chapter 9

Edge Sealing Systems

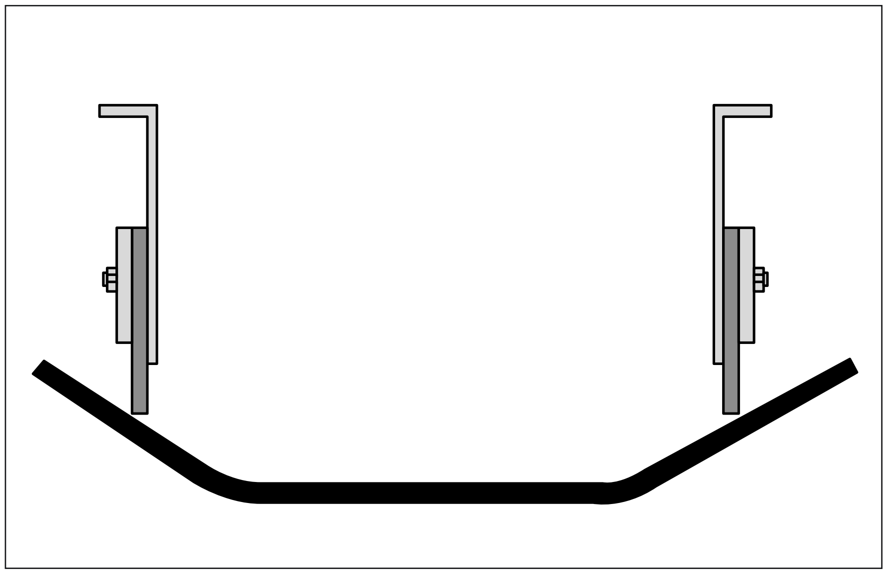

Figure 9.1

The sealing system is installed below the skirtboard to keep the material on the belt.

"The proper application of belt support and wear liner allows the sealing system the opportunity to work effectively."

Another requirement in a transfer point designed for reduced spillage and high efficiency is an effective sealing system at the edges of the belt in the loading zone. **(Figure 9.1)** This is typically a flexible elastomer strip installed on the sides of the skirtboard on either side of the belt to bridge the gap between the steel structures and the moving belt.

Some might argue that the application of the sealing rubber should be the first step or primary requirement for sealing a conveyor transfer point (rather than the final step). After all, the containment of fugitive materials is the sole reason for the sealing system's existence. However, this view does not address the problems of belt sag and the forces of material side loading. The performance of any sealing system suffers when the crucial first steps of installing proper belt support and wear liner are not taken. The proper application of belt support and wear liner allows the sealing system the opportunity to work effectively.

The Goals of a Sealing System

The goals of any sealing system is to effectively contain material fines to keep material on the belt. Desirable attributes include minimum contact area and downward pressure to reduce drag against the conveyor power supply and minimize wear on the belt and seal.

Belts suffer wear along the skirted area at a set distance in from either edge of the belt. Often the sealing system is blamed for this wear. However, most often this wear is not caused by abrasion from the sealing strip, but rather from the material entrapped in the seal or skirtboard seal that is held against the moving belt.

What Sealing Systems Can Do and Cannot Do

In the past, the elastomer sealing strip has been expected to perform an almost miraculous function. It would be installed in a straight line on an unloaded belt, and then be expected to provide a leak-proof seal when the belt was deflected under load. If the deflection (or sag) of the loaded belt could be accurately predicted, and the skirt rubber cut into the proper "roller coaster" shape and installed and maintained in that shape, theoretically an effective seal would be created.

However, as a conveyor belt travels, the seal will wear at different rates along its length, making it unrealistic to attempt to create this type of seal over the long run.

When the belt is not properly supported or there is no wear lining, the elastomer edge seal is asked to act as a dam to contain the full weight of the material load. To ask these flexible sealing strips to do more than contain dust on the belt is asking for the unattainable. Elastomer strips are not suited for this purpose. The pressure from the weight of the material load quickly abrades the belt and the sealing strip, or pushes the strip away from the wall or up from the belt. These failures allow the resumption and acceleration of spillage. **(Figure 9.2)**

In an attempt to stop the escape of particles, plant personnel will adjust their sealing systems down to the belt, increasing the sealing pressure. But this adjustment can lead to several undesirable results. Any pressure beyond a gentle "kiss" of the seal onto the belt results in increased friction. The increase in pressure can raise the conveyor's power requirements, sometimes to the point where it is possible to stop the belt. In addition, the increased friction causes a heat buildup that will soften the sealing strip elastomer. This shortens its life, sometimes to the point where the seal will virtually melt away. Wear will be most obvious at the points where there is the highest pressure. Typically, this is directly above the idlers.

A more practical solution is the application of wear liner and belt support as discussed in this volume. If proper belt support and wear liner are provided, the edge-sealing problem is nearly solved. In that case, the mission of the skirtboard seal becomes only to contain any small pieces of material and fines that pass under the wear liner. This is a chore a well-designed, well-installed, well-maintained sealing system can perform.

