JOINING AND FASTENING OPTIONS FOR FOOD GRADE CONVEYOR BELTING

Introduction

There comes a time when the ends of a conveyor belt must be joined. Whether a first time installation, replacement or repair, the question is what methods are available to fasten the two ends, and which one is best for your application.

A conveyor belt arrives at the plant in a fixed length. It comes open-ended, since it can't be installed in its endless or looped form. So the ends have to be joined after the belt is positioned on the conveying equipment.

Shutting down a conveyor system to install a new belt, or repair an old one, involves downtime. Downtime means lost productivity. Even if the belt is replaced during scheduled maintenance, care must be taken to ensure that the splice meets certain operating criteria. For raw food processing in particular, the belt splice must meet strict hygienic standards.

Other key considerations include belt installation know-how and cost. Maintenance crews in food manufacturing plants are probably familiar with mechanical splicing equipment and techniques. Mechanical splices are easier to make and less costly than vulcanized or welded splices. However, they may compromise belt integrity and pose a food safety hazard.

In this paper we'll examine the more common types of mechanical and vulcanized splices and discuss the pros and cons of each, especially with respect to sanitation, ease of installation, longevity and cost.

Food Grade Conveying Belts

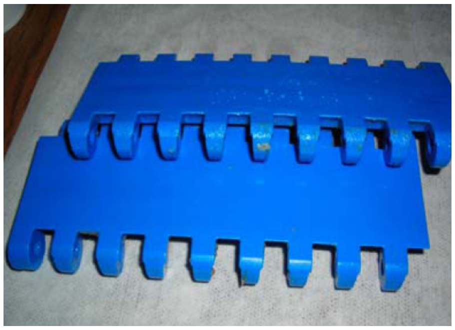
Not long ago, fabric-ply rubber belting was the prevalent technology for a wide range of conveying applications, including food processing.

For food handling operations, the ends of PVC-coated, fabric belts were usually joined on conveying equipment by vulcanization (heat welding). The two ends were cut in opposing zigzag patterns, called a finger splice, and then placed into a heated press that melted the vinyl ends together. This process required specialized machinery to apply heat and pressure over time.

Using the equipment to make these splices took skill and craftsmanship. Maintenance departments were trained in the use of the machinery and had the know-how to complete the operation successfully. Many distributors also had the necessary equipment and skill.

When a fabric-ply belt needed to be replaced due to wear or damage, mechanical splices were generally used. By comparison to the vulcanization process, mechanical splices were easy to accomplish in the field, and required simple, inexpensive tools.

Modular Plastic Belting



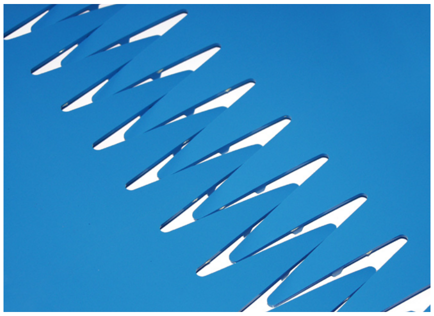
Modular plastic belting can be joined in the field with no special tools or skill.

Over time, modular plastic belting began to replace fabric-ply rubber belting. Modular plastic belting is also referred to as table top chain or modular chain. This type of belting is formed by a series of interlocking hinges and pins. Because it's strong and durable, it has gained popularity for a wide range of conveying applications, including food manufacturing.

Since replacing hinges and pins is a relatively simple matter, belt ends could be joined easily to any length in the plant. The need for expensive vulcanizing equipment went by the wayside, along with the skill of vulcanizing belts. Today, vulcanizing operations are primarily performed by belt manufacturers and specialized fabricators.

Despite its popularity, modular belting has a major drawback relative to sanitation. The hinges and crevices can harbor bacteria. In the processing of foods such as meat, poultry and dairy products, hygienic standards are high. So the modular plastic belts must be removed from the conveying machinery and soaked in a sanitizing solution following every shift, often for hours. This cleaning process creates downtime, offsetting the benefits of easy belt assembly and disassembly.

