Fines, Angel Hair and Streamers: Understanding and Minimizing Their Generation

Fines, fluff, streamers, snake skin, dust and angel hair are all unwelcome occurrences that usually indicate a problem in the pellet transfer system.

Figure 1. Fines next to Polyolefin Pellets

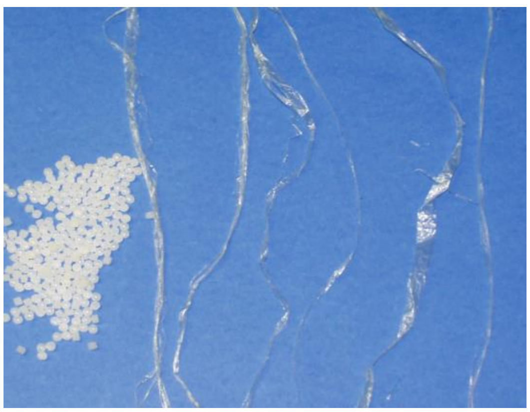

Figure 2. Streamers next to PE Pellets

Figure 3. Angel Hair next to PE Pellets

Fines (dust) are a result of the tearing of polyolefin pellets as they come into contact with rough conveying surfaces at high velocities.

Streamers (sometimes called snakeskin) are long and ribbon-like and are formed by frictional heat through extended contact with smooth internal surfaces, as in a long sweeping bend.

Angel hair is a collection of hair-like particles that look like baby streamers and are formed by frictional heat through brief contact with smooth internal surfaces.

Fluff is usually used to describe a collection of angel hair.

Angel hair and streamers are eventually dislodged by trailing pellets and can end up in silos, feed hoppers, and other unwanted areas where they can negatively affect production. The figures throughout this publication provide examples of fines, streamers, and angel hair.

Angel Hair and Streamers: Cause and Effect

Specific conditions contribute to the accelerated formation of angel hair and streamers. Transfer velocities, conveyor system design, temperatures of polyolefin resins and conveyor media, and pellet-to-air ratios all play a significant part in their formation.

Transfer Velocity

The most common type of pneumatic conveying is dilute phase conveying, characterized by low pressures (2 to 12 psig), high velocities (3200 to 10,000 fpm), and pellets-to-air ratios from 2 to 10 lbs/lb. We will focus on this method of conveyance.

Frictional heat is the major contributing factor to the generation of angel hair and streamers. As polyolefin pellets slide along internal surfaces, high transfer velocities can lead to excessive frictional heat, causing the pellets to melt. The liquefied product instantly freezes to the internal surface wall, forming angel hair or streamers.

Saltation velocity is the minimum transfer velocity where all of the pellets remain airborne. Dropping below saltation velocity results in an increase in the percentage of pellets that slide along the inside surface of the pipe. Ideally, keeping transfer velocities slightly above this point produces the least amount of frictional heat and thus the least amount of angel hair and streamers. However, for practical reasons, operation barely above saltation velocity is not recommended. Industry experience recommends that transfer velocities should be comfortably above the saltation velocity but should not exceed 5500 ft. /min.

Common Misconceptions

The concept of transfer velocity increasing as system pressure decreases is counterintuitive, but actually happens. As pressure in the piping system is lost, pellets speed up. A closer examination reveals why this is so.

Assuming temperature is constant; a cross-section of the transfer piping system near the point of resin entry contains a fixed volume of air at a specified pressure. However, as air moves downstream, a cross-section viewed adjacent to the silo would contain the same amount of air but lower pressure, due to a loss in system pressure.

Pressure loss occurs in piping due to frictional losses from piping walls. Since the volume of air is fixed by the pipe diameter, the air can only expand horizontally, instantaneously "pushing" any pellets in the vicinity, and thus increasing their velocity. While one individual section may not significantly affect transfer velocity, as pressure decreases along the transfer system, transfer velocity will increase.

Ideally, a piping system should be designed in the shape of a megaphone, beginning with a small diameter and constantly increasing as the pipe length is extended. While this is obviously an impractical solution, in some instances success has been achieved by stepping up the piping diameter over long distances of piping. For long piping runs, consider increasing the pipe diameter from three to four inches over the last third of piping, providing room for air to expand upwardly, and removing most of the increased "push effect" that was increasing transfer velocity. The increased volume can be enough to keep the transfer velocity under control, thereby minimizing angel hair generation.

System Design

Along with controlling pellet transfer velocity, good system design is also key to controlling frictional heat. The highest amount of contact with the pipe wall, and thus the highest frictional heat, is found in bends. Straight vertical runs actually minimize pellet contact with the pipe wall, and are preferred. Any changes in direction of piping should be laid out to minimize the number of bends. Avoid using vertically sloped piping that forces the pellets to slide along the walls of the pipe. While practical conditions do not allow for the complete elimination of bends, transfer systems should be designed with both the minimum amount of piping distance and number of bends.