Engineered Sealing Systems

The job of sealing a transfer point is challenging. Even in the best transfer points where the belt tracks properly on a stable line, the sealing system must face a certain amount of sideways motion and vibration, due to variations in load and conditions. The sealing system must conform to these fluctuations in belt travel to form an effective seal. The system also needs to be rugged to stand up to belt abrasion and splice impact without undue wear and without catching the splice. The system should also offer a simple mechanism adjustment to compensate for wear over time.

No sealing system can stand up for long in the face of abuse from the material load. If the seals are not sheltered from the material flow, both the effectiveness and the life of the sealing strips will be diminished. When you get the impact of the loading material onto a sealing system, the loading material forces the sealing strips down onto the belt, accelerating wear in both seal and belt. The transfer point should be constructed to avoid both loading impacts on the seals and material flow against the seals.

Figure 9.2

Spillage at transfer points can quickly accumulate in piles beside the conveyor.

Figure 9.3

Laying a large rope against the skirtboard is one crude attempt to prevent spillage.

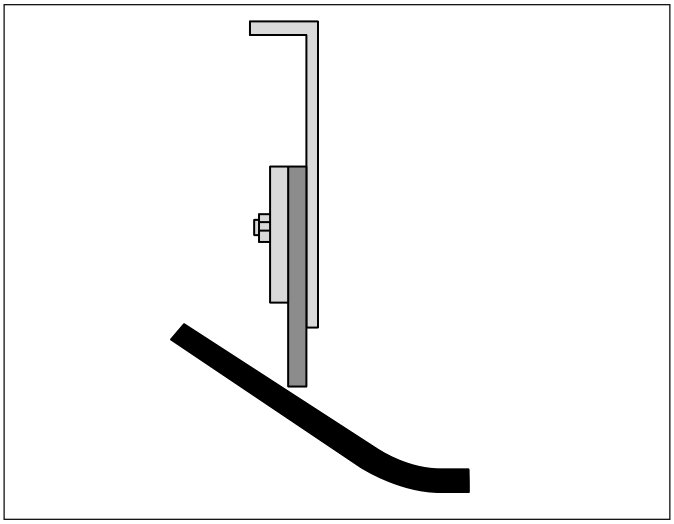

Figure 9.4

"Straight up and down" sealing systems extend down from the skirtboard.

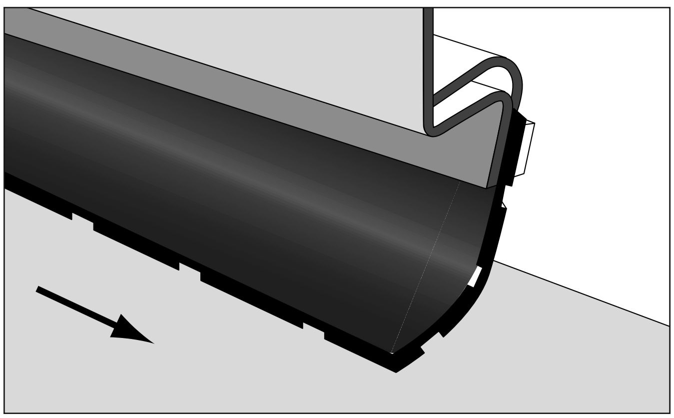

Figure 9.5

A sealing system that lies on the belt underneath or inside the skirtboard may limit the cargo-carrying area.

Figure 9.6

A sealing system that is placed inside the chute wall faces abuse from the material load, and may reduce capacity.

The first skirt seals were fabricated in-house from readily available materials such as used belting and large "barge" ropes. **(Figure 9.3)** These primitive systems were pushed down onto the belt edges and held their position due to gravity. But these systems were not very successful. They could become loaded with material, that would abrade the belt, and they lacked a method to adjust for wear. Eventually, the lack of success with these homemade techniques led to the desire for more effective systems.

In the last fifteen to twenty years, much work has been done to develop systems that effectively meet sealing requirements. The state of the art in the engineering of transfer point components has progressed from sealing strips that could barely contain lumps of material to the current systems that can prevent the escape of fines and even dust. There are a number of sealing systems now commercially available. In general, they consist of long strips of an elastomer held against the lower edge of the skirtboard by an arrangement of clamps.

Innies, Outies, and Straight Up and Down

There are a number of different approaches to skirtboard sealing. Like belly buttons, there are "innies," "outies," and a few that are pretty much straight up and down. In other words, there are some that stick back inside the chute, some that are on the outside of the skirtboard, and some that stick straight down from the skirtboard.

The "straight up and down" systems typically use just a rubber strip; it may be a compliment to call them engineered systems. **(Figure 9.4)** Typically, one supplier offers a system of clamps, and another provides the rubber strip. Sometimes a specially fabricated elastomer strip is installed; other times, strips of used belting have been applied.

A specific caution must be given against the use of old, used, or leftover belting as a skirting seal. Used belting may be impregnated with abrasive materials–sand, cinders, or fines–from its years of service. In addition, all belting contains fabric reinforcement or steel cord. These embedded materials can grind away at the moving belt, wearing its cover and leading to premature failure and costly replacement.

