

TITLE: PELLET TRANSFER - PREVENTATIVE MEASURES EMPLOYED TO REDUCE STREAMER FORMATION

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ABSTRACT

The movement of polymer pellets through transfer systems can lead to the formation of streamers (angel hair, snakeskins, or fluff) under certain conditions. The presence of these streamers may introduce several downstream processing and quality concerns. Preventative equipment and procedures can be put in place to eliminate or reduce the generation of streamers at several points in the resin handling process.

INTRODUCTION

Polymer pellets are typically transferred through dilute phase pneumatic conveying systems. Pellets are entrained in streams of air and effectively “blown” from one location to another. This method of transfer is employed both at the resin supplier location (to move pellets from production areas into railcars) and at the final article manufacturer (to move pellets from the railcar to holding silos and equipment hoppers). The transfer of pellets at both the supplier plant and at the manufacturer can lead to the build-up of resin imperfections and contamination that can have significant adverse effects on processing.

As pellets are blown through transfer pipes they have a tendency to slide along the walls of the piping and fittings. This sliding action produces frictional heat which can cause the pellet to melt and smear along the walls of the transfer pipe. The melted smear can release from the walls of the pipe creating what is referred to as a streamer (also referred to as angel hair and snakeskins). The movement of plastic pellets through transfer systems also tends to generate polymer dust, fluff, and fine particles. The presence of streamers and dust can lead to downstream processing problems as well as contamination issues (when several different resins are transferred through the same system).

As streamers move through the system, there is a tendency for them to tangle into larger aggregates. The tangled streamers can plug up transfer lines and restrict the movement of product throughout the manufacturing site. Since most transfer equipment is designed for the movement of polymer pellets, the presence of streamers will affect the function and effectiveness of certain equipment. Filters, feeders, and blowers are susceptible to decrease in performance when streamers are found in the system. Railcar loading and unloading systems will become less efficient if there is an abundance of larger streamers. Even silo level indicators will perform poorly when streamers hang up on level probes.

In addition to a decrease in transfer system efficiency, the presence of streamers, dust, fluff, and fines can have several negative effects on downstream extrusion. The nature of formation of streamers (frictional melting) introduces product into the system that has experienced a different heat history than product that has remained in pellet form. The effective transfer of streamers (tendency to get held up in transfer lines) introduces the potential for contamination when several different products are transferred through the same system. The shape and surface area differences between streamers and pellets introduce the potential for extruder bridging and poor extruder performance. These factors can limit a manufacturer’s ability to produce quality films and coatings.

RESIN IMPERFECTIONS

The finishing process for polyethylene pellets including transfer in and out of bulk shipping mechanisms can lead to several imperfections in the shape and form of the polymer. These imperfections can lead to several downstream processing problems or if held up in the transfer system can introduce contamination. This section is designed to describe several different types of resin imperfections.

Streamers: Also referred to as angel hair or snakeskins. Streamers are formed as transferred plastic is melted and smeared along the walls of transfer pipe. Over time the melted plastic will accumulate and form large ribbons or streamers that flake off into moving pellet stream.

Tails: Tails are typically the result of ineffective pellet cut at resin supplier. As molten polymer passes through the die plate, the pelletizing knives are not achieving an effect cut, and essentially the pellet is left with an attached “tail”.

Clusters: Clusters are basically the fusion of two or more partially melted pellets together. Clusters are usually the result of a blower that is too hot causing entrained pellets to melt together.

Fluff/Fines: Fluff and fines are terms that are basically used as a catch all for other small particles and dust created in the transfer system. The terms can be used to describe any small order streamers or snakeskins, any tails that were freed from the pellets themselves, small polymer chips formed at rotary feeders, as well as any other polymer fluff or dust present in the transfer system.

DISCUSSION

The presence of streamers can lead to several manufacturing and operational problems in both resin production and converting facilities. Reducing the effects of streamers can be approached in three basic ways – Minimizing the potential to form streamers in the system, removal of streamers before downstream use, and through general good resin handling practices.

Minimizing Streamer Formation in Transfer System

In order to minimize the formation of streamers in the transfer system, it is important to focus on the key components of any transfer system. The most basic transfer systems consist of holding vessels (silos), a blowing mechanism, transfer piping, and fittings. Each of these components can be designed and operated in a manner that reduces the formation of streamers.