Polyurethane belting is the newest technology for food conveying applications.



A long finger weld provides the highest strength bond, virtually indistinguishable from the rest of the belt.

Polyurethane Belting

The newest technology in conveyor belting is extruded polyurethane. This new technology offers many benefits over modular plastic chain in food conveying operations.

Polyurethane belts are available in a wide range of profiles, materials, and covers. They can be reinforced with tensile cords to add load capacity. And they offer high resistance to the harsh detergents and chemicals used in wash-down.

Having smooth surfaces and sealed edges, there is no place for microbes to take hold, so the belts can be easily sanitized using clean-in-place (CIP) practices. And there is no risk of contamination by broken hinges or pins.

Sanitizing the belt on the conveyor can reduce the use of cleaning/ sanitizing water by up to 45% for every foot of 24" modular plastic chain, and reduce cleaning labor by half.

However, polyurethane belts present their own set of issues when it comes to joining and fastening.

› Joining and Fastening Options for Polyurethane Belts

Joining or fastening a polyurethane belt offers the same challenges as did splicing the fabric-ply rubber belting of the past. The same two options are available:

- Vulcanization or welding (the process of joining belt ends using heat and/or chemicals)
- Mechanical splicing (the process of joining belt ends using metal or plastic hinges or plates)

Today, knowledge of the vulcanization process is not as prevalent in maintenance departments as it once was, so some plants hesitate to consider this method.

We'll review both options to make clear which is best under what circumstances, and remove potential mental hurdles that may exist concerning the vulcanization process.

Factory finger welding equipment requires 220v current, a source of water for cooling, and a controlled environment.

A short finger weld can be performed in the field, and provides the same benefits as a factory weld.

Vulcanizing or Welding

Heat welding the two ends of a polyurethane belt can be done in the factory, in a specialized belt shop, or in the field. The belt ends are typically joined using either a finger splice or a butt splice, as described below.

Finger Splice—Factory Weld

At the factory or in a fabricator's shop, an endless belt is formed using a long finger splice. The ends of the belt are precisely cut in an interlocking pattern. Using specialized equipment, the long fingers are joined together and subjected to heat and pressure for a period of time. The result is a heat-welded bond that is virtually indistinguishable from the rest of the belt.

A factory finger splice produces the highest strength bond possible. This heat-welding process completely seals any exposed tensile cords or fibers in reinforced belts, eliminating any places for microbes to hide. The smooth splice maintains the integrity of the belt profile, which avoids the risk of the splice tearing, snagging or catching on equipment. And there are no metal or plastic pieces to break off and contaminate the food.

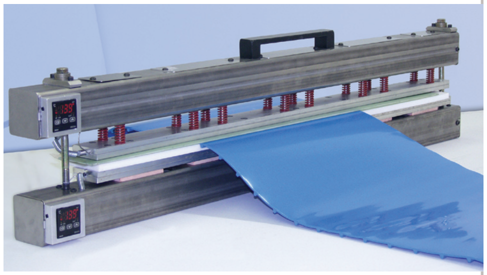
Producing a factory finger weld requires a large, water-cooled press with separate controls operating on 220 volt current. The splice should be performed in a controlled environment with respect to temperature, moisture and contaminants. The splicing operation takes several hours to complete, and is not suitable for old, dirty or unevenly worn belts.

Factory splicing equipment costs approximately $10,000. Given the time and cost considerations, factory splices are impractical for many end-user (plant) operations.

Finger Splice—Field Weld

It's not always possible to produce an endless belt for a piece of conveying equipment in the factory. Often that task must be performed on site, in the field. Perhaps the belt is replacing an existing belt on conveying equipment already in the plant. Or the joining operation may be needed to repair a damaged belt.