Sealing on the Inside

Some sealing systems are clamped on the outside of the chute, and then curl the sealing strip back under the steel to form a seal on the inside of the chute wall. **(Figure 9.5)** These "innie" systems work well on conveyors with light, fluffy materials and fine, non-abrasive materials such as carbon black.

This may be an attempt to minimize the edge distance requirement and so increase the working capacity of the belt. Another advantage of this design is it is less vulnerable to damage from belt mistracking. But this system has some weaknesses, too.

As noted earlier, wear liner is a major factor in protecting the sealing system. The wear liner prevents side-loading forces of the material from pushing the material out to the edge of the belt. Even the protective benefit from the installation of wear liner is neutralized if the sealing system reaches back under the chute wall and places the sealing strip on the inside of the steel. **(Figure 9.6)** In this position, it can easily be damaged by the load forces.

Other problems have been noted with this "inside the chute" sealing system design. Material can work under the strip as it lies on the belt inside or under the chutework and abrade a wider area of the belt surface. In addition, negative air pressure inside the chute created by the dust collection system may lift these sealing strips off the belt, allowing dust to escape. In contrast, sealing strips that are installed on the outside of the skirtboard steel are pulled down onto the belt by the negative air pressure created by the dust collection system.

In addition to the reduced wear life cited above, this design induces another problem. As this skirting is inside the chute, it can reduce the usable area of the belt by taking up space where the load could be carried. Due to a "rainbow" effect, moving in the edges of the carrying area reduces capacity all the way across the belt. If the skirting seals are positioned inside the chute, the carrying capacity of the belt is reduced. **(Figure 9.7)**

It is important to remember that the chute and transfer point are designed for an established rate of flow by providing a constant load on the belt. But rarely is flow constant. Rather, it is a question of surges, peaks, and valleys. In addition, the action of loading has caused the volume of material to expand beyond its normal density. As a result, the material pile inside the loading zone spreads, so it stands wider on the belt. Due to this "rainbow" effect, moving in the edges of the carrying area reduces capacity all the way across the belt. If the skirting seals are positioned inside the chute, the carrying capacity of the belt is reduced.

The time when the seal should be placed inside the skirtboard is when there is too little free belt area outside the skirtboard to allow effective sealing. In this case, an "outside" design is more likely to create or allow damage to belt or sealing system from belt mistracking and spillage.

Outside Sealing Systems

It is often critical to overall plant efficiency to maintain the capacity of a conveyor. History has demonstrated that demand on systems goes up rather than down. Conveyors are called on to carry more material, at faster speeds, on shorter operating schedules. The last thing any plant should want is to reduce its conveyor capacity by placing its sealing system on the inside of its skirtboard inside the loading zone.

It is much better to place the seals on the outside of the chutework. When the sealing system is positioned outside the skirtboard steel, it is removed and protected from the severe downward and outward forces of material loading. **(Figure 9.8)** The installation of wear liner inside the skirtboard creates a dam to keep the weight of the material load away from the sealing strips. Now the system can seal effectively without reducing capacity and without being subjected to a barrage of

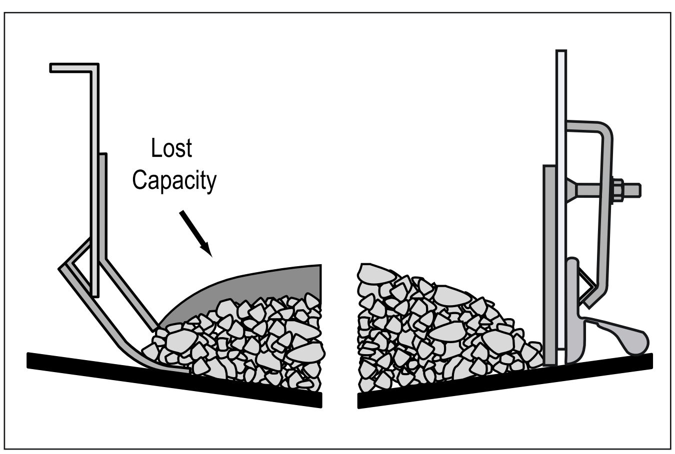

Figure 9.7

Due to the "rainbow effect," moving the edge of the material in will reduce capacity across the full width of the belt.

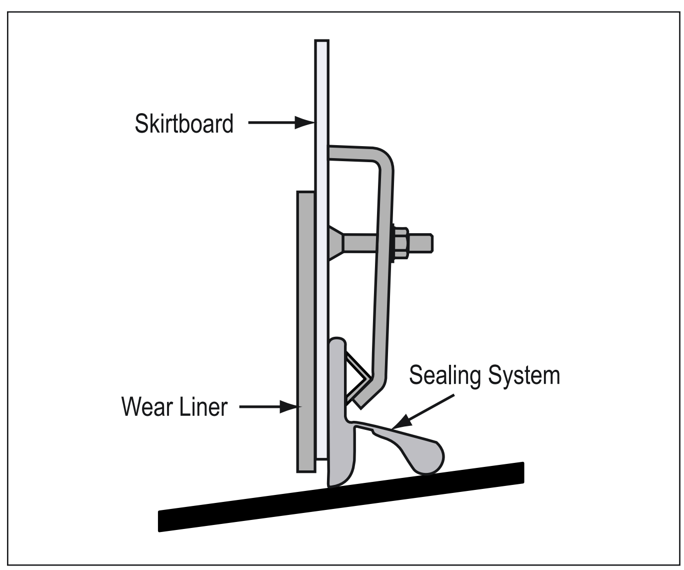

Figure 9.8

Wear liner will protect the sealing system from the force of the material load and allow the seal to contain fines and dust.

material. The conveyor can use the full capacity of the belt without artificial limitations, and the belt's service life is greatly increased.

