, steering the belt toward the center of the troughed idler set. This gravitational tracking force is so pronounced that bulk conveyors usually depend upon it as their major tracking influence.

Another constant rule of belt tracking is that the tracking of the belt at any given point is more affected by the idlers and other components upstream (the places the belt has already passed) than the components downstream (which the belt has not yet reached). This means at any point where mistracking is visible, the cause is at a point the belt has already passed. Consequently, corrective measures should be applied some distance before the point where the belt shows visible mistracking (**Figure 16.9**).

With these basic rules in mind, operators and maintenance personnel can make the adjustments to the conveyor that will bring the belt path into alignment.

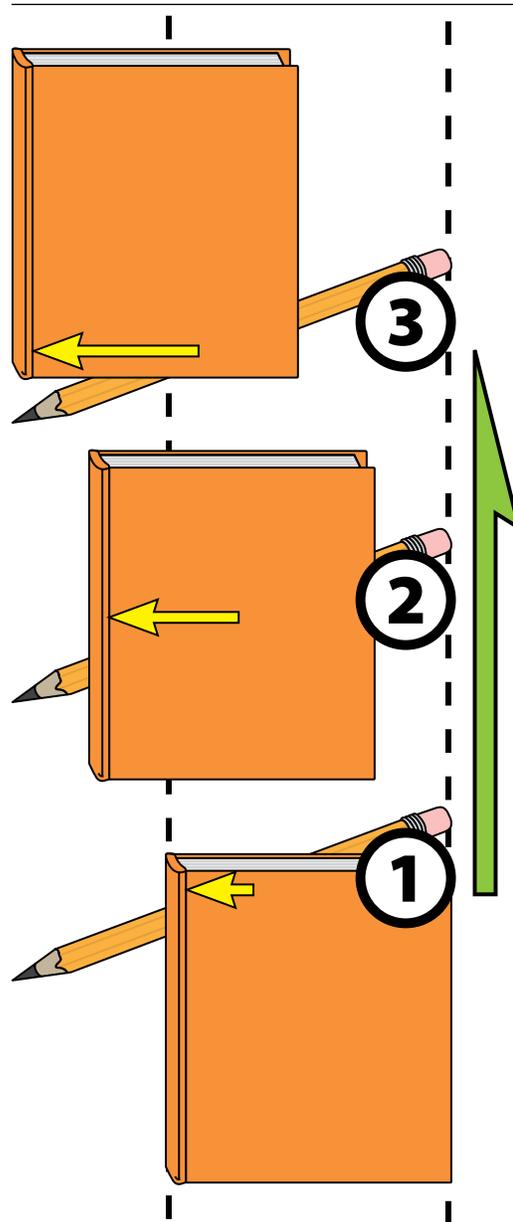


Figure 16.8

The basic rule of belt training can be demonstrated by laying a book on top of a round pencil. When pushed away, the book will shift to the left or right depending upon which end of the pencil is closer to the person doing the pushing: that is, the end the book is contacting first.

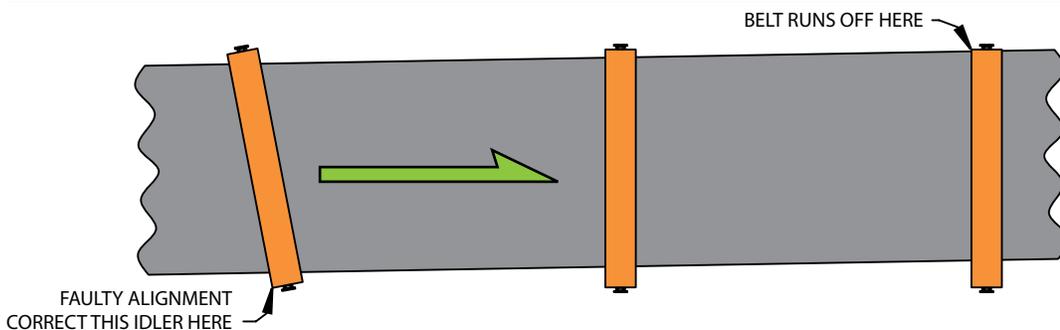


Figure 16.9

Because mistracking takes place after the point of cause, corrective measures should be applied some distance before the point where the mistracking is visible.

CAUSES OF MISTRACKING

The Avoidable Problem of Belt Wander

To properly train a conveyor, the first step is to survey the existing system to understand the state of the structure and components and to determine the causes of mistracking.

As Clar Cukor noted in the undated Georgia Duck (now Fenner Dunlop) monograph *Tracking (Reference 16.1)*:

The problem of tracking should be approached from a systems point of view. The belt may well be at fault—however, it is more likely merely reacting to a structural defect or maladjustment in the system....[A conveyor belt] is flexible and if designed, manufactured, slit and cut properly, will “go where directed” by the conveyor system as designed and built. The conveyor belt serves as an indicator and should be so regarded.

Belt wander can be caused by a number of problems. Factors contributing to belt wander include misalignment of conveyor components, off-center loading of cargo, accumulation of fugitive material on rolling components, poor belt splices, structural damage caused by inattentive heavy-equipment operators, ground subsidence, and many others. And these problems may occur in any combination, greatly complicating the process of correction.

In spite of the complexity of these problems, they are solvable. Misaligned components can be straightened, chutes can be redesigned to load the cargo in the center of the belt, material accumulations can be prevented or removed, belt splices can be improved, and operators can be trained. The challenge comes in identifying which of the long list of possibilities is the specific cause of a given belt’s problems. Once the cause of mistracking is identified, it can be corrected.

Causes of Mistracking

In many cases, the cause of mistracking can be determined from the form the mistracking takes. When all portions of a belt run off-center at one certain part of the conveyor length, the cause is probably in the alignment or leveling of the conveyor structure, idlers, or pulleys in that area. If one or more sections of the belt mistrack at all points along the conveyor, the cause is more likely in the belt construction, in the splice(s), or in the loading of the belt. If the belt mistracks when full and then tracks in the center when empty or vice versa, the cause is usually off-center loading or buildup in the chute that creates varying loading situations.

The most common causes of mistracking can be split into three groups: faults with the belt or its splices; faults with the conveyor structure, components, or the environment; and faults with material loading.

Faults with the Belt or its Splices

A. Belting

- a. The belt is bowed, cambered, or cupped.
- b. There are defects or damage in the carcass (plies or cords) of the belt.
- c. The belt edge or cover is damaged.
- d. There is belt degradation from exposure to the elements or to chemicals.

B. Manufacturing and application

- a. The belt is poorly matched to the structure or application.
- b. The belt has a “bow” or “camber” from its manufacturing process.
- c. The belt was not stored properly.

C. Splices

- a. There was poor installation of a vulcanized or mechanical splice, resulting in a splice that is not square to the belt.
- b. A belt was formed from several pieces joined at the wrong ends, resulting in a camber or crooked section.

- c. Different types, thicknesses, or widths of belt have been spliced together.
- d. The belt has splices that are damaged or coming apart.

Faults with the Conveyor Structure, Components, or the Environment

- A. Structure
 - a. The structure was not accurately aligned during its construction.
 - b. The structure has settled on one side through ground subsidence.
 - c. The structure has been damaged from plugged chutes, fires, or collisions with mobile equipment.
- B. Components
 - a. Rolling components (idlers and pulleys) are not aligned in all three axes.
 - b. The gravity take-up is misaligned.
 - c. Idler rolls have seized or been removed.
 - d. Material buildup or wear has altered the profile of idlers or pulleys.
- C. Environment
 - a. The conveyor is subjected to high winds.
 - b. Rain, frost, or ice and snow buildup altered the friction on one side of the belt.
 - c. The sun shines on one side of the conveyor.

Faults with Material Loading

- A. The load is not centered on the receiving belt.
- B. The load is segregated, with larger lumps on one side of the belt.
- C. There is intermittent loading on a belt that is tracked for a constant load.

Sometimes, a combination of these problems will produce belt wander, and the root cause will not be evident. However, if a sufficient number of belt revolutions are observed, the belt's running pattern generally will become clear, and the cause

of mistracking will be disclosed. When a pattern does not emerge, the usual causes for belt mistracking are an unloaded belt that does not trough well or a belt that is unevenly loaded.

Wander Due To Faults with Splices or the Belt

Improper belt splicing is a significant cause of mistracking. If the belt is not spliced squarely, the belt will wander back and forth on the conveyor structure. This can usually be seen at the tail pulley. The belt will wander the same amount each time the splice reaches the tail pulley, only to return to its original position after passage of the splice. If the splice is bad enough, it can negate all alignment efforts. The solution is to resplice the belt squarely. (*See Chapter 5: Conveyors 101—Splicing the Belt.*)

A second significant cause of belt mistracking is a cupped belt. A cupped belt will track poorly because of differences in friction as it lays in the troughed idlers. Belt cupping is almost always a result of unequal shrinkage between the top and bottom covers of fabric belts. Heat, chemicals, trough angles, and over-tensioning can also cause belt cupping. This problem can usually be avoided by keeping the proper aspect ratio between top and bottom cover thicknesses: usually 3:1 or less. In some cases, the belt will cup as the top cover rubber properties change as the result of aging or exposure to chemicals. A cupped belt is hard to make track consistently, because tracking depends upon the friction between the belt and the rolling components. If the belt is so badly damaged that the contact area is reduced, the ability of the components to keep the belt in line is also reduced.

