



# **SEPARATION AND SEGREGATION**

## **ISSUES IN FOOD BLENDS**



# YOUR GUIDE TO OVERCOMING FOOD BLENDING CHALLENGES

When it comes to food, your customers expect a consistent final product every time they purchase your products. When separation and segregation occur, many issues can arise in blending and extruding processes – like poor product quality, hopper/silo discharge flow issues, and rejected finished product. If you have noticed any of these issues taking place, use this guide to learn how to identify where separation and segregation occur through sampling, know the latest industry trends and learn what factors in food blending can contribute to ingredient separation and segregation.





## SAMPLING

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In order to solve blending and extrusion issues, it is critical to determine the process steps where the separation and segregation are occurring. You should take samples for evaluation at each major step in the process to locate the area of occurrence and evaluate them directly after mixing — before the product blend gets handled and after every transfer and storage step between the blender and extruder inlets. Auto sampling equipment (Figure 1.1) can help take samples in a consistent manner.

You should also take enough samples over a period of time from the same sampling points to ensure statistically significant and accurate results. Horizon's recommendation is at least 5-10 samples to determine blend consistency and quality, and 10-20 over several hours to determine separation defects from different process transfer points.

Consider the following areas when evaluating where separation and segregation can occur:

- Blending performance
- Changes in ingredients/formulation
- Material handling/storage designs

## BLENDING PERFORMANCE

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Before searching for the causes of ingredient separation and segregation, verify that the starting blend quality is acceptable. You can do this by monitoring material fill levels in the heat mixer to ensure proper mixing. Overfilling or underfilling a mixer or having worn mixing tools/blades will reduce its blending efficiency, creating inconsistent samples. 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 mixer discharge before any handling of the product blend occurs.