In the field, you can form an endless belt by joining the two ends using a short finger splice. This splice is similar to a factory weld, but the fingers are shorter and therefore easier to weld.



Air-cooled butt splicing equipment from Gates Mectrol® uses 110v current and a short heat cycle to create a smooth weld.

Like the factory weld, a field finger weld produces a strong, smooth bond that maintains the integrity of the belt profile and provides a sanitary surface for ease of cleaning.

However, the equipment and operator skill needed to produce a field finger splice is similar to that required for the factory splice. Large manufacturing plants with skilled maintenance personnel may be able to invest in the equipment and training; smaller plants may not.

Field Butt Splice

A butt splice involves making a straight cut perpendicular to the belt centerline, and then joining the two ends using a hot vulcanization process.

Different belt manufacturers have different methods of heat welding the straight belt ends together. One method uses a “hot plate” to melt the ends of the belt. The hot plate is removed and the ends pushed together. This method produces a relatively weak bond because only the surfaces of the belt are joined.

Another method involves the use of a welding rod. A 45° “V trough” is cut into the end of each belt and the ends are melted together using a plastic electrode.

Another butt splice method uses a heat wand placed between the clamped ends of the belt. A fixture drives the two belt ends together against the heat wand, melting the urethane. The heat wand is removed and the ends cooled and trimmed to complete the splice.

Making butt welds in the field involves smaller, more user-friendly and less expensive equipment than that used for finger welds. For example, Gates Mectrol® offers an air-cooled field welder that operates on 110 volt current and does not require compressed air. The machine applies pressure to the belt ends from top and bottom, and operates on an eight minute heat cycle. At roughly $5,000, it costs half as much as finger welding equipment.

While easier to perform in the field, butt welds do not produce the strength of finger welds. A butt weld is more likely to come apart as it stresses over the pulleys. When butt welding urethane belts with reinforcing tensile cords, some methods are unsuitable because they push the cords to the top of the belt, destroying the integrity of the reinforcement.

Mechanical Fastening

Mechanical fastening is the process of joining belt ends by means of metal or plastic hinges or plates. Many fasteners used today were born in the era of fabric ply belts, and are now being applied to the newer polyurethane belts.

Food grade polyurethane belting is typically joined using hinged fasteners, including wire hooks, lacing, staples and rivets. The fasteners are attached to each end of the belt, and then joined by means of a hinge pin.

Operational Considerations

The most important factors affecting splice life and performance are

- belt working tension
- pulley size
- construction of the belting

One must also consider

- belt width, length, thickness
- speed
- the presence of cleaners
- metal detectors.

An important consideration for food manufacturers is splice cleaning and sanitation.

Belt working tension is rated in Pounds per Inch of Belt Width (PIW). Factors that affect belt tensioning include the load to be carried, gravity, acceleration and coefficient of friction. When deciding which splicing method to use, one must consider the weakening affect of the splice on belt working tension.

The following chart shows the working tension rating by type of splice for two Gates Mectrol food grade urethane belts. You can see that in this instance, the factory finger splice produces the strongest splice, and the butt splice produces the weakest.

Before deciding which fastener system to use, determine the belt tension rating (in PIW), measure the thickness of the belt, and measure the smallest diameter pulley in the system. Based on these criteria, choose the appropriate fastener size, and then choose the material suited to the application. Hinge pins and fasteners are available in a wide range of metallic and non-metallic materials, including stainless steel and plastic.