While manufacturing defects in the belt or failures of components are often blamed for many belt-alignment problems, most of these problems can be traced to improper application of the belt. A belt that is poorly matched to the application will usually track poorly on the structure.

Wander Due to Structural and Component Problems

To be able to keep the belt running straight, the structure must be properly erected and corrected if damaged. Most structural damage occurs when the conveyor structure is struck by mobile equipment. Structural damage can also occur as the result of corrosion or a settling of the foundations.

It is equally important that the components be properly installed and maintained in relation to the belt for reliable belt travel. One major source of belt wander is gravity take-up systems that are out of alignment or that have too much side-to-side movement, or “slop.” The take-up pulley, like all other main pulleys, must remain in alignment with the belt throughout the take-up’s travel, or the belt will mistrack.

Rotating components can have a significant mistracking effect on the belt. Rotating components that have become frozen or inoperative due to material buildup or those with material accumulations that alter their circumference can be major contributors to erratic belt tracking. Consequently, transfer points should be engineered, constructed, and maintained to prevent material spillage. An effective multiple-cleaner belt-cleaning system should be installed to prevent material carryback. If necessary, cleaners can be installed to clean snub, take-up, and other pulleys. (See *Chapter 14: Belt Cleaning*.)

Figure 16.10

A belt that is not loaded in the center will mistrack, running the risk of damage to belt and structure.



Wander Due To Environmental Conditions

Strong winds on one side of the conveyor can provide enough force to move the belt off its center line or even blow the belt off the idlers. The solution is to install retaining rings known as “wind hoops” over the conveyor to keep the belt in place, provide a windbreak on the windward side, or enclose the entire conveyor.

Should rain, ice, or snow be blown onto one side of the conveyor, the result would be a difference in friction on the idlers. This difference may be enough to push lightly-loaded belts off the proper path. Even the difference created when the sun warms one side of a belt in the morning is enough to cause a belt to wander. Here again, the solution would be some form of conveyor cover.

In some cases, the conveyor’s design was not sufficiently strong to withstand lateral winds, and the entire conveyor will sway back and forth in high winds. The path of a belt can also be greatly influenced by a slight shift of the take-up pulley due to crosswind.

Wander from Loading Faults

Mistracking that arises from loading problems is generally easy to spot, because the belt will run in one position when loaded and another position when unloaded (**Figure 16.10**). This observation may be confused on older conveyors where years of adjustments performed to “fix” the belt’s path have altered the natural track of the belt.

The load’s center of gravity will seek the lowest point of the troughing idlers (**Figure 16.11**). When the belt is not center-loaded, the weight of the cargo pushes the belt off-center toward the conveyor’s more lightly-loaded side. This can be corrected by proper loading-chute arrangements, or through the use of deflectors, grids, or chute bottoms that can be adjusted to correct the placement of the load on the belt. (See *Chapter 8: Conventional Transfer Chutes*.)

Wander on Reversing Belts

Reversing conveyors can be a special source of frustration. When the belt direction is reversed, the tension areas in the belting change location in relation to the drive pulley and loading area(s). Imagine having a conveyor that has a head drive, and at the flip of a switch, it becomes the tail drive. When the top side of the belt is running toward the drive pulley, the tight side of the belt is on top. However, when the belt is reversed and the top side is running away from the drive pulley, the tight side is now on the bottom. The carrying side of the conveyor actually changes from being pulled to being pushed. A belt being pushed is inherently more unstable than a belt being pulled; thus, it is more difficult to train.

This poses especially difficult problems, because all of the components now contribute differently to the tracking problems. The belt may run fine in one direction and wander all over when reversed, because different sets of rollers and pulleys control the steering of the belt. In order to overcome this type of problem, the system should be surveyed to determine which components are out of alignment. Corrections should be made as required to get all rotating components in alignment.

Other problems encountered and aggravated by reversing belts relate to off-center loading, multiple load points, and loading different materials on the same belt. Off-center loading can greatly aggravate tracking problems on reversing belts, especially if the load is applied closer to one end of the conveyor than to the other. This can be corrected by proper loading-chute design and the use of adjustable deflectors, grids, and chute bottoms that can be adjusted to correct the placement of the load on the belt.

Different materials on the same reversing belt can also cause problems. Suppose the belt has been “set” to track with a material with a specific bulk density. Now, reverse the direction of travel and introduce a

material with a different bulk density, and all of the previously-applied training adjustments may be wrong. In order to overcome this type of problem, a survey of the structure should be conducted to determine if the take-up pulley counterweight is insufficient or if the components are out of alignment, and corrections should be made as required.

Problems with Traveling Conveyors

Conveyor systems that move (such as bucket-wheel reclaimers, traveling stackers, or tripper belts) are greatly influenced by the rail structure on which they ride. For instance, if one rail is higher or lower at a given point than the parallel point on the other rail, the traveling conveyor can tip or rock (sometimes several millimeters (in.) on tall structures), leading to belt-mistracking problems.

Many times this problem is overlooked when trying to find the cause of belt mistracking and the resultant damage. The “traveler” part of the system might be parked in an area where the rails are level when a survey is performed. The survey results then would show everything to be in alignment; however, when the traveling system is moved to a different location, the belt mistracks, because the supporting structure is not level.

The rail systems must also be checked for parallel alignment. Improper alignment may cause the carrying wheels to “ride up” on the inside or outside of the rail, causing the same effect as one rail point being higher than its opposite counterpart.

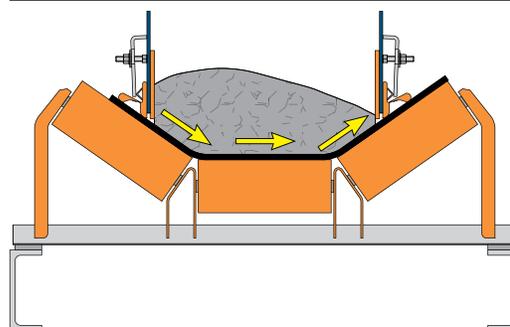


Figure 16.11

When the belt is not center-loaded, the weight of the cargo pushes the belt off-center toward the conveyor's more lightly-loaded side.

**INVESTIGATING THE PROBLEM:
THE SURVEY**

The first, and most important, step in training a conveyor is to check and align the structure. The best way to begin this process is to make a detailed survey of existing conditions and the original design criteria. This allows measured corrections to be made returning the system to original specifications, rather than adopting an unplanned “let’s ‘tweak’ the idlers a little more today” approach.

The traditional method of checking alignment has been to stretch a piano wire from one end of the conveyor to the other and use this wire as a baseline to take the measurements to evaluate alignment. However, this method has a number of potential problems. For example, the wire is vulnerable to shifts in its line. Changes in ambient temperature from the warmth of the sun, or even the actual weight of the wire itself, can stretch the wire, changing the line. Another problem is that there is no accurate

way to measure a 90-degree angle from the wire. If the wire moves when touched when laying a ruler or square against it, the accuracy of subsequent measurements is destroyed.

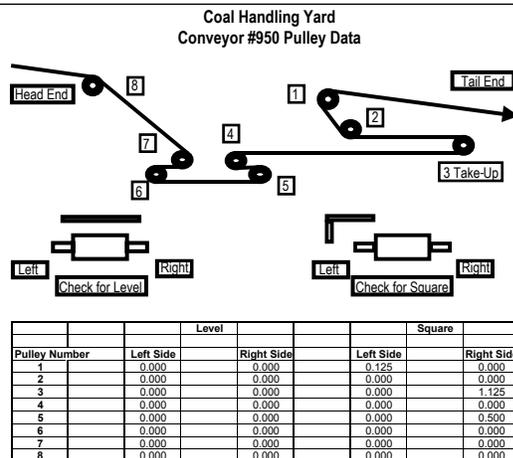
Now, high technology, in the form of beams of light from a laser transit set in parallel to the conveyor structure, provides an unobstructed and repeatable reference for the alignment of the conveyor-structure components (**Figure 16.12**).

This laser-surveying technology avoids the problems encountered with the old “piano wire” technique. The laser generates a perfectly straight beam with an effective range of 150 meters (500 ft), with multiple set-ups allowing unlimited distance. To check objects set at angles to the baseline, prisms can be used to bend the beam. With a laser transit, the survey crew is no longer trying to measure a perpendicular line; they have created one. Since a laser beam cannot be touched, it cannot be moved accidentally when taking readings from it.

Figure 16.12
The beam of light from a laser transit provides an unobstructed and repeatable reference for the alignment of the conveyor-structure components.



Figure 16.13
The laser-survey report will tell which components are out of alignment and by how much, so the plant maintenance crew or the specialty contractor can adjust these components to improve the belt’s tracking.



For “Level” a positive number indicates that side is higher.
For “Square” a positive number indicates that side is farther forward.

Most operations do not have the equipment and expertise to properly conduct a laser survey. Therefore, it is in the best interest of the operation to hire a specialty contractor or service with the hardware and experience to conduct this survey. A specialty contractor will laser survey the belt, inscribe a permanent series of benchmarks or alignment points, create a detailed report, and offer recommendations as to how to correct the major tracking problems.

