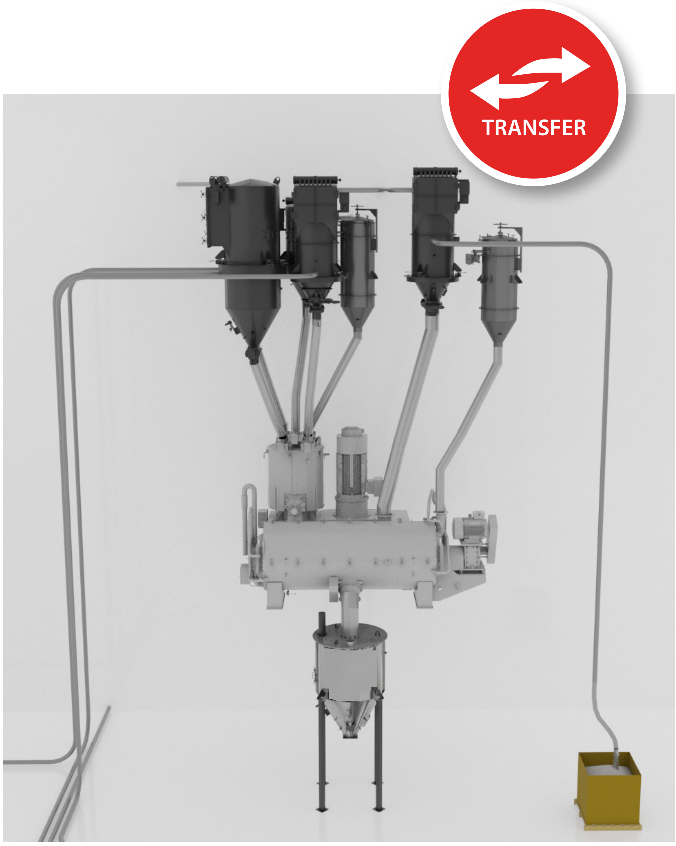
SEPARATION/SEGREGATION ISSUES OF PVC COMPOUND

Separation or segregation of PVC compound is often the cause of issues in blending and extrusion facilities, including poor product quality, excessive reject parts or hopper/storage silo flow ability issues.

At HorizonPSI, we have had frequent inquiries from PVC plant operators and ingredient suppliers looking to solve compound separation issues. We theorized that the industry trend of using finer fillers in greater percentages within a given blend have caused an increase in compound separation issues. Testing in our facility and discussions with customers confirmed that the changes in processing and blend makeup are frequently associated with these issues.

In order to solve separation issues, it is critical to determine the specific process steps where separation is occurring. Customers should take samples and evaluate each major step of the process, taking enough samples over a period of time to be statistically significant and to rule out any sampling error. Samples should be evaluated directly after mixing, before handling the compound, and after every transfer and storage step between the blender and the extruder inlets.

Our experience points to areas to consider when evaluating where separation can occur. These include blending performance, changes in ingredients/formulation and material handling/storage designs.



Contact your manufacturer for proper fill levels and equipment setups to maximize your mixer's performance.

BLENDING PERFORMANCE

The first thing to verify when searching for the cause of separation is that the starting blend quality is acceptable. Technicians should monitor the material fill levels in the heat mixer to ensure the proper mixing vortex. Overfilling a mixer will reduce its blending efficiency. Worn mixing tools/blades in the mixer will also decrease blending efficiency. Mixer manufacturers can provide guidelines for proper fill levels and equipment setups to maximize a blender's performance. Samples need to be taken and evaluated at the cooler discharge before any handling of the compound occurs.

INDUSTRY TRENDS OF INGREDIENTS AND FORMULATIONS

In most cases when customers ask us to assist in evaluating separation issues, we find that changes have occurred in formulation related to fillers (calcium carbonate and talc). Filler suppliers are now offering much finer fillers than were available in the past. Often, these fillers are 1-2 micron or smaller particle size.

The small particle size of these fillers allows them to easily be suspended in an air stream. It is common to see terminal or suspension velocities below 50-100 ft/min when testing these fine fillers. Resins commonly have lower end terminal velocities around 150-300 ft/min. The differences in the suspension velocities within a blend will contribute to separation as described later in this document. If there are any issues related to filler particle size, these issues will be more pronounced as filler percentages increase

HANDLING SYSTEMS' EFFECT ON BLENDS

PVC blend/compound is a mixture of individual particles with different behaviors. Particles with different sizes and densities will tend to separate from each other wherever handled.

It is important to understand the causes of separation in conveying and storage of compound in order to design equipment to minimize separation. Compound gets exposed to two main processes between blending and extrusion: pneumatic conveying and storage in silos and hoppers.