Piping systems

The design of piping systems to be used for resin transfer requires special consideration. The goal of the design is to implement the shortest possible path with the least number of bends and fittings. Transfer pipe should also always be either completely horizontal or vertical. Diagonal piping layouts increase the sliding effect of polymer pellets and can lead to the formation of more streamers.

The pipe itself can also be chosen to minimize streamer formation. Choosing pipe with a non-uniform inner surface does not allow the pellets to slide along the wall and melt due to frictional heat. These designed surface imperfections actually promote a rolling or bouncing motion of the pellets allowing them to become more easily entrained in the air stream and limiting the amount of pellet slide. Using transfer pipe with a modified inner surface will create some additional fines, but it will greatly reduce the potential to form streamers and snakeskins. Effective pipe surface designs include shot-peened pipe, sandblasted pipe, spiral grooved pipe, and irregular raised surface pattern pipe.

The transfer of plastic pellets through transfer pipe not only introduces the potential to damage the pellets, but over time the steady transfer will cause wear on the inner walls of the pipe. The same sliding motion of pellets that promotes the formation of streamers also acts to wear out the transfer pipe. As the pipe walls smooth out and wear down it can actually increase the potential for streamer formation. Additionally, the release of transfer air through holes worn in the pipe introduces plastic dust (and possibly pellets) to the manufacturing area while significantly affecting pressure drop through the system.

The effective wear on the pipe is significantly reduced when using piping with treated inner surfaces. Another procedure that can increase the life of piping is simply to periodically rotate transfer pipe. Rotating the pipe 90 degrees will allow for the wear to be evenly distributed rather than concentrated on one side of the pipe. This procedure will allow for piping systems to last longer and can eliminate the potential for wear leaks, dust, and pressure drop.

Elbows and Fittings

Transfer pipe fittings (elbows) facilitate changes in the directional movement of plastic pellets through the transfer system. The movement of plastic pellets through elbows and other fittings however, increases the

surface contact between the plastic and metal. This increased contact can lead to further formation of streamers and will wear the transfer system.

The typical elbow fitting design used in the transfer of plastic pellets is the long radius elbow. These fittings are designed and sized as a ratio of the bend radius to the pipe diameter. Long radius elbows are effective for allowing a gradual change in direction of pellet motion and minimizing the pressure drop across the fitting. However, the long radius design actually promotes the sliding of pellets along the inside of the bend. This sliding motion will not only lead to the formation of streamers, but it will also result in significant wear of the fitting itself. Product transfer quality, short lifetime, and maintenance are significant issues with long radius elbows. Several alternative elbow designs are being employed in transfer systems throughout the industry.

Plugged fittings serve to reduce product and equipment wear by actually reducing the pellet to metal contact at the bend. The basic idea of a plugged fitting is that polymer pellets will collect in the plug area forming a layer of plastic for moving pellets to slide along (reducing pellet to pipe surface contact). Plugged fittings come in various designs (plugged tees, plugged radial bends) and are priced competitively with long radius elbows. Increased pressure drop across plugged fittings can be a factor.

Several manufacturers have introduced different versions of advanced geometric fittings. These systems each use unique configurations to tailor the motion of pellets through the bend. Effective designs are able to achieve reduced pellet to metal contact while maintaining a minimal pressure drop. These fittings are typically more expensive than traditional bends; however, they offer the potential to improve product quality, maintain longer service life, and provide minimal pressure drop in the system.

Alternative fitting designs may be worthy of consideration when designing new transfer systems, replacing existing components, or improving transfer system performance. The fittings chosen should provide a good balance between design factors (pressure drop, product quality, cost, and required maintenance).

Blowing Mechanism

The blower mechanism is a key component of any dilute phase transfer system. The blower functions to produce the air stream necessary to entrain plastic pellets and effectively move them from location to location. Typical blower systems come in two forms – positive pressure and vacuum (or a combination of the two). The type of blower system employed depends on the desired path of the material to be transferred and the position of the blower relative to that path. Blowers can contribute to streamer formation by introducing more heat into the transfer system. Increased temperature will facilitate easier melting of plastic as it slides along piping walls and promote the formation of streamers in the system.

The key design consideration for blowers is its capacity to deliver sufficient air pressure to move plastic pellets; however, other features can be incorporated into the blower system to minimize the formation of streamers. Blower coolers can be effective means of maintaining ideal temperatures throughout the transfer system and eliminating the effects of hot blower air. These coolers are also effective in countering the effects of environmental heat from outdoors (typically an issue for producers in warmer regions). The “air conditioning” effect of blower coolers can significantly minimize the potential to form streamers.