The report should tell which components are out of alignment and by how much, so the plant maintenance crew or the specialty contractor can adjust these components to improve the belt’s tracking (**Figure 16.13**). By doing repeat surveys of the same conveyor at regular intervals—annually, for example—plant management can provide a regular check of the condition of the conveyor structure. The survey will tell if the structure is deteriorating or if other circumstances—such as subsidence of the ground under the conveyor or change in

the counterweight mass—are occurring. This information can be used to prevent unexpected shutdowns and subsequent loss of production by alerting the plant’s engineering and maintenance staff to problems as they develop.

TRAINING THE BELT

Getting the belt to track in the center of the conveyor’s structure and components is a process of adjusting idlers and loading conditions to correct any tendency of the belt to run outside the desired path. The first step is to get the structure into alignment with the belt’s theoretical centerline, as identified in the system survey. Once the structure is aligned, all the pulleys and idlers must be aligned so they are level and square to the center line. Then attention can be given to getting the belt to run true.

When training a belt, only one person should be in charge of the procedure. When more than one person adjusts the conveyor at the same time, it can lead to conflicting “corrections” that make the belt’s path more difficult to correct. It is important that records be kept, noting the conveyor’s problem areas and detailing the corrective steps taken. This will prevent, or at least identify, the problems arising from correction, re-correction, over-correction, and counter-correction when problems return to a specific area.

Procedure for Training

The following is a step-by-step process for training the belt to correct for component alignment and loading problems.

Determine Areas of Belt Tension

Adjustments to components in the low-tension areas have the highest impact on correcting the path of the belt. By identifying and starting in the low-tension areas, the training process can have the greatest impact with the least amount of changes. In high-tension areas, there is too much tension on the belt for relatively minor adjustments to have significant impact on the

belt path. Belt tension is usually highest at the drive pulley (**Figure 16.14**). The area of lowest tension will vary on the location of the snub and take-up pulleys. The low-tension areas are completely dependent on the individual conveyor and must be identified for each application. Conveyor Equipment Manufacturers Association’s (CEMA) *BELT CONVEYORS for BULK MATERIALS, Sixth Edition*, or an experienced conveyor engineer can be consulted for additional information.

It is important to make sure the take-up weight is applying the correct tension required by the current belt and capacity ratings. If the belt is inadequately or improperly tensioned by the take-up pulley, it is likely to have severe variations in its path.

Determine Locations of Mistracking

It is best if inspection for mistracking begins with the first rolling component directly after the highest-tension area (typically where the belt leaves the drive pulley), as the tension will usually be lower in that area, and continues along the path of the belt until a point where the belt is visibly off track.

It is important to remember that the track of the belt at any given point is affected more by the idlers and other components upstream (the points the belt has already passed) than the components downstream (the points the belt has not yet reached). This means where mistracking is visible, the cause of mistracking is at a point the belt has already passed.

Therefore, corrective measures should be applied at points the belt passes before the area where it shows visible mistracking. The movement of one idler generally has its greatest training effect in an area within 5 to 8 meters (15 to 25 ft) downstream.

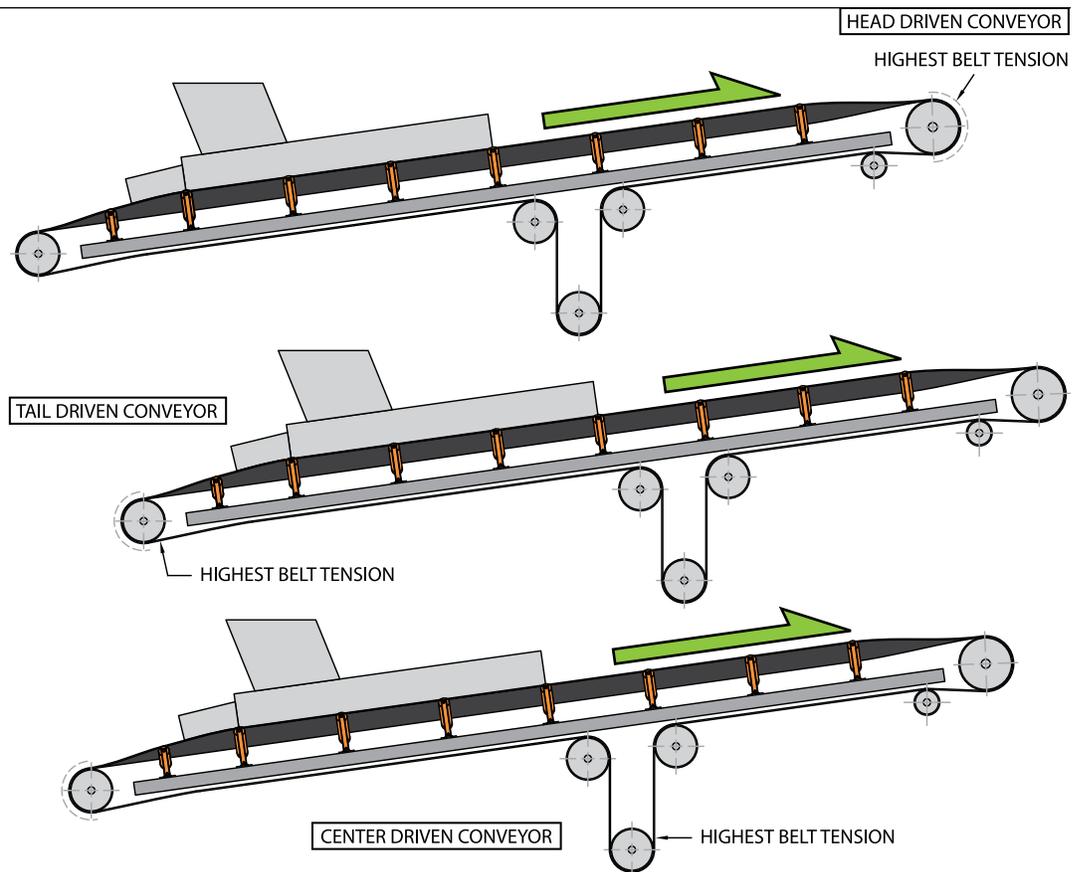
Train the Belt

The conveyor must be locked out / tagged out / blocked out / tested out before making any adjustment to components or belt tension to correct mistracking.

Figure 16.14

Belt tension is usually highest as the belt enters the drive pulley; areas of low tension will vary depending on the location of the snub and take-up pulleys.

To train a belt, start inspection for mistracking directly behind the highest-tension area (where the belt leaves the drive pulley).



To correct the belt's running path, it is necessary to start in the areas of lower tension and move around the conveyor, making adjustments to idlers to move the belt back into the center. Then, following the route of the belt from the driven pulley toward the next rolling component in sequence, the belt path can be corrected by adjusting the idlers, one place at a time.

Starting with the first or second idler set before a point where the belt is visibly off track, the idler should be skewed in a direction opposite the misalignment. Then, the conveyor should be restarted to check for the belt's running alignment. The conveyor needs to be run to evaluate the effect of the correction, but it is important to wait two or three complete revolutions of the belt before further adjustments are made.

Figure 16.15

The most basic technique for training a belt is shifting the idler axis with respect to the path of the belt, commonly called "knocking the idlers."



It is best to shift only one idler at a time, as pivoting additional idlers may cause over-correction or competing corrections. If the observation shows the belt path has been over-corrected, the path should be restored by moving the original idler back, rather than shifting additional idlers.

The belt should be tracked empty all the way around the conveyor, making especially sure the belt is centered as it enters the loading zone and discharge zone.

Techniques for Training the Belt

The most basic training technique is to adjust idlers. Training a belt by using its return and carrying idlers is accomplished by shifting the idler axis with respect to the path of the belt. This is commonly called “knocking the idlers,” because the idler base is shifted with a blow from a hammer (**Figure 16.15**).

Training a belt by shifting the position of one or more idlers is the same as steering a bicycle with its handlebars (**Figure 16.16**). When you pull one end of the handlebars (or the idler) toward you, the bicycle (or belt) turns in that direction. This is in keeping with the basic rule of belt training: The belt will steer to the side of the idler it touches first.

This handlebar principle of steering is sound, but only if the belt makes good contact with all three troughing rollers. So before training a belt, it is necessary to check to be sure the belt is troughing well at all points along the carrying side, even when unloaded. If the belt does not “sit down” in the trough, there may be a problem with its compatibility with the structure (**Figure 16.17**). A belt that is too thick and not suitable for a given conveyor might never track correctly.

Adjustments to the idlers should be small. Research at Australia’s University of Newcastle has shown that once an idler is skewed past a certain point, it will not correct the belt path more, because the belt slides across the idler like a car skidding across a patch of ice (*Reference 16.2*).

Obviously, such shifting of idlers is effective for only one direction of belt travel. A shifted idler that has a correcting influence when the belt runs in one direction will likely misdirect the belt when the conveyor is running in the other direction.

For unidirectional conveyors, shifting the position of idlers has benefits in belt training. However, there are drawbacks as well. It should be obvious that a belt

might be made to run straight with half the idlers knocked one way and the other half knocked in the opposite direction, but this would be at the expense of increasing rolling friction between belt and idlers. Idlers turned in all different directions in an effort to train the belt create extra friction, resulting unnecessarily in increased wear in the bottom belt cover and increased power consumption.

Adjustments should be made to idlers only—never to pulleys. Pulleys should be kept level with their axis 90 degrees to the intended path of the belt.