CHART 1: Maximum Allowable Tension

Gates Mectrol Food Grade Belt	PC20			PC10
Belt Options	Stan-dard	Hi Torque	Cold Temp	Stan-dard
Fastening Options				
Max Allowable Tension (lbs per inch width)(1)				
Factory Weld (Finger length 80mm)	30	51	50	N/A
Field Finger Weld (Finger Length 25mm)	22	39	35	19
Field Weld Straight Cut	15	26	23	13
PosiLace™	13	13	13	N/A
Flexco® UX1SS Clipper® Wire Hooks	15	26	23	13
Flexco® APF150 Alligator® Plastic Rivet	15	26	23	N/A
Fexco® APF 100 Alligator® Plastic Rivet	N/A	N/A	N/A	10
Flexco® RS125 Alligator® Ready Set Staple	26	26	26	26

(1) Max allowable set as the lower of the 1/4 yeild strength of weld or 2% stretch of weld

Some fastening systems can be attached directly to the belt cover; others need to be countersunk to make the fastener even with the belt surface and maintain the belt profile. This may involve skiving, or shaving material off the end of the belt before attaching the fastener. Hidden splices are a form of countersunk fastener that involves covering the splice with belt material—replacement cover stock that is laid over the splice and cured—to protect the splice from abrasion and wear.

Individual belt manufacturers can provide recommendations for styles of fasteners based on type of service. Most belt manufacturers have guidelines and tables, plus installation techniques and tools that suit their belts.

Pros and Cons of Mechanical Fastening Systems

Mechanical splicing is quick and economical compared to vulcanizing or heat welding. Splicing materials and installation tools cost relatively little. And splices can be made in minutes versus hours. Mechanical splices can be temporary or permanent.

While some skill is needed to make a field mechanical splice, nearly anyone can do so. Some mechanical splices can be installed with nothing more than a straight edge, a knife and a hammer. A mechanical splice wastes less belt material—just the amount needed to square both ends of the belt.

The ability to make quick splices on the plant floor helps reduce downtime. Splices are safe to install, since there is no exposure to heat and chemicals. They are easy to inspect for damage, because the splice is plainly visible. And mechanical splices are compatible with almost any type of belt.

In food operations, the biggest disadvantage to mechanical splices is sanitation. Unlike vulcanized splices, mechanical splices penetrate the belt, leaving holes where bacteria can accumulate. Also, with reinforced polyurethane belts, mechanical splices leave the tensile cords on the belt ends exposed, providing another area for microbes to grow.

Some mechanical fastening systems are prone to breakage. The broken pieces can potentially contaminate the food being conveyed. In cases where food streams must pass through metal detectors, fastening systems should not have metal parts.

Mechanical splices are not as strong as vulcanized finger splices, so tensile strength is compromised to a greater degree. And mechanical splices require a larger pulley diameter because the splice components lack flexibility.

Some mechanical splice styles raise the belt profile, so they don't pass as easily over pulleys and cleaners. If not properly installed they can snag and tear, leaving pieces that can contaminate the food stream.

All these factors must be taken into account when considering whether to use a mechanical splice or a vulcanized one.

Common Hinged Mechanical Fastening Systems

Wire Hooks

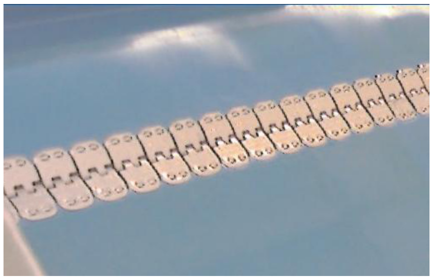
Wire hook fasteners

Wire hooks date back to the days of flat, fabric belts. The hooks were designed to penetrate and grab onto the fabric plies of the belt carcass.

Wire hooks offer a low profile fastening system that is relatively simple to install. The tooling is inexpensive. Hooks are available in a wide variety of wire diameters, materials, leg and point lengths, and strip lengths. There are various methods of installation, including a rolling device and a hydraulic device.

Hooks and connecting pins are available in stainless steel for food processing operations where sanitation is a prime concern. The key benefit to this fastening system is ease of installation and the ability to take the belt on and off. The risk of the hooks breaking and contaminating the food stream is a factor to consider before employing this fastening method.