It is critical that there is adequate free belt area to allow effective sealing. Free belt area–the amount of belt outside the skirtboard on either side of the conveyor–provides the space available for sealing. Too often, in the interest of putting the greatest load on the narrowest belt, the belt free area is reduced. This invariably comes at the price of ineffective sealing systems. The required edge distance for any sealing system must be provided, or the system risks failure.

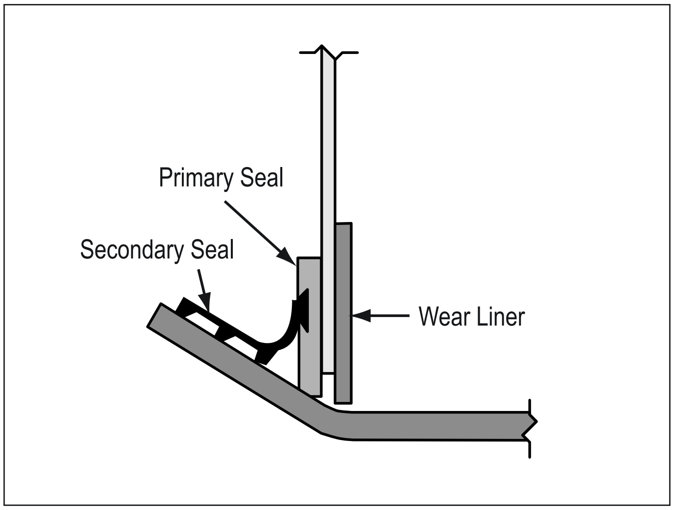

Figure 9.9

An effective multiple-barrier sealing system incorporates wear liner, a primary sealing strip, and a secondary strip.

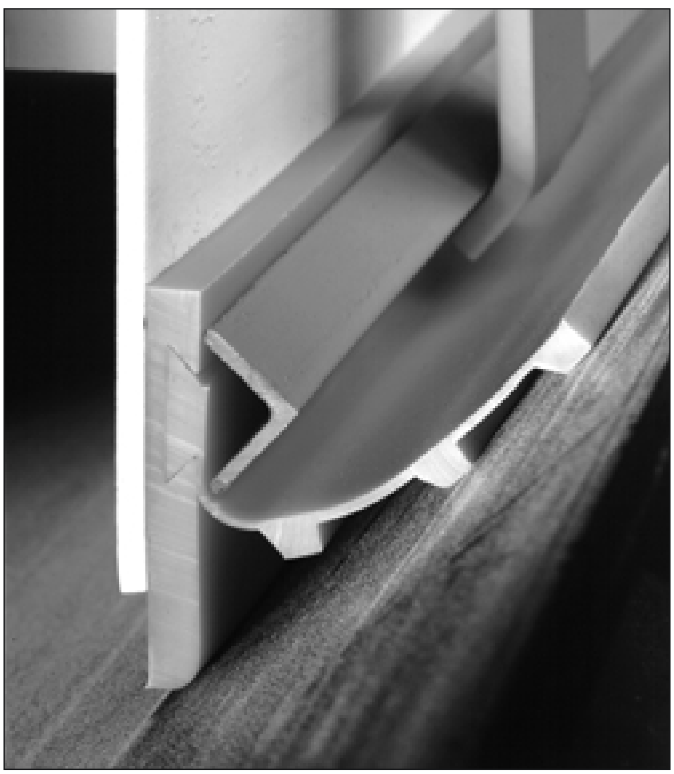

Figure 9.10

This multiple-layer sealing system uses a primary seal that is pushed gently down on the belt and a secondary strip that captures fines in its ribs.

For more information on free belt area and effective belt width, see Chapter 6.

Dressing in Layers

When outdoor sportsmen such as mountain climbers, hunters, and skiers prepare for cold-weather activities, they dress in layers. They know it is better to put on multiple layers of clothing–undershirt, shirt, sweatshirt, and jacket–than to wear one thick layer. The same is true for transfer point sealing: it is better to work with several thin layers than one thick, all-purpose one.

The first layer is provided by the wear liner installed inside the chute. Extending down to less than one inch (25 mm) off the belt, it keeps the larger particles (and the large volumes of material) well away from the belt edge.