Other Techniques to Center the Belt

Another approach to centering the belt is to tilt the carrying idlers slightly, up to two degrees, in the direction of belt travel. The friction of the belt on the wing rollers creates a centering force that is directed to the centerline of the belt. This can be done by simply inserting flat metal washers beneath

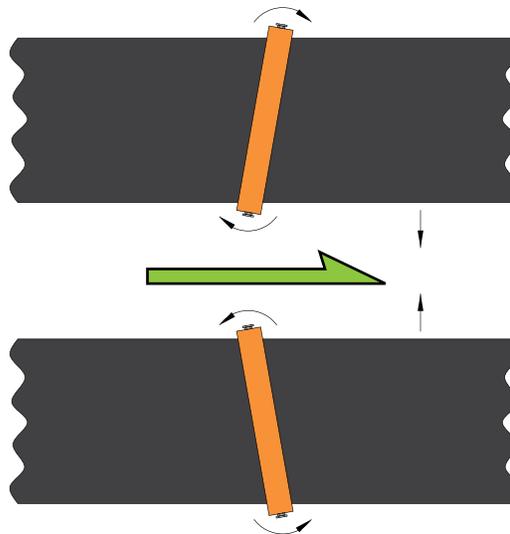


Figure 16.16

Training a belt by shifting the position of one or more idlers is the same as steering a bicycle. When you pull one end of the handlebars (or the idler) toward you, the bike (or belt) turns in that direction.



Figure 16.17

For a belt to track well, it must trough well along the conveyor’s carrying side. If the belt does not “sit down” in the trough, it might never track correctly.

the back side of the idler frame. Many idler manufacturers build this tilt into their products. Just as with “knocking” the idlers, there is a limit to the effectiveness of this technique, and it does increase the power consumption of the conveyor and wear on the belt bottom cover and idlers (**Figure 16.18**).

An ill-advised method to center the belt as it approaches the tail pulley is to slightly skew in opposite directions (**Figure 16.19**) or raise opposite ends of the two return rolls nearest the tail pulley (**Figure 16.20**). The theory is that this deliberately-induced mistracking in opposite directions produces competing forces that work to center the belt. Though this may sound reasonable in the abstract, the practical application of it is problematic. This method incorporates instability into a system when the goal for optimum operation is stability. It could be argued that there is enough of a problem with getting the system square in order to

run true, without adding two more variables in the form of deliberately-misaligned idlers.

Training the Belt at Start-Up of New Conveyors

If a new conveyor system has been designed and built in accordance with sound engineering and installation practice, the belt will probably track at start-up on a path close to the desired one. There may be minor variations from the ideal structure that result in the belt not tracking perfectly; however, in these circumstances, the variations should be relatively minor, so the belt can be operated without damage long enough for a training procedure to take place.

The first movement of the belt through a new conveyor should be slow and intermittent, so any tendency of the belt to wander may be quickly recognized and the belt stopped before damage occurs. The first alterations must be made at points where the belt is in immediate danger of damage. Once the belt is clear of danger points, the conventional sequence for belt training, as noted previously, can be followed.

Insufficient attention at start-up can create problems, including serious runoff and edge damage, belt creasing or fold-over, spillage, and damage to other conveyor components. For conveyor start-up, observers should be positioned at locations where trouble might be expected or where the belt is at greatest risk—where it enters the discharge and loading chutes. These “spotters” should have a radio, telephone, or, at a minimum, a pull-rope emergency-stop switch within easy reach.

In severe cases, it may be necessary to shut the conveyor down, make any adjustments indicated, and reposition the belt before a new start-up is undertaken.

Training of Replacement Belts

A new belt—whether new belting on a new conveyor or a replacement belt on an established system—often has to be gradu-

Figure 16.18

Tilting carrying idlers by inserting flat metal washers beneath the back side of the idler will increase the centering force.

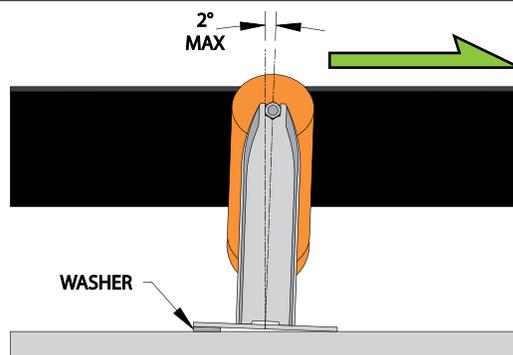


Figure 16.19

An ill-advised method to center the belt as it approaches the tail pulley is to slightly skew the two closest return rolls in opposite directions.

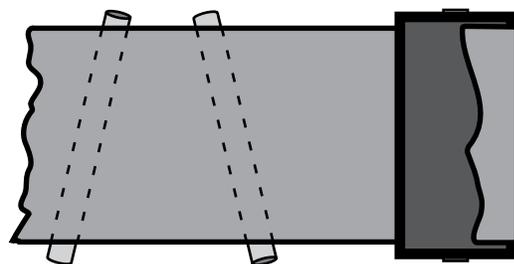
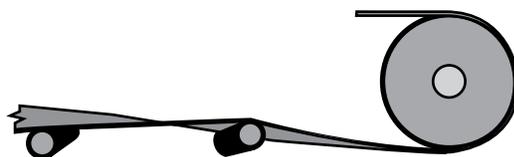


Figure 16.20

Raising the opposite ends of the two returns rollers nearest the tail pulley is an ill-advised method to help center the belt.



ally “worn in” like a new pair of shoes. It is relatively rare to pull a new belt onto an existing conveyor, splice it together, push the conveyor’s start button, and have the belt track down the middle of the structure. All new systems must be run for several hours before the final training of the belt to run in the idlers and stretch the belt.

Some new belts will tend to run to one side in one or more portions of their length because of a permanent camber or a temporary unequal distribution of tension arising from the storage, handling, or stringing of the belt. In many cases, operation of the belt under tension for a break-in period will correct this condition. Loading the belt to 60 percent capacity will help the belt fit the conveyor.

The conveyor structure may not be neutral to the new belt, particularly in the case of a new belt going onto an existing conveyor. If numerous training adjustments have been made over time to correct the mistracking of the previous belt, these adjustments may have to be “undone” to allow the new belt to track correctly.

Training Feeder Belts

Feeder belts are normally short, high-tension, slow-moving belts that use flat rollers or picking-style idlers on the carrying side. A square splice is critical for tracking on these belts, and the head and tail pulleys must be perfectly aligned. Training can be done on only the return, or slack, side of a feeder belt because of the construction and high loads on the carrying side. If needed, a single training device can be placed in the center of the return where there is some slack in the belt to allow the training device to function.

Training Reversing Belts

None of the techniques such as knocking or tilting the idlers is effective on reversing belts. Any correction made to track a reversing belt in one direction will have the opposite mistracking effect when the belt reverses. This makes reversing belts one of the most difficult belt-training challenges.

Consequently, all idlers and pulleys must be in perfect alignment and the splice must be square to make the system as clean or neutral as possible. Only training devices designed for reversing belts should be installed.

HARDWARE FOR TRAINING THE BELT

Most conveyors need some tracking correction to account for unexpected or environment-induced belt wander. There are also occasions when the training procedure is not successful at providing a long-term solution to a mistracking problem. As a result, the operation is faced with repeating the training procedure on a frequent (sometimes daily) basis or installing some form of mechanical belt-training system to reduce this requirement. Engineered training solutions are devices that sense the position of a belt and, through a mechanism or geometry change, actively adjust the belt’s path.

Belt Misalignment Switches

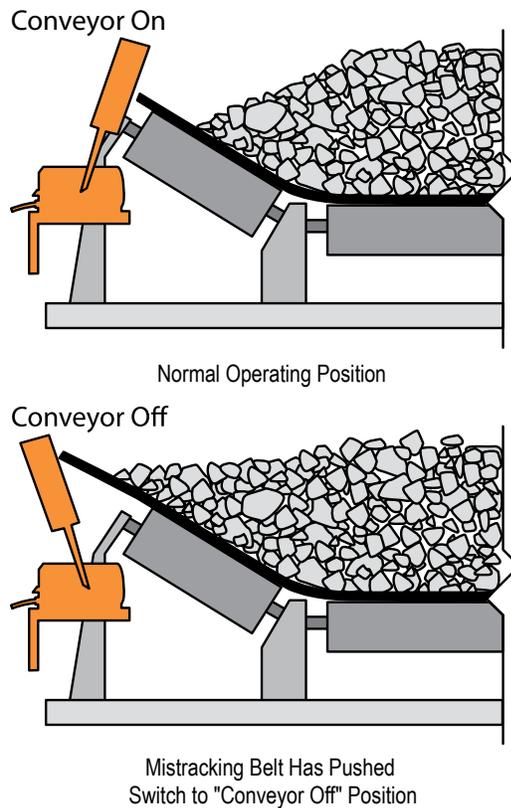
While not a corrective device, a belt misalignment switch is a hardware system that offers some control over belt tracking. These switches are electro-mechanical sensors that send a signal when activated by the mistracking belt. These switches are installed at intervals along the length of the conveyor on both sides of the belt near the outer limit of safe belt travel. When the belt moves too far in either direction, it pushes over the lever arm to activate a switch or send a signal interrupting the conveyor’s power circuit, stopping the belt so the operator has the opportunity to make corrections (**Figure 16.21**). In many cases, plant personnel will need to walk the conveyor to manually reset the switch before operation can begin again. Some devices have the ability to send multiple signals: the first one an alarm indicating a pre-set amount of belt wander, and the second signal cutting drive power due to a more serious tracking problem.