Metal Staples



Metal staples

Metal staples are well suited for light and medium duty fastener applications on synthetic carcass belts. The staples can be pre-inserted into a one-piece fastener strip which is placed over the ends of the belt and installed using a lightweight tool. The staples are then driven into place with a hammer.

Metal staples are available in stainless steel alloys for food grade applications. They can be used to repair a belt for temporary use, or as a permanent splice.

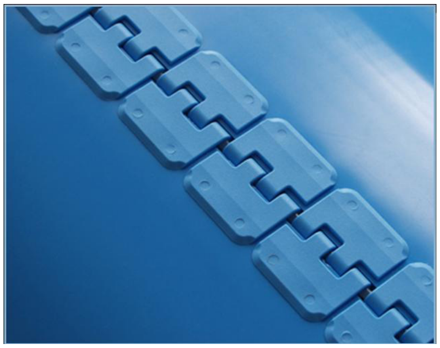
Metal Lacing

Metal lacing gives the appearance of a piano hinge. The laces are provided in a continuous strip to match the width of the belt. They are placed over the ends of the belt and the teeth are embedded into the belt carcass with a hammer.

Metal lacing creates a low profile splice that is economical to install. It can operate over pulleys as small as 1" in diameter.

Both fasteners and hinge pins are available in stainless steel for food grade applications. The hinge pins are removable so the belt can be separated for cleaning.

Plastic Rivets

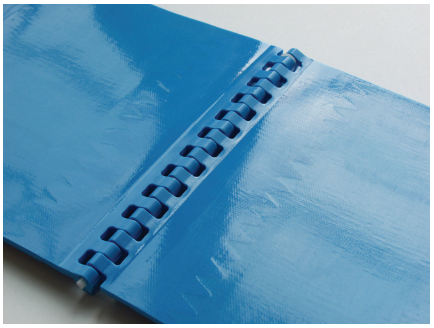


Plastic rivets

Plastic rivets are a non-metallic fastener that can pass through metal detectors. This non-scratching, non-magnetic fastening system has rivets with beveled front edges that are molded into the carcass to present a flat surface. They travel over conveyor components more easily and quietly than metal systems.

Plastic rivet fasteners have hinge pins that can be removed for belt disassembly and cleaning. This fastening system requires a special tool for assembly, and offers a low-cost alternative to vulcanization. Plastic rivet fasteners have mechanical fastener ratings up to 65 PIW, and a minimum pulley size of 1 ½".

Hybrid Joining System: PosiLace™ Pin Splice



PosiLace™ joining system combines vulcanization with mechanical fastening using a plastic pin.

Gates Mectrol PosiLace™ joining system combines vulcanization with mechanical fastening. Designed for light to medium weight loads, the fastening system has no metal parts to set off metal detectors.

The PosiLace pin splice is designed for fiber-reinforced food grade urethane belts. The vulcanization process takes place at the factory, where urethane is welded to the belt in the pin area. An end cap is welded to the belt ends to seal off the tensile cords and maintain the integrity of the reinforcement. This process also prevents exposing the cords to bacteria.

A plastic pin is inserted through the splice to join the belt ends in the field. No special tooling or equipment is needed. The splice is easy to clean and sanitize.

Conclusion

There are many factors to consider when choosing a belt joining or fastening system. For food grade polyurethane belts, vulcanization is a superior method for creating a splice that meets the highest sanitation standards. In raw food processing operations especially, hygienic considerations may outweigh the lower cost and ease of installation that characterize most mechanical fastening systems.

Additional Resources

Gates Mectrol provides application engineering help for industrial conveying belts and systems. Contact Gates Mectrol by phone at (800) 505-8494, or email apps@gatesmectrol.com.

A white paper detailing sanitation differences between Gates Mectrol PosiClean belting and plastic modular chain, as well as more information on Gates Mectrol Food Grade Belting can be found at www.gates.com/foodgrade.

Also visit www.gatesmectrol.com for tools and resources to help you with conveying, linear positioning, power transmission and lifting applications.