The sealing system provides the next barrier. Now, in the interest of improved performance, sealing systems have been developed that, rather than relying on a single strip, also use multiple layers. These sealing systems incorporate two layers; a primary strip that is pushed gently down to the belt to contain most particles, and a secondary strip that lies on the belt's outer edge to contain any fines that push under the wear liner and primary strip. **(Figure 9.9)** These secondary strips contain a channel to capture the fines, eventually redirecting the particles into the main body of material.

A castle has a moat for outer defense, a wall for an inner defense, and a stronghold or keep for final defense. An effective sealing system uses the same "layer" principles to contain material. The wear liner on the inside of the chute forms the first line of defense, a primary sealing strip forms the inner wall, a secondary seal provides the final barrier to the escape of fugitive material.

A Low-Pressure Multiple-Layer System

One successful multiple seal installed on the outside of the skirtboard uses a two-component system. It is composed of two strips of urethane: a primary strip and a secondary strip, installed one in front of the other to form an effective seal. **(Figure 9.10)** The primary strip clamps against the outside of the chutework and extends vertically down to lightly touch the belt. It is applied with light pressure: the clamp applies force horizontally toward the chute, rather than down onto the belt. Because the clamping force is horizontal (against the chute) rather than vertical (down onto the belt), this primary strip contains material without the application of pressure that increases wear and conveyor power consumption. This primary strip contains most of the material that has escaped past the chute's wear liner.

The secondary sealing strip is joined to the back of the primary with a dovetail and lies on the belt's outer edge like an apron. It is designed with ridges or legs molded into its surface to capture any fugitive material that has passed under the primary seal. This fugitive material is then carried down the belt in the tunnels formed by these legs. With these tunnels, the material is trapped until it reaches the end of the sealing strip. By that time, the material has settled, and will fall back into the main material stream.

The secondary sealing strip requires only the force of its own elasticity to provide sealing tension against the belt, and consequently, will wear a long time without the need for adjustment.

This sealing system works well with many types of clamps, allowing reuse of old ones or the purchase of inexpensive new ones. These clamps install on the exterior of the chute or skirtboard without needing any backing plate system.

Because this multiple-layer sealing system lies on the outside of the chute, it does not reduce the conveyor's load capacity and is not subject to abuse from the material load.

Multiple Layers with a Single Strip

Recently, a twist has been added to this multiple-layer concept. New designs combine multiple-layer seal effectiveness with the simplicity of single strip systems. These designs feature a rugged single-strip that is manufactured with a molded-in flap that serves as a secondary seal. **(Figure 9.11)** This "outrigger" contains the fines that have passed under the primary portion of the single strip. As this sealing strip is a one-piece extrusion, installation is a simple procedure without requiring the assembly of two components. Single-piece, multiple-layer sealing systems are now available in both standard and heavy-duty constructions.

Floating Skirting Systems

Another sealing system uses sealing strips mounted to the steel skirtboard on independent, freely-rotating link arms. **(Figure 9.12)** The links allow the sealing strip to float, reacting with changes in the belt line while remaining in sealing contact with the belt. This system also allows the sealing system to self-adjust, using its own weight to compensate for wear. **(Figure 9.13)**

Edge Distance Requirements

Care must be taken in selecting an edge sealing system to fit into the available distance between the belt's edge and the steel skirtboard. It is generally not a good idea to have the sealing strips all the way out to the belt edge, as this risks damage in the event of even minor belt mistracking. It is better to have additional belt width outside the sealing strip to allow for belt wander and to act as an additional distance for material to pass before escape.

In general, three inches (75 mm) of edge distance outside the chute wall is recommended as the minimum distance to establish an effective seal for conveyor belts 18-30 inches (450 to 750 mm) in width. For conveyor belts 36 inches (900 mm) and above, a minimum of four inches (100 mm) edge distance is recommended. As the edge distance is diminished toward the minimum, it becomes more critical to control belt tracking through the use of belt training devices. *A more detailed discussion of skirtboard width and belt edge distance is presented in Chapter 7: Skirtboard.*

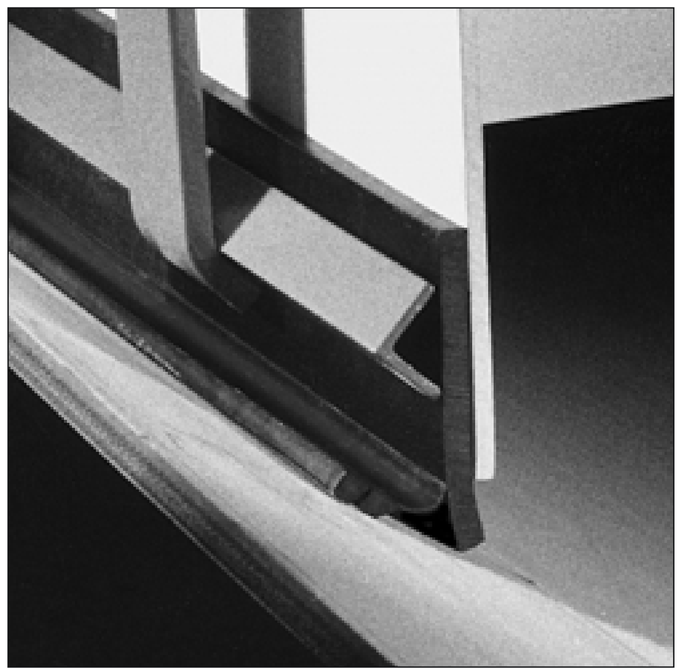

Figure 9.11

This multiple-layer sealing system is composed of a single strip of elastomer.