Of course, the tripping of a belt misalignment switch is a signal indicating something is wrong with the conveyor system. It is like a light on a car instrument panel that shows red when the engine is too

hot. It is possible to ignore this light, to reset the switch and resume conveyor operations, but both the car's warning light and the conveyor misalignment switch should serve as a warning that there may be more serious, more expensive, possibly catastrophic problems. Conveyor stoppages can be a nuisance and very costly; each outage creates downtime and lost production. Belt misalignment switches are not a solution to the problem of misaligned belts; they are an indicator of a severe problem.

Figure 16.21

When the belt moves too far in either direction, the misalignment switch will activate a switch or send a signal interrupting the conveyor's power circuit, stopping the belt.



Passive Tracking Solutions

Vertical Edge Guides

The first impulse on seeing a wandering belt may be to install some sort of barrier to keep the belt straight, or at least keep it away from obstacles (**Figure 16.22**). One version of this simple approach to minor tracking problems is the vertical edge guide (**Figure 16.23**). These devices place a spool or roller on a simple frame close to the belt edge. The vertical edge guides are installed in a position approximately perpendicular to the belt's path to keep the belt edge away from the conveyor structure. These side guides do not train the belt. Rather than preventing belt wander, they perform a damage-control function, allowing the belt to strike a rolling surface rather than unyielding structural steel. Vertical edge guides are most effective on short, low-tension belt installations where the belt can be forced to stay in position through brute force on the edge of the belt. Vertical edge guides can allow severe belt or structure damage when the belt rides up over the guide into the structure or the guide causes the belt to roll over on itself. Vertical edge guides should not be used to compensate for persistent misalignment problems. They are not particularly effective on very thin belts.

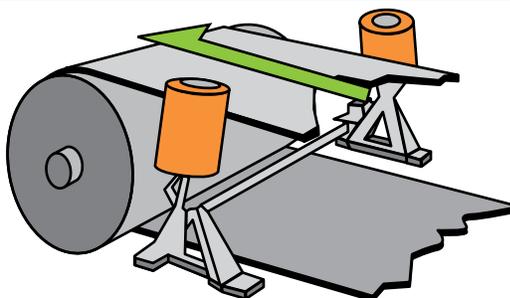
Figure 16.22

The first impulse may be to install some sort of barrier to keep the belt away from obstacles.



Figure 16.23

Vertical edge guides place a spool or roller on a simple frame close to the belt edge to keep the belt away from the conveyor structure.



"Vee" Idlers

Another hardware addition that can help remedy belt wander is the installation of "Vee" idlers on the belt return; they are becoming popular on longer, high-tension

conveyors. They are available in two versions: traditional “Vee” rollers (**Figure 16.24**) and inverted “Vee” rollers (**Figure 16.25**). Both systems form the belt into a trough to assist in steering it into the center. They rely on a centering force to correct the belt path, so they place added stress on the belt, which can lead to damage. These systems are more expensive and require somewhat more maintenance than a conventional return idler.

“Crowned” Pulleys

Pulleys that have larger diameters at the center than at the edges are sometimes used to provide a centering effect (**Figure 16.26**). These “crowned” pulleys operate from the basic tracking principle, also. As the raised portion of the pulley (the crown) touches the belt first, it steers the belt into the center. The outer sections of the belt on both sides then produce a force driving it toward the center. If the belt is centered, these forces cancel each other out. If the belt misaligns and the belt wanders to one side of the pulley, the friction force will be greater on that side, acting to push the belt back toward the center.

Crowned pulleys are most effective on conveyors with short, low-tension belts. With higher-tension or steel-cable belts, little steering effect is obtained from the crown of the pulley. That is because the centering force created is smaller in magnitude than the forces of mistracking and most of the contact force between the belt and pulley is on the outer edges of the pulley due to the transition of the belt. Crowned pulleys are most effective where there is a long unsupported span—four times the belt width or greater—approaching the pulley. As this spacing is not often possible on the carrying side of the conveyor, the use of crowned head pulleys is relatively ineffective and may not be worth the stress it produces in the belt. They are somewhat more effective when used as a conveyor’s tail pulley. (See *Chapter 6: Before the Loading Zone*.) Another problem with crowned pulleys is that they can create inef-

fective belt cleaning, because the cleaning blade(s) may not mate properly with the whole belt surface.

Dynamic Training Solutions

There are a number of dynamic belt-tracking systems: systems that when activated move a component to correct the belt path. These belt-training systems are designed to “self-align.” That means the force of the mistracking belt causes an idler to reposition itself, creating a steering action that directs the belt back into the center.

As with adjusting fixed idlers, the correcting force of a skewed idler approaches a limit as the skew angle of the idler increases. All trainers will eventually reach this limit. It is more effective to stimulate quick, low-angle corrections of belt mistracking than to wait for one larger angle.

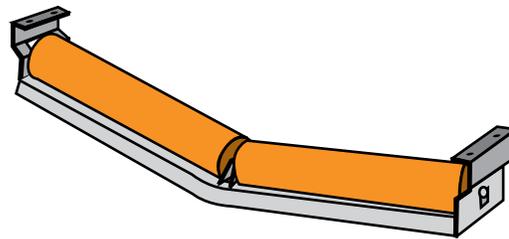


Figure 16.24

Traditional “Vee” idlers form a trough to keep the belt centered.



Figure 16.25

Although installed in an attempt to keep the return run of the belt in alignment, inverted “Vee” idlers risk damage to the belt.

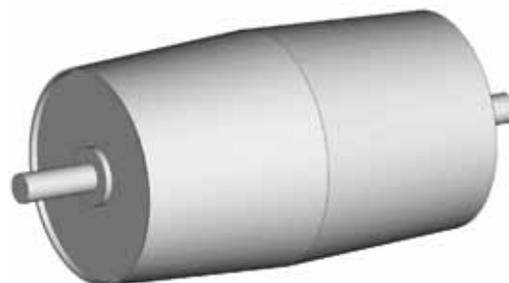


Figure 16.26

Pulleys with a “crown,” or larger diameters at the center than at the edges, are sometimes used to provide a centralizing effect.

Many tracking solutions carry the seeds for their own destruction. Because they are designed to move to provide a correcting influence on the belt path, they are particularly vulnerable to the accumulations of fugitive material. Piles of spillage can block their range of motion or seize the pivot bearing (**Figure 16.27**). This can lock the belt-training idler into a position where it functions as a “misalignment” idler. It now pushes the belt out of the proper track, creating (or worsening) the problem it was installed to correct. To correct the now misaligned system, the maintenance crew may tie the training idler into (approximately)

the right position (**Figure 16.28**). In such case, when a tracking solution is not capable of functioning properly, it is better to remove it, rather than to just “tie it off.”

All these systems work under the disadvantage of being “after the fact.” They correct mistracking after it has occurred. A certain amount of wander must happen before the required correction can take place. But these systems do function as a form of insurance against a problem becoming so severe that the belt suffers costly damage before the mistracking can be discovered and corrected.

In-Line Sensing-Roll Trainers

The simplest belt-trainer design, the in-line sensing-roll trainer, has a carrying roll in a framework mounted on a central pivot bearing (**Figure 16.29**). Vertical guide rolls that act as sensors to the belt’s path are mounted on both sides of the belt in line with the roller, with their centerline running through the idler’s pivot point. Movement of the belt against either of these sensing rolls causes that roll to move in the direction of the belt misalignment. This pivots the entire idler. In keeping with the basic rule of tracking that the belt always moves toward the side it contacts first, the pivoted idler then steers the out-of-track belt back to the proper path.

Yet these in-line sensing rollers have almost no leverage. They require considerable force from the edge of the moving belt to create a correction. With this design, the belt wanders from side to side; the correcting action is caused by the belt literally slamming into one side or the other. When the correcting action takes place, the idler may “kick over” with such force that the belt is then directed all the way over to the other side of the structure; the belt, in turn, contacts the roller on the other side of the tracking idler, which corrects the belt path back in the other direction. Because the tracking idler has a single, central pivot point, belt movement to one side brings the opposite guide roll into a hard, pinching contact against the belt, which can lead to

Figure 16.27

Piles of spillage can block a training idler’s range of motion or seize its pivot bearing.



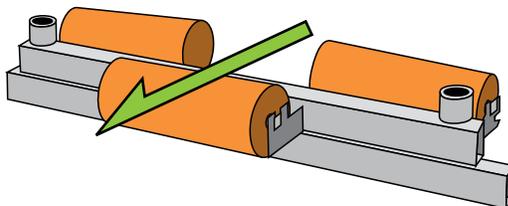
Figure 16.28

To correct a misaligned system, a training idler is sometimes “tied-off”—secured into what is thought to be the right position. But changes in conditions will likely render this position incorrect.



Figure 16.29

The in-line sensing-roll trainer has a carrying roll on a central pivot bearing with vertical guide rolls mounted on both sides of the belt in line with the roller.



edge damage. The belt can be kept constantly in motion, back and forth between the two sides, risking edge damage and overuse of the pivot bearing.