Removal of Streamers Prior to Downstream Application

The negative effect streamers have on downstream applications can be significantly reduced by employing machinery to separate and remove streamers from polymer pellets. Several types of equipment are available for large-scale use by resin producers and for small-scale use by resin consumers.

Scalperator

Scalperators are simply large-scale filtration devices used by resin manufacturers to separate polymer pellets from other plastic material (agglomerates, streamers, fluff, and fines) prior to railcar loading. The machine consists of a rotating basket filter with external vacuum draws. Polymer pellets are allowed to pass through the filter and move on to the railcar loading process while both undersized and oversized materials are removed. Larger materials (typically agglomerates of multiple pellets or large streamers) that do not fit through the basket are knocked out of system. Smaller dust particles, fluff, and fines are

entrained in a vertical air stream and pulled out of the system. Scalperators provide an effective method to deliver product in pellet form only to the railcar loading system.

Filters

Various filter mechanisms (of simple and complex configurations) can be used throughout the transfer system to remove any streamers, polymer dust, or any other non-pellet material that has formed in the systems.

Deduster

Deduster boxes are simple knockout mechanisms by which smaller polymer dust and fine materials can be removed from the pellet stream just prior to introduction into the extruder. Dedusting is an effective method for assuring that any remaining dust, fluff, or fines are removed before the product is converted into film or coating. The deduster itself typically consists of a vacuum box with a vertical air stream. Pellets are allowed to move down the machine while smaller particles are entrained in the vertical air stream and pulled out of the system by a small vacuum.

Good Resin Handling Practices

The design and operation of transfer systems is a key factor in limiting the formation of streamers. Several simple guidelines can improve the efficiency and quality of product transfer.

System Design

Transfer piping should run horizontally and vertically only (diagonally sloped lines can increase pellet slide and allow product to drop back in the system). The length of transfer pipe from the storage silo to the processing area should not exceed 300 feet, and the number of directional changes in the layout should be minimized to reduce pressure drop. Plugged fittings and special bends should be used whenever possible to reduce the formation of streamers and fines.

In order for pellets to accelerate to conveying velocities, an initial section of straight piping is necessary. The general rule of thumb is that a straight section equal to 25 times the pipe diameter is required before the first vertical bend.

System Operation

The blowing air system used to transfer polymer pellets must be monitored to insure that temperatures do not exceed 120°F for polyethylene material. Higher temperatures in the transfer system will compound the effects of frictional heat on the pellets and lead to the formation of streamers. The air velocities through the transfer system must be maintained at a rate high enough to prevent pellets from dropping out of the air stream (saltation); however, the velocity should not exceed 4200 ft/minute. Every pound of air pressure increase correlates approximately to a 15°F increase in temperature. The operation of the transfer system requires a balance between velocity and temperature.

Other Practices

The piping and fittings of the transfer system should be inspected on a regular basis to assess the amount of wear on the system. Heavily worn piping, elbows, and other fittings should be replaced or serviced before continued operation. Straight section of pipe can be rotated 90 or 180 degrees to extend the service life of the pipe.

Flexible hoses used in the loading and unloading of railcars should be inspected to ensure that product flows in the direction of the coils or spirals. The flow of product in the opposite direction can create fines and dust.

Product silos should be maintained at higher levels whenever possible. Streamers and fines present in the resin collect at top of the silo during the loading and unloading cycles (of the same product). Completely emptying the silo can introduce a higher concentration of streamers and fines from the top of the silo into the pellet stream.

SUMMARY

The transfer of polyethylene pellets is a key component of product quality for both resin suppliers and resin consumers. The presence of resin imperfections such as streamers, fluff, and fines can be detrimental to the extrusion process used to produce films and coatings. Several measures can be taken to address the problem of streamers.

Employing measures to reduce the formation of streamers in the transfer system, utilizing equipment to filter and remove streamers from product in the pellet form, and following good resin handling procedures will cooperatively work to eliminate problems associated with resin imperfections.

The transfer systems employed in the polyethylene industry are often considered to be the trivial means by which product is moved from bulk transport to processing areas (or vice versa). Careful consideration in the design and operation of these systems will greatly improve the quality output of any facility. Investment in maintenance and improvement of transfer systems is essential to the production of quality end use products.