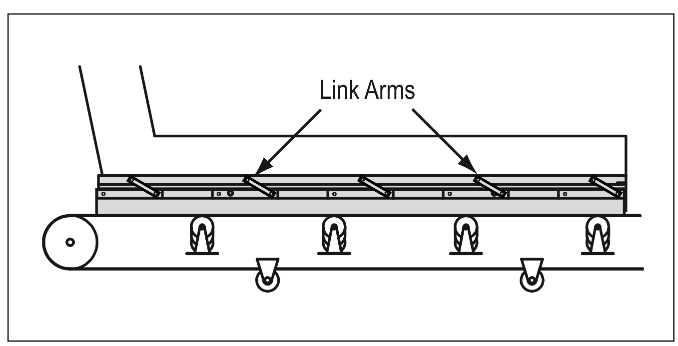

Figure 9.12

The floating skirting system remains in contact with the belt as its line fluctuates under various loading conditions.

Power Requirements of Sealing Systems

In order to be effective in keeping material on the belt, sealing materials must exert some amount of pressure against the belt. This pressure will increase the drag against the belt, and hence increase the power consumption of the conveyor. This additional power requirement is generally independent of the width of the belt or the width of the seal material. It is directly dependent on the length of the seal and the pressure applied to the seal to keep it down on the belt.

In the book *Belt Conveyors for Bulk Materials,* CEMA uses a pressure of three pounds tension per foot (4.5 kg/m) of seal as its standard reference. Tension equals the force perpendicular to the belt times the coefficient of friction. (Remember, any transfer point must be sealed on both sides, effectively doubling the tension added per unit length.) In test facilities and actual field situations, it has been found that many skirtboard sealing systems can be adjusted down onto the belt with very high levels of force. In these cases, the CEMA standard underestimates the actual tension applied to the belt.

The multiple-layer sealing system recommended above relies only on the pressure supplied by the resilience of the "outrigger" leg, and therefore seals with much less pressure down against the belt. The clamping pressure is applied horizontally against the steel skirtboard rather than vertically against the belt. It applies much less tension to the belt, and consequently consumes less conveyor power.

For demonstration purposes, the pressure that sealing materials exert against the belt was chosen as 6 lb/ft (8.9 kg/m) for rubber strip, rubber segments, and UHMW wear liner/seal combination, and 1 lb/ft (1.5 kg/m) for the multiple-layer seal. These figures have been found to present a reasonable approximation of the start-up power requirements as measured in the field. The running power requirement is typically one-half to two-thirds of the start-up power requirement. If actual conditions are known, the actual power requirements or tension should be calculated and used.

Comparing Sealing System Power Consumption

Figure 9.14 displays the approximate power consumption for sealing systems composed of the following materials:

A. Rubber Slab (60 to 70 Shore D SBR Rubber).
B. UHMW Wear Liner/Seal Combination (Wear liner extends down to touch the belt).
C. Multiple-Layer Sealing System (Urethane).
D. CEMA Standard (For Reference).

This chart is based on friction factors of 0.75 for a rubber sealing system on rubber belt and 0.545 for UHMW side rail support on rubber belt. These friction factors are based on actual tests against rubber belting, both with and without material present.

Figure 9.13

Link arms allow this sealing system to self-adjust, using its own weight to compensate for wear.

These tables provide a means of estimating the power required for edge sealing. By multiplying the length of one side of a transfer point by the belt speed and then studying the figures, a reasonable estimation of start-up power consumption required by the conveyor sealing system can be determined.

The power requirements for Sealing Systems A., B., and C. above have been calculated using a side rail sealing support cradle under the belt. The CEMA standard was determined using standard idler belt support.

For example, a transfer point that is 20 feet (6 m) long and operates at 400 fpm (2 m/sec) with a rubber strip seal and side rail support would have a start-up power requirement of approximately 3.7 hp (2.8 kW). In contrast, the use of a multiple-layer sealing system on the same transfer point would consume only 0.62 hp (0.5 kW).