Leading Sensing-Roll Trainers

The most common belt-training design has a carrying roll (or troughing set) held in a framework that is mounted on a central pivot bearing (**Figure 16.30**). Guide rolls are mounted on short arms and positioned 25 to 75 millimeters (1 to 3 in.) from the belt on both sides. The rolls are positioned in advance of the pivoting roller; hence the designation leading sensing-roll trainers (**Figure 16.31**). Some designs tilt the pivot shaft slightly in the direction of belt travel to improve the sensitivity of the trainer. Leading sensing-roll trainers are available designed for use both on the upper (or carrying) side of the belt and on the lower (or return) side.

Movement of the belt against either guide roll causes the steering idler to pivot, correcting the belt path back toward the center. Again, as the belt always moves toward the side it contacts first, the pivoted roll steers the out-of-track belt back to the proper path.

Sensing rollers installed on short arms in advance of the steering idler have slightly more leverage than the in-line sensing idlers, but they still require considerable force from the belt edge to cause correction. Consequently, this trainer design suffers from all the delay, pinching, and fugitive-material problems of the in-line sensing idler.

The leading sensing-roll trainer is the most popular and most common tracking idler. It is supplied as original equipment on almost all new conveyors sold. It is typically installed at intervals of approximately 30 meters (100 ft) on both the carrying and return sides.

In the field, however, these trainers are commonly seen in two unsatisfactory conditions. The first condition is “frozen” from

material accumulations or corrosion of the center pivot (**Figure 16.32**). This problem can be solved with better maintenance or a higher quality pivot point. The second condition is “tied off”—locked in place with a rope or wire—so the training device is the equivalent of a “knocked” idler (**Figure 16.33**). The reason these are “tied

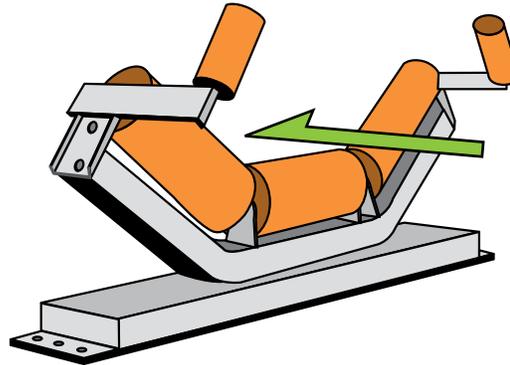


Figure 16.30

The most common belt-training design, the leading sensing-roll trainer, has a central idler mounted on a pivot bearing; guide rolls are positioned on short arms on both sides in advance of the positioning roller.

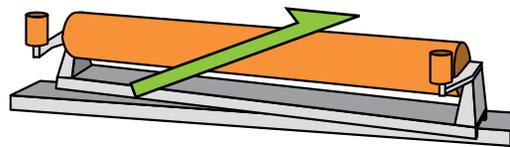


Figure 16.31

On a leading sensing-roll trainer, the guide rolls are mounted on short arms in advance of the pivoting roller.



Figure 16.32

Leading sensing-roll belt trainers are subject to material accumulation that can “freeze” the trainers in place.



Figure 16.33

To control erratic movement, belt trainers are often “tied off” or locked in place with a rope or wire.

off” originates in the design. The sensing rolls swing in an arc about the center pivot; therefore, the rolls must be spaced far enough apart to not pinch the belt when the rolls reach extreme positions. As the pivot becomes fixed in position from material accumulation, lack of maintenance, or corrosion, the idler will not react until the belt has mistracked a distance equal to this wide spacing. Consequently, the idler oversteers and, therefore, becomes an unstable control system. The idlers often overreact, providing unpredictable results, and, as a result, they are frequently “tied off.”

Torsion-Spring Trainers

The torsion-spring trainer is an improved version of the leading sensing-roll trainer (Figure 16.34). This system removes one sensing roll and incorporates a spring into

the pivot (Figure 16.35). This spring keeps the one remaining sensing roll in contact with the belt edge at all times. As the belt mistracks in either direction, the idler will compensate by pivoting and steering the belt.

These spring-loaded leading-sensor trainers tend to have the sensing rolls installed on long arms in advance of the steering idler. This creates more leverage and a greater mechanical advantage in converting belt wander into steering torque. There is no delay in reaction of this trainer, due to the fact that the sensing roll is in constant contact with the belt. There is also no pinching, because there is only one sensing roll. Because of the constant “fine-tuning” action of the idler, it is harder for fugitive material to accumulate to the point it can impede the pivoting action of the tracking device.

One drawback of this trainer is the fact that it cannot function with a troughed idler set. In addition, because the single roller is in constant contact with the belt, this roller is subject to more frequent replacement than those on leading sensing-roll trainers.

Multi-Pivot Belt Trainers

There is another belt-tracking system that uses the force of the wandering belt to position a steering idler and so correct the path. This device uses a multiple-pivot, torque-multiplying system to supply a mechanical advantage to improve belt-path correction (Figure 16.36).

This style of training device transfers the motion of mistracking to the steering idler through a unique parallel linkage (Figure 16.37). This requires less force to initiate the correction, and as it steers, it needs less force to turn the belt. Belt training becomes a continuous, active, precise fine-tuning of the belt path. This design is available in models for the troughed (or carrying side) or the return side of the conveyor (Figure 16.38).

Figure 16.34

The torsion-spring trainer uses only one sensing roll that is in continuous contact with the belt.



Figure 16.35

The torsion-spring trainer incorporates a spring into its pivot point.



Figure 16.36

Multi-pivot belt trainers use a torque-multiplying system to supply a mechanical advantage to improve belt path correction.



This multiple-pivot training device uses guide rolls that are set very close—6 millimeters (1/4 in.) from the belt (**Figure 16.39**). With the rollers set at the edge of the belt, the device can sense smaller movements of the belt and make corrections after very slight misalignments. Rather than waiting for a powerful mistracking force, the multi-pivot belt-training device adjusts constantly, reacting to smaller forces and providing continuous, precise corrections of the steering roller.

The sensing rollers of the multi-pivot trainer use longer arms to increase the distance from the guide rolls to the steering idler. This allows the unit's torque arm to act as a force multiplier, increasing the mechanical advantage of the steering action. As a result, this belt-training system can correct the belt line with one-half the force required for conventional tracking idlers.

Unlike the other training devices, the multiple-pivot device is installed so the belt crosses the steering roller before it reaches the guide rollers (**Figure 16.40**). This means the guide rolls adjust the “corrected” belt path rather than the mistracking belt path. The result is a roller that is continuously working to prevent the belt from moving very far from the proper path. The multi-pivot design allows the rollers to move perpendicular to the structure's centerline while directing the steering idler to the proper angle, instead of pivoting and pinching the belt edge.

Variations of Multi-Pivot Belt Trainers

Several manufacturers have created a slight modification to the multi-pivot belt-training device (**Figure 16.41**). These use the same force amplification geometry, but the idler slides laterally as well as pivoting. With the sliding-idler system, the sensing roll has to overcome the resistance to pivoting as well as the friction force of trying to move an idler from under a belt. This greatly decreases the overall steering force of this training system.

Free-Pivoting Trainers

Manufacturers have developed training idlers in which the steering roll also serves as the sensing roll. With this design, there is a bearing in the center of the roll, so the ends of the roll can pivot around the axis of the roller as well as rotate. The pivot shaft is usually tilted in the direction of

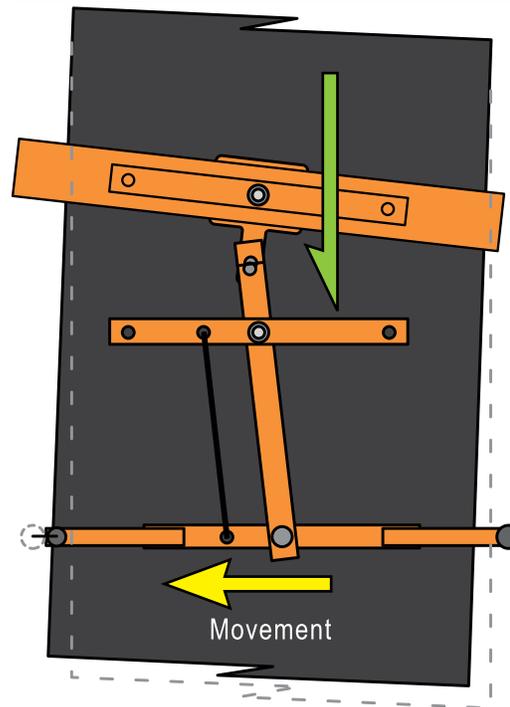


Figure 16.37

Because it transfers the motion of mistracking to the steering idler through a unique parallel linkage, the multi-pivot system requires less force to initiate the correction, and as it steers, it needs less force to turn the belt.



Figure 16.38

The multi-pivot trainer is available in models for the troughed (or carrying side) or the return side of the conveyor.



Figure 16.39

With the rollers set at the edge of the belt, the multiple-pivot training devices can sense smaller movements of the belt and make corrections after very slight misalignments.

belt travel to improve the sensitivity of this type of training idler. Some manufacturers have used a rubber-covered tapered roll to improve the performance of this tracking solution (**Figure 16.42** and **16.43**).

Figure 16.40

With the multiple-pivot training devices, the belt crosses the steering roller before it reaches the guide rollers. This way, the guide rolls adjust the “corrected” belt path rather than the mistracking belt path.