Keep in mind that the longer the transfer system, the higher the transfer velocity of the pellets. When designing a new facility, equipment layout should, where possible, control transfer distances and piping layouts.

Pneumatic transfer systems traditionally have used commercial grade long sweep bends between 5 and 10 pipe diameters of radius. Anything above 10 D typically results in an increase in product slide, creating angel hair and streamers. Below 5 D, angel hair generation is less, but the increase in system pressure drop is unfavorable. Other bends have been found to outperform commercial grade sweep bends. These bends include

Directionally Peened Bends, Hammertek® Bends, Dead End Tees, Gamma® Bends, and Vortex Traps. Through different technologies, these bends attempt to cause the pellets to skip and bounce instead of slide. For more details on these bends, please contact INEOS Olefins & Polymers USA Technical Service.

System design is critical in the regrind system as well, to prevent the generation of excessive fines that cause dusty regrind rooms. If excessive dust generation is a factor, the easiest initial corrective action is to disconnect and inspect all regrind pipe couplings. If there is tube misalignment, a step could exist on the downstream pipe end and act as a sharp edge that knocks fines off the traveling regrind particles. A bevel or chamfer on the downstream pipe end may be needed to correct this. In addition to system design, fines or dust generation is caused primarily by dull granulator knives, incorrect knife blade gaps, rotor shaft/bearing wear, and air flow rate through the screen.

Temperatures of Polyolefin pellets and Conveyance Media

Even though frictional heat is the major source of angel hair generation, the temperature of the polyolefin pellets and conveyance media (blowers and piping) should be minimized for best results in angel hair reduction. For a conveyor system with its inherent bends and transfer distances, even a small amount of frictional heat can produce angel hair and streamers as pellet and conveyance media temperatures increase. Typically, ambient temperatures, and thus the temperature of the pellet products, cannot be controlled. However, through the use of conveyance cooling (i.e., water heat exchangers) and proper selection of blower sizing, the conveyance media can be controlled within the preferred operating temperature range of 90–100_F. Operating in this range helps reduce angel hair generation. A maximum temperature of 130_F should not be exceeded. Elevated scrap temperatures can increase the amount of regrind dust.

Pellet-to-Air Ratios

One way of slowing down pellet velocity without adjusting blower speed is to increase the ratio of pellets to air (lbs to lbs) in the transfer lines. This can be accomplished by increasing the frequency with which the air locks dump transfer material. Every pound of air has to move more pellets; as a result, less product will contact wall surfaces and overall average pellet velocity will decrease. Both factors will reduce angel hair and streamers.

However, increasing the ratio means that more pellets will move at less than the saltation velocity and will slide along the pipe wall. The system pressure drop will also increase, resulting in the need for more blower amps, a requirement that may be near or at its maximum. Recommended pellets-to-air ratios should range from 6-8. Ratios above this range may cause difficulties as the system will be overly sensitive to changes in product and transfer rates.

Internal Surface Wall Treatments

Existing smooth-bore piping systems, along with smooth-bore long radius bends, are leading contributors to angel hair and streamer generation. Internal surface treatments can be used to remedy this. While the simple solution would be to roughen the internal surface so that pellets would tumble and skip rather than slide, fines are formed through contact with rough surfaces at high velocity.

Research has shown that sandblasting and directional shot peening (a.k.a. hammer finishes) can produce good results. After initial sandblasting, an increase in fines may be observed until the edges become rounded. Shot peening leaves a much deeper penetration, resulting in rounded edges and longer service life. Treatments should last even longer at other plant sites since conveyor lines will not be continuously running. Reapplying surface treatments as needed is critical in the prevention of angel hair generation.

End of Line Defense

If existing conditions in your plant do not allow for angel hair and streamer reduction as discussed above, screen installations may be the last line of defense. Prior to pre-blenders or the machine feed hopper, screens can be installed at the takeoff box of the silo to collect angel hair and streamers. Screens can be installed anywhere in the transfer process where angel hair or streamer generation is a problem. Maintaining these end of line defenses is critical.

INEOS Olefin & Polymers Methods to Control and Eliminate Angel Hair and Streamers

INEOS recognizes the importance of angel hair-free product. To prevent angel hair and streamer formation, we closely control transfer velocities and transfer gas temperature, and utilize angel hair separators to remove any that are formed. Scheduled maintenance is conducted on all screening equipment to assure a high standard of quality in our product.

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