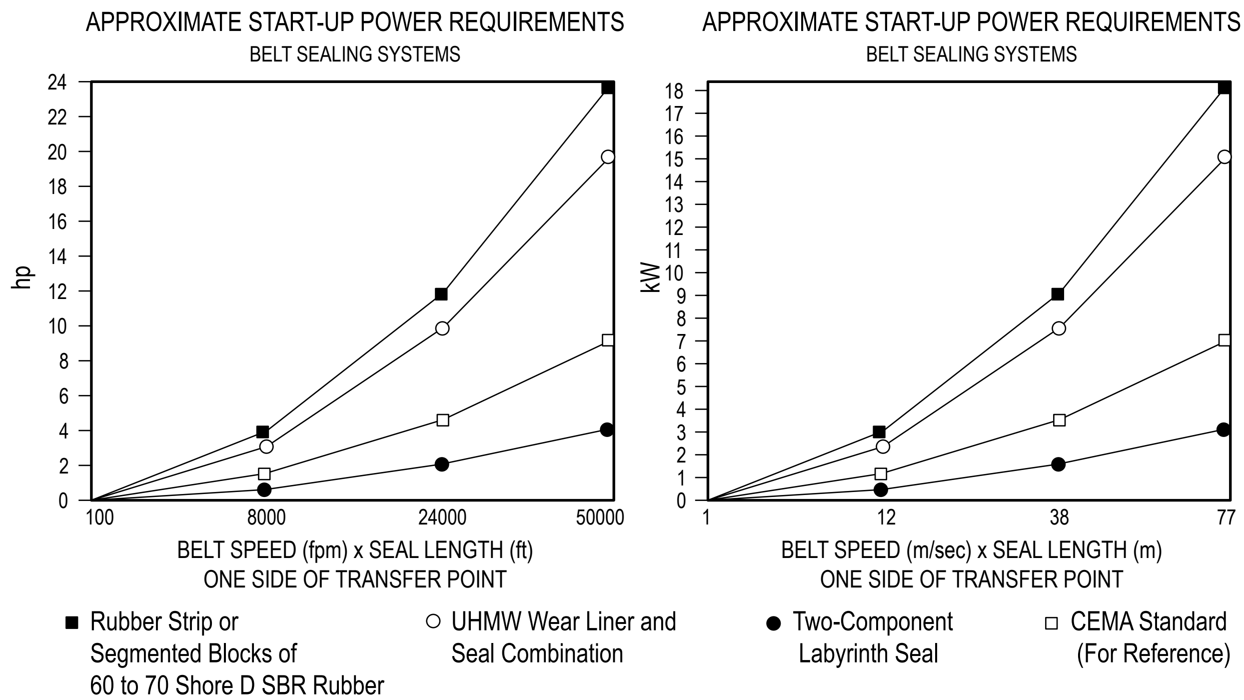

Figure 9.14

Approximate Start-Up Power Requirements of Various Belt Sealing Systems.

Sealing Systems and Belt Cover Wear

A research project was done to determine to what extent engineered belt cleaning and sealing systems increased or decreased belt wear. This study tested the abrasion of several edge sealing systems against a typical conveyor belting. The conclusions of the study report the use of more sophisticated belt cleaning and sealing systems with adequate maintenance can extend the life of the conveyor belt. While belt wear is introduced by these devices, the amount of this wear is approximately one-half the rate to be expected when the belt runs through accumulations of fugitive material, resulting from the lack of (or failure of) cleaning and sealing systems.

Skirt Seals and Belt Wander

All skirt sealing systems are vulnerable to damage from a mistracking belt. If the belt wanders out from underneath one side of the skirtboard, the then-unsupported sealing strip will hang down below the line of the belt, regardless of whether its normal position is inside or outside the chute. When the belt moves back into the proper position, the seal will be abraded from contact with the edge of the moving belt. Or it can be bent backward into an unnatural position and worn away. Either outcome risks a significant increase in spillage.

Having adequate edge distance is an advantage, as the more free belt area provided, the more the belt can wander before it risks significant damage. But key to avoiding this damage, of course, is to control belt tracking.

For information on control of conveyor belt tracking, see Chapter 15.

Avoiding Grooves in the Belt

It is a common misconception that the sealing system must be “softer” than the belt cover, so the seal wears before the belt. Usually softer materials are more cut resistant and, therefore, provide longer life. However, it is possible to make seals from materials with a wide range of hardness and wear resistance. The key is to avoid material entrapment and high pressure against the belt.

Grooves in the belt underneath the skirtboard are often blamed on the sealing system. These grooves can be caused by excessive pressure between the skirt and the belt that can heat the cover to the point it loses its wear resistance.

Grooves are often started by the entrapment of lumps of material between the liner and the belt. This starts out scratching the surface and gradually wears away the belt cover. Loading while the belt is in transition makes it easy for material to be trapped under the skirtboard.

A key to minimizing grooves in the belt is to make the skirt sealing system sacrificial. This is done by making sure the sealing strip has a lower abrasion resistance than the belt and by making sure the strip has the flexibility to move out of the way when a lump of material moves underneath the skirtboard.

To avoid grooving the belt, a transfer point must have proper belt support, effective wear liner, and light sealing pressure.

Installation Guidelines

A sealing system must form a continuous unit along the sides of the steel skirtboard. If simple, end-to-end butt joints are employed to splice lengths of sealing strip together, material will eventually push between the adjoining surfaces and leak out. An interlocking or overlapping joint is best to prevent this spillage.

With all strip skirting systems, it is a good idea to "round off" the strip's leading edge at the tail end of the conveyor where the belt enters the back of the loading zone. **(Figure 9.15)** By presenting a rounded edge to the belt, this reduces the chance a mechanical belt fastener can catch the strip to rip it or pull it off the chute.