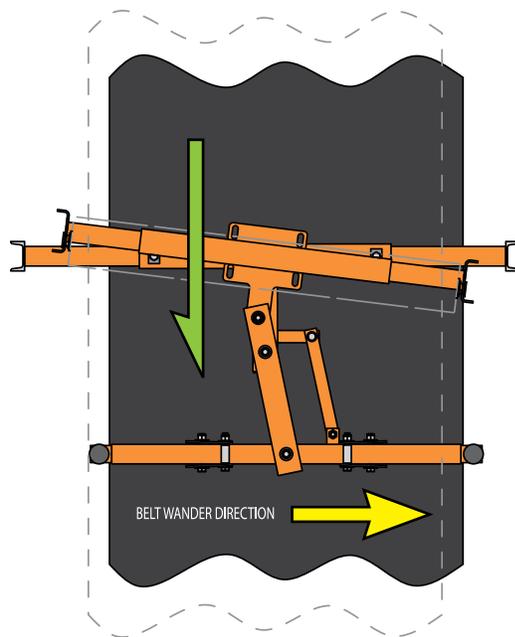


Figure 16.41

Some multi-pivot belt-training devices feature rollers that slide laterally as well as pivot.

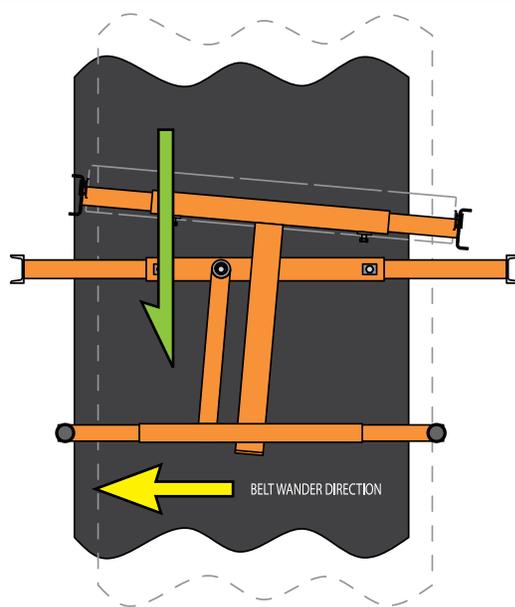


Figure 16.42

Some manufacturers use a rubber-covered tapered roll to improve the performance of the free-pivoting trainer.



When the belt wanders to one side of the roll, it creates a larger friction force on that side. The trainer’s roll will pivot in reaction, moving in the direction that the larger force is pushing it. In accordance with the basic principle of belt steering, the pivoting roll will steer the belt back toward the center. When the belt is moving, the force on each side of the idler evens out, and the idler moves back into a position that is perpendicular to the path of the belt.

While this solution is effective and has very few moving parts, it still contains a complex bearing structure that is susceptible to airborne dust. As the forces that cause the unit to pivot are very small, the unit must be very free to pivot. Such freedom allows the unit to be influenced by many different environmental conditions, thus causing it to pivot when the belt is not wandering.

Trainers for Reversing Conveyors

Conveyors that run in two directions have always been the “last frontier” of belt tracking. With reversing conveyors, even experienced plant personnel are hesitant to adjust the idlers and perform the maintenance “tricks” typically used to train wandering belts. Conventional belt-training devices cannot be used, all for the same reason: because what works to centralize a belt’s path when it runs in one direction may have the opposite effect when the belt direction is reversed. A pivoted idler that correctly steers the belt when the conveyor is operating in one way will work to mistrack a belt moving in the opposite direction.

Some manufacturers have developed trainers for reversing belts. The in-line sensing-roll trainers will correctly steer these belts, because the sensors are not direction dependent. The torsion-spring trainer can be modified to accommodate reversing belts. Adding a second arm and sensor in the opposite direction allows the torsion-spring trainer to switch sensing arms based on the direction of the belt movement (**Figure 16.44**).

These reversing trainers will have the benefits and shortcomings associated with their use on one-direction conveyors.

INSTALLATION OF BELT-TRAINING DEVICES

Training devices can be installed at any point the belt path needs adjustment. They should be installed approximately three to four times the width of the belt in advance of the point of the mistracking. The conveyor must be locked out / tagged out / blocked out / tested out before installing a belt trainer.

The typical places belt-training devices are installed include (Figure 16.45):

- A. Just before the belt enters the tail pulley, to ensure it is centered on the pulley and into the loading zone
- B. Shortly after the loading zone, to make sure the loaded belt is tracking in the center
- C. Just before the discharge pulley, to make sure the belt is in the center before it enters the enclosure and discharges the cargo

Dynamic training devices can be installed over the entire length of conveyor, especially to cover any problems. Training

devices may need to be installed to correct the path at any place the belt enters an enclosure. They should not be positioned so close together that they will “compete,” or contradict each other’s steering action. There should be 21 to 50 meters (70 to 150 ft) between units, depending on the severity of the mistracking problem (Figure 16.46).



Figure 16.43

A rubber-covered roll improves the performance of this belt-training device.

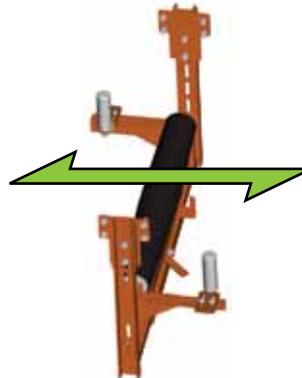


Figure 16.44

Adding a second arm and sensor in the opposite direction allows the torsion-spring trainer to be used on reversing belts.

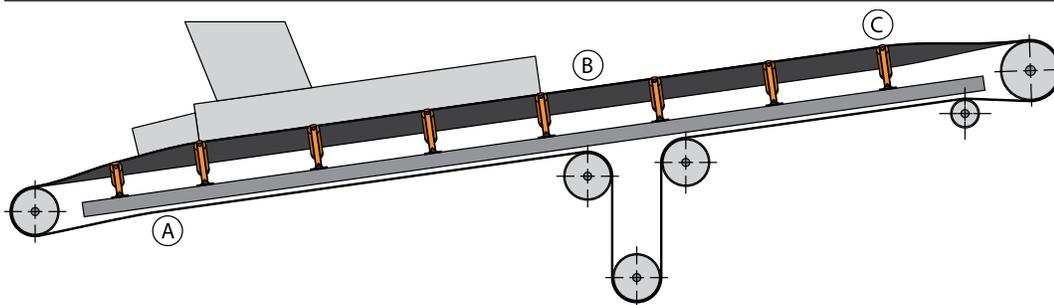


Figure 16.45

The typical places training devices are installed include:
A. Just before the belt enters the tail pulley
B. Shortly after the loading zone
C. Just before the discharge pulley

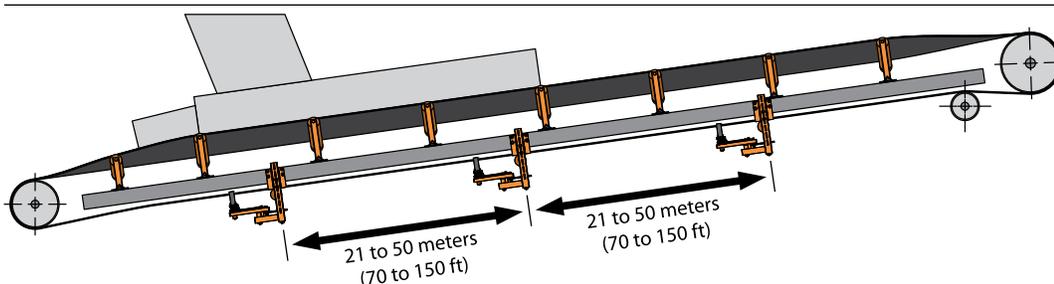
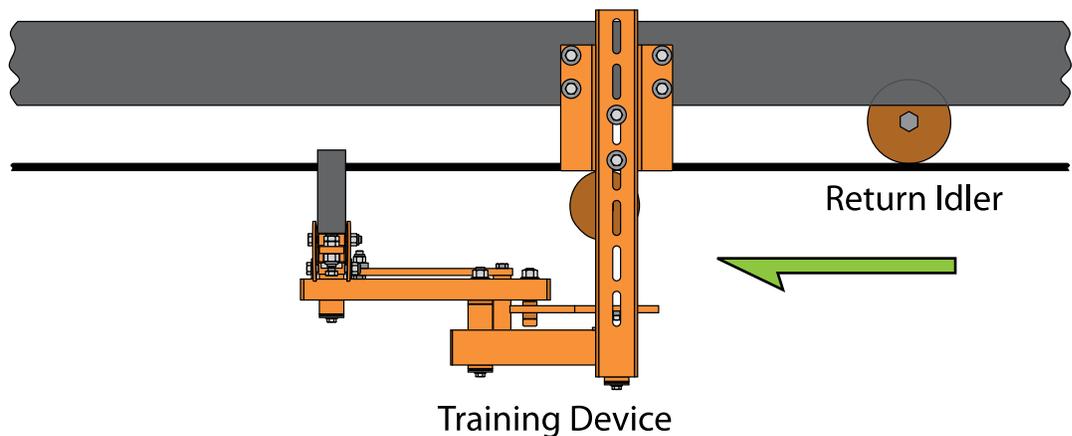


Figure 16.46

Belt trainers should be positioned from 21 to 50 meters (70 to 150 ft) apart to prevent them competing or contradicting each other’s steering action.