HORIZON PSI
OUR BUSINESS IS YOUR BUSINESS
1101 Horizon Drive
Lawrence, KS 66046-4951 USA
800.842.1600 | 785.842.1299
horizonpsi.com

PNEUMATIC CONVEYING

Pneumatic conveying of compound exposes the compound to velocities within the conveying equipment that can naturally separate the particles within a blend. Larger particles within a blend (resin, larger particle additives, etc.) have horizontal conveying velocity requirements of 3,600-4,000 ft/min. Fine particles within a blend (stearate, impact modifier, fine fillers, etc.) can convey at much lower velocities. If a transfer system's design has a velocity too low, some separation can occur within the conveying line. Generally, the separation of product within the conveying line is minimal if designed for the worst-case velocity needed for any component of a blend.

The area of a transfer system with the highest potential for separation is at the exit of a conveying pipe. When compound exits a conveying system, it enters a larger vessel and starts to fall via gravity to a pile. The vessel's air flow direction to exhaust is upward. This upward velocity will cause particles to suspend in the air stream if it is too high. In silos, this velocity is very low due to the cross section of the vessel. In filter receivers, like those above extrusion lines, the velocity can be high enough to suspend finer particles. The suspension or terminal velocity of the larger particles in a blend is typically between 300-600 ft/min. The suspension velocity of the fine fillers that are commonly used today in the industry are 50-150 ft/min. If the velocities within a filter are above a given component's suspension velocity, that component will separate and go up towards the filter media instead of falling into the hopper.

The technical terms for the velocities within a filter receiver are *can velocity* and *interstitial velocity*. Can velocity is the upward velocity of the airstream as it enters the filter housing. Interstitial velocity is the upward velocity between the filter elements or bags in the filter section. Filter receiver designs with tightly packed filter media have much higher interstitial velocities.

If velocities within a filter receiver are too high, the fine particles will tend to go up and the coarse particles will go down as they enter the receiver. If the flow of air and product into the filter receiver is continuous, this effect can cause the filter media to blind over and cause damage to the cartridges or bags.

Intermittent product and airflow that is typical on vacuum sequencing receivers above extruders may not have an issue with blinding of filters, but will have a high potential for separation of blends. Filter receiver designs with small diameters and tightly packed filter media (both common in extruder receivers) have higher can and interstitial velocities. The most common designs minimize space requirements and cost. Many of these legacy designs are presenting issues with separation as finer ingredients get introduced in larger percentages within blends.

Separation will occur during the convey cycle of a receiver with too high can/interstitial velocity. The fine particles will go up into the filter media section and hold there until the conveying airflow stops. Once the airflow stops, there is nothing to hold the fine particles up and they pulse off the filters and drop in a layer on top of the coarse product that fell into the hopper. These layers of product then discharge to the extruder. If the separation of blends occurs in a filter receiver, the receiver must be replaced with a unit that has lower can and interstitial velocities to solve the problem.

SILO/BIN FILL AND DISCHARGE

Product separation can occur when filling and emptying storage silos. Product will have a velocity trajectory when exiting a conveying system into a silo. Different size and density particles will travel differing distances before they settle. When filling a bin or silo, the entry point should be as close as possible to the center top of the vessel. Blowing product horizontally into the side of a larger silo or bin should be avoided.

When discharging from larger storage vessels, flow patterns can contribute to separation. There are two kinds of product flow from large vessels.

1. **Mass Flow** of product from a vessel causes the entire cross section of product to move at the same rate towards the discharge. This type of flow results in "first in/first out" performance discharging of the material. Product that fills on top of existing product will not exit the silo before the product below it. Hopper slopes on mass flow design vessels have more steep cone angles or internal devices to interrupt a funnel flow pattern.

2. **Funnel Flow** within vessels is a flow pattern where the product in the center of the vessel moves towards the outlet at a higher velocity. The product at the perimeter of the vessel moves much more slowly or sometimes not at all until the center area of the vessel is empty. The result of this type of flow is "last in/first out." This type of flow can contribute to separation as product discharges.

In some cases, funnel flow may actually help to remix product that may have separated out when filling. If we know that a vessel discharges with funnel flow, it is good practice to allow that vessel to discharge to completely or nearly empty on a regular basis. Funnel flow bins kept full all of the time will have stagnant product that never discharges which may cause other issues like product hang ups and bridging.

SUMMARY

When you encounter product separation issues, it is important to determine what part of the process is contributing to the problem. Once you identify the source of the separation, the equipment in that part of the process can be evaluated for function, operation parameters and design to develop a plan to remedy the issue.

In closing, it is important to realize that the blend that is being handled today is probably different from what the original equipment was designed for. Any changes to equipment should be made with possible future changes in mind to avoid needing to make changes in the future.