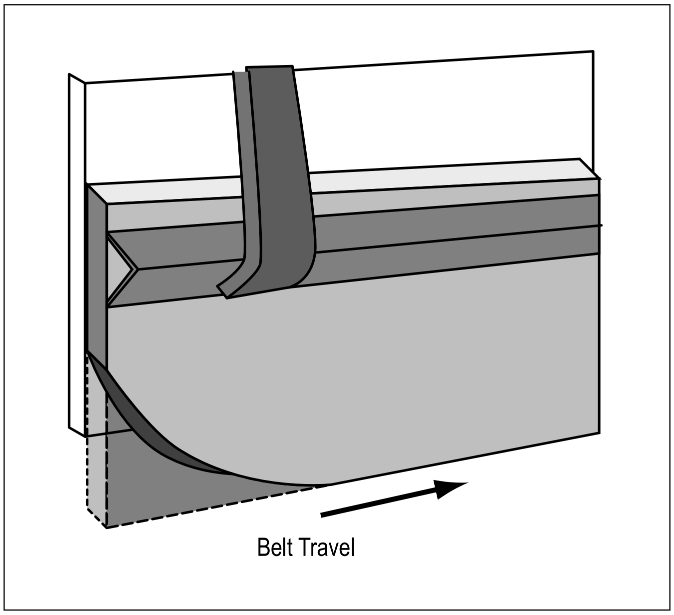

Figure 9.15

Rounding the leading edge of the sealing strip will avoid damage from mechanical belt splices.

Maintenance of the Sealing System

When specifying a skirt sealing system, it is wise to consider the mechanism for the adjustment and replacement of the wearable rubber. As the conveyor runs, the heat generated by the friction of the belt against the skirting seal combines with the wearing action of the fines to erode the sealing strip. To counter this wear, the sealing strip must be adjusted down against the belt.

Elastomer skirtboard edging should be adjusted so that the edging just "kisses" the belt surface. Forcing the edging hard against the belt cover will lead to extra wear in both the belt and the seal because of the additional heat generated from the increased friction. Applying too much pressure to the sealing system will also require additional power to move the belt. On conveyors with lengthy skirtboards, rubber sealing systems applied with excessive pressure may overload the conveyor's drive motor, particularly at conveyor start.

However, if the procedures for service of skirting rubber are cumbersome or complicated, three detrimental consequences are likely:

1. Adjustment does not happen at all, so the skirting sealing strip wears, and leakage resumes.
2. Adjustment is made only rarely, so spillage occurs intermittently.
3. The maintenance man or conveyor operator, compensating for not making regular adjustments, will over-adjust the rubber, forcing it too hard and too far down onto the belt. This risks damaging the belt or catching a splice and ripping out the entire section of skirting.

To prevent these problems, maintenance procedures should be as free of complications, tools, and downtime as possible. The simpler it is to adjust the sealing strip downward onto the belt–the fewer fasteners to loosen, the fewer clamps to remove–the more likely it is that the adjustments required to maintain an effectively sealed, low-spillage transfer point will actually take place.

Skirting systems that lie on the belt in some fashion can minimize the need for maintenance adjustment. The forces of gravity combine with the resilience of the rubber to keep an effective sealing posture.

The multiple-layer sealing system provides a self-adjusting function, where elastomeric memory maintains the sealing pressure. As the "legs" of the secondary strip wear, the internal resilience of the strip keeps it down onto the belt, maintaining seal effectiveness. The primary strip may require periodic adjustment downward to allow for wear and belt pressure upwards. This adjustment can be accomplished by loosening the clamps and pushing the strip down. It can even be performed with a judicious hammer blow onto the top of the primary strip.

Choosing a Skirtboard Sealing System

When selecting a skirtboard sealing system, it is important to match the severity of your application. Factors such as belt speed, material load, and free belt area should be reviewed to make sure the application receives a suitable system.

To prevent the sealing strips from wearing the belt, the sealing strips should be composed of material that has a lower abrasion resistance than the top cover. That way the seal will wear before the belt cover. Note that abrasion resistance is not measured by durometer (which is a rating of hardness) but rather an abrasion index, such as Pico, DIN, or Taber ratings. ASTM D2228 recognizes the Pico abrader as the standard test method.

It is advisable to specify a multiple-barrier sealing system, as this will afford more opportunities to contain the material. The barriers should includes legs or grooves to capture fine particles and allow the particles to continue along on the conveyor until they can eventually return to the main material body.

You are well advised to install long strips that will allow a continuous seal along the load zone. This will avoid the butt joints that are typically the first place for sealing problems to appear.

Periodic inspection and maintenance will prevent damage, extend life, improve performance, and boost satisfaction. That will ensure that you receive optimum value for your investment in an engineered sealing system.

The Final Step In Spillage Control

Rather than being the first step in solving conveyor spillage, the skirtboard seal is the last chance to corral fugitive material and prevent its release. The better the job done with the belt support and wear liner systems to contain material and keep it away from the edge, the better will be the performance from the belt's edge sealing system. A multiple-layer system will provide effective material containment for a transfer point and improve the operations of the belt conveyor.

Back to Contents

To next chapter