Figure 16.47

To improve the performance of return belt-tracking systems, a return idler can be installed before the device above the belt to increase the training idler's grip on the belt.



When installing any form of dynamic training device, the center roll is typically elevated 12 to 19 millimeters (1/2 to 3/4 in.) higher than the rolls of the adjacent conventional idlers. This increases the belt's pressure on the tracking device and improves the corrective action. This is applicable to both troughed (carrying side) and flat (return side) self-aligning idlers. Some training-idler manufacturers build this feature into their various models.

Another technique to improve the performance of return belt-training systems is to reinstall a conventional return idler upstream of the tracking device above the belt to push the belt down, increasing the pressure on the training idler, allowing it to work more effectively (**Figure 16.47**).

Rubber-covered rollers are often useful on belt-tracking devices, particularly where the material is slippery or the belt wet from the climate or the process. These rollers may require replacement more often than "steel can" rollers, but may be necessary to achieve the friction needed to steer the belt.

SYSTEM MAINTENANCE

Tracking a conveyor is a maintenance function. Because a belt is moving and under load, belt training is subject to problems/corrections, requiring on-going inspection and probably maintenance.

Once a belt is properly trained, an operation should include checks on its alignment as part of the on-going maintenance program. The belt's alignment should be reviewed on a regular basis, and minor corrections should be made as needed and documented.

Mechanical training devices should also be inspected regularly. Most mechanical training devices contain moving parts that are vulnerable to contamination. The devices should be inspected to determine that all parts are free to move and the device is still tracking the belt properly. (*See Chapter 27: Conveyor System Survey.*)

Maintenance personnel should look for conditions out of the ordinary or things that have changed that might affect belt



SAFETY CONCERNS

In some facilities, it is common to make adjustments to correct belt tracking while the conveyor is in operation. However, a responsible safety program will always recommend that the conveyor be locked out / tagged out / blocked out / tested out before mak-

ing adjustments to components or the belt tension in order to correct mistracking. While adhering to this practice may require several shutdowns and start-ups of the belt to observe the effect of corrections, it is the safe way to train the belt.

alignment. Changes could be anything such as the addition of a new piece of equipment, a large dent in the structure where a piece of heavy equipment collided with the conveyor, or changes in material condition that affect loading patterns. As seen above, misalignment has many causes, and small disturbances can manifest in a major mistracking incident.

TYPICAL SPECIFICATIONS

Belt-Training Device

A. Belt trainer(s)

To control the path of the belt and prevent belt mistracking, one or more belt-training devices will be installed on the conveyor.

B. Belt-path correction

The belt-training devices will sense any mistracking of the moving belt and use the force of that mistracking to articulate an idler. This idler will steer the belt back into the center of the structure.

C. Location

To keep the belt centered in the conveyor loading zone, one belt-training device will be installed on the conveyor return as the belt enters the tail pulley. To make certain the loaded belt is centered properly, a second belt-training device will be installed at the exit end of the loading zone. Additional training devices will be located along the conveyor as required to correct belt wander.

ADVANCED TOPICS

Power Consumption and Belt Trainers

Any alteration in a conveyor's rolling equipment, from skewing idlers to installing special mechanical training devices, has implications for the system's power requirements.

There are several styles of training idlers, all designed to exert a centering force on the belt perpendicular to its direction of travel. This centering force must be considered in calculation of the power consumption of the conveyor.

Analyzing the power consumption of a training idler requires knowledge of the load on the idler. This load is due to the weight of the belt and any component of the belt tension arising from the idler misalignment. In operation, the typical training idler can pivot from 2 to 5 degrees. It is common practice to install training idlers 12 to 19 millimeters (1/2 to 3/4 in.) above the standard idlers. This results in greater load on these idlers, which creates enough centering force to influence the travel of the loaded belt. This extra load is described by The Conveyor Equipment Manufacturers Association (CEMA) in *BELT CONVEYORS for BULK MATERIALS, Sixth Edition*, as idler misalignment load (IML).

When an idler is pivoted, it will exert a force on the belt in a direction perpendicular to the pivoted idler. This is called the

$Tr = PIW \cdot BW \cdot \tan \phi$			
Given: A 450-millimeter (18-in.) belt with a tension of 17,5 newtons per millimeter (100 lb _f /in.) travels over an idler that is pivoted 3,5 degrees. Find: The misalignment force due to the idler.			
	Variables	Metric Units	Imperial Units
Tr	Misalignment Force	newtons	pounds-force
PIW	Belt Tension per Unit of Belt Width	17,5 N/mm	100 lb _f /in.
BW	Belt Width	450 mm	18 in.
φ	Idler Misalignment	3,5°	3.5°
Metric: $Tr = 17,5 \cdot 450 \cdot \tan 3,5 = 481$			
Imperial: $Tr = 100 \cdot 18 \cdot \tan 3.5 = 110$			
Tr	Misalignment Force	481 N	110 lb _f

Equation 16.1

Calculating Misalignment Force

16

misalignment force and can be calculated (**Equation 16.1**).

The component of the misalignment force in the direction of belt travel is called the misalignment drag force and can also be calculated (**Equation 16.2**).

The misalignment drag force is used to find the power required to compensate for a tracking idler (**Equation 16.3**).

This additional power requirement should be multiplied by the number of tracking idlers installed.

It is interesting to note that an 1800-milimeter (72-in.) belt with 175 newtons per millimeter (500 PIW) slack-side tension would have a centering force of approximately 9640 newtons (2200 lb_f) and a centering force component in the direction

of travel of approximately 589 newtons (134 lb_f). A tracking idler on this belt would require 1,177 kilowatts (1.6 hp) per tracking idler.

If the training idler becomes frozen and is neither rotating nor pivoting, it can add a substantial power requirement.

The power consumed by the tracking solutions should be considered when selecting a tracking solution. While some methods of training may be effective, the solution could draw more power than the drive of the conveyor can deliver. Most engineering companies include a healthy safety factor to account for unknowns such as this when designing a conveyor, but it is in an operation's best interest to verify its conveyor(s) have sufficient power to handle these increased loads.

Equation 16.2

Calculating Misalignment Drag Force

$$T_m = T_r \cdot \sin \phi$$

Given: A misalignment force of 481 newtons (110 lb_f) and an idler pivot of 3,5 degrees. **Find:** The misalignment drag force.

Variables		Metric Units	Imperial Units
T_m	Misalignment Drag Force	newtons	pounds-force
T_r	Misalignment Force (Calculated in Equation 16.1)	481 N	110 lb _f
φ	Idler Misalignment	3,5°	3.5°
Metric: $T_m = 481 \cdot \sin 3,5^\circ = 29$			
Imperial: $T_m = 110 \cdot \sin 3.5^\circ = 6.7$			
T_m	Misalignment Drag Force	29 N	6.7 lb _f

Equation 16.3

Calculating Power to Compensate for a Training Idler

$$P = T_m \cdot V \cdot f \cdot k$$

Given: A misaligned idler exerts 29 newtons (6.7 lb_f) on a conveyor system. The belt is traveling at 2 meters per second (400 ft/min). The interface friction between the belt and the idler is 1. **Find:** The power added to the drive due to the training idler.

Variables		Metric Units	Imperial Units
P	Power Added to Belt Drive	kilowatts	horsepower
T_m	Misalignment Drag Force (Calculated in Equation 16.2)	29 N	6.7 lb _f
V	Belt Speed	2,0 m/s	400 ft/min
f	Friction Coefficient	1,0	1.0
k	Conversion Factor	1/1000	1/33000
Metric: $P = \frac{29 \cdot 2 \cdot 1}{1000} = 0,058$			
Imperial: $P = \frac{6.7 \cdot 400 \cdot 1}{33000} = 0.081$			
P	Power Added to Belt Drive	0,058 kW	0.081 hp

BELTS IN THE REAL WORLD

In Closing...

In the real world, conveyor belts wander. But allowing a belt to chronically mistrack can lead to personal injury, release of fugitive materials, and belt and structural damage. However, training a belt without some knowledge of the effects of the training actions can result in increased energy usage, component failure, and belt damage.

There are a variety of self-aligning idlers that can help control belt tracking. But it is wise to note that conveyor operations should not depend on these training idlers to overcome gross misalignment of conveyor structure or significant and continuing loading problems. The continuous working of a training idler indicates more serious problems that should be identified and corrected. It is much better to discover what the real problem is and make the necessary corrections.

While belt wander is a complex problem, it can be controlled by systematically and proactively identifying the root causes of mistracking and eliminating them. Training a belt is a skill that takes time to learn and is best left to a qualified and experienced employee or specialty contractor.

Looking Ahead...

This chapter about Belt Alignment, the last chapter in the section Return Run of the Belt, explained how fugitive materials can cause belt mistracking and how, in turn, belt mistracking can cause increased fugitive material. The following chapter, Dust Management Overview, begins the next section about Dust Management.

REFERENCES

- 16.1 Cukor, Clar. (Undated). *Tracking: A Monograph*. Scottdale, Georgia: Georgia Duck and Cordage Mill (now Fenner Dunlop).
- 16.2 Barfoot, Greg J. (January/March 1995). "Quantifying the Effect of Idler Misalignment on Belt Conveyor Tracking," *Bulk Solids Handling*, Volume 15, #1, pp. 33–35. Clausthal Zellerfeld, Germany: Trans Tech Publications.