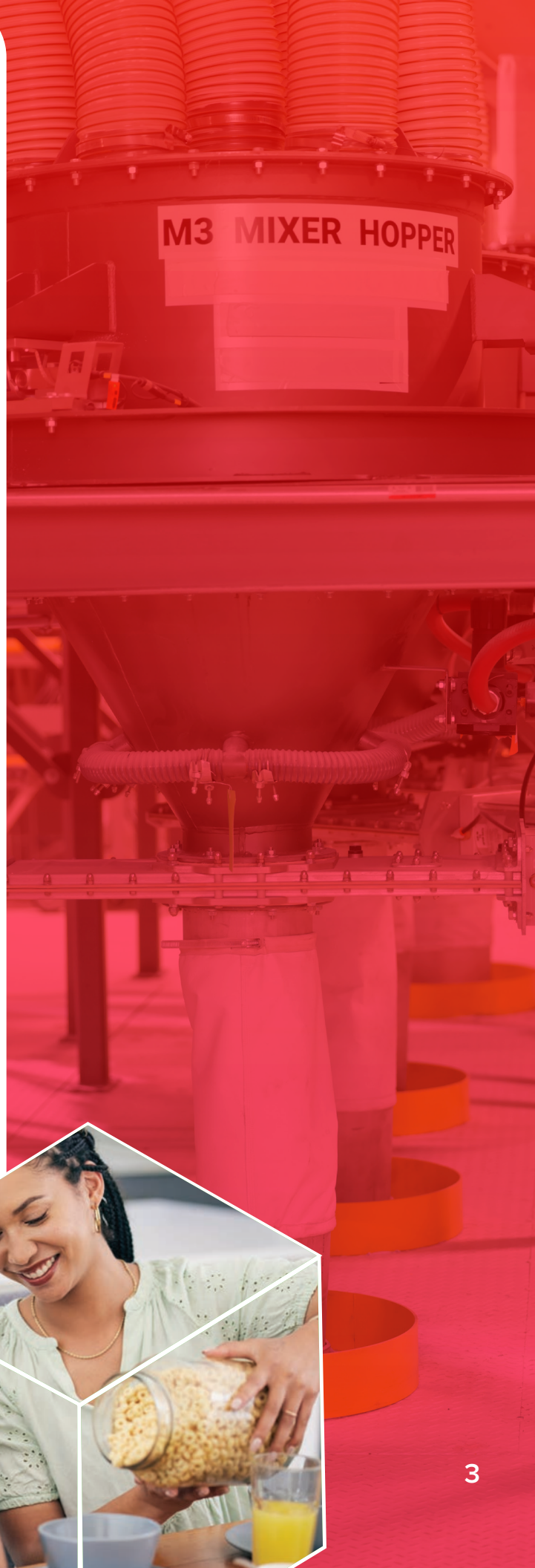
Figure 1.1

## INDUSTRY TRENDS ON INGREDIENTS AND FORMULATIONS

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Horizon Systems has had frequent inquiries from food plant operators and ingredient suppliers looking to solve product blend separation issues. After various testing in our facility, we believe that the industry trend of using finer ingredients like starches, fillers and flow agents in greater percentages within a given blend is one of the causes of separation and segregation. Since product blends are a mixture of individual particles with different behaviors, adjusting formulations of the different ingredients or adding new ones can greatly affect blending processes. Additions of more regrind/recycle materials can also cause issues.

The increased use of these smaller particle size ingredients is likely because they suspend more easily in an air stream. It is common to see terminal or suspension velocities below 50-100 ft/min when testing these fine products. These particles with different sizes and densities will tend to separate from each other wherever they get handled.



# HANDLING SYSTEMS EFFECT ON BLENDS

It is important to understand the causes of separation in conveying and storage of product blends in order to have equipment that is designed to minimize separation. The two main processes that product blend gets exposed to between blending and processing are pneumatic conveying and storage in silos and hoppers. Figure 1.2 shows physical properties of some common blend components.

| Material       | Particle Size Range (Mesh) | Bulk Density (lb/cu ft) | Terminal Velocity (ft/min) |
|----------------|----------------------------|-------------------------|----------------------------|
| Wheat Starch   | 150 mesh                   | 32                      | 100-300                    |
| Potato Starch  | 150 mesh                   | 43                      | 100-250                    |
| Corn Starch    | 100 mesh                   | 30                      | 150-450                    |
| Granular Sugar | 40-80 mesh                 | 55                      | 400-700                    |
| Salt           | 40-60 mesh                 | 65                      | 500-700                    |
| Wheat Flour    | 150 mesh                   | 35                      | 150-350                    |

Figure 1.2





## PNEUMATIC CONVEYING, FILTERS AND DISCHARGE

Pneumatic conveying exposes the product blend to velocities within the conveying equipment that can naturally separate the particles within a blend. Larger particles within a blend (sugars, salts, whole grain) typically have horizontal conveying velocity requirements of 3,600 ft/min to 4,400 ft/min. Fine particles within a blend (stearates, starches) can convey at much lower velocities. If a transfer system's velocity is too low, separation and segregation can occur within the conveying line. Generally, the separation and segregation of product within the conveying line is minimal if systems are 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 and segregation is typically at the end or exit of a conveying pipe. When product blend exits a conveying system, it enters

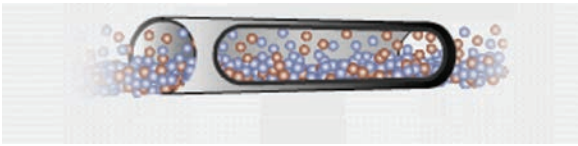
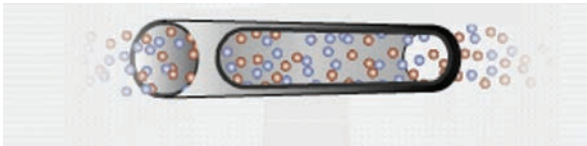
a larger vessel and starts to fall via gravity to a pile. The air flow direction to exhaust from the vessel is upward, causing particles to suspend in the air stream if it is too high. Silos have a much lower velocity due to the cross section of the vessel. In filter receivers, like those above processing lines, the velocity can be high enough to suspend finer particles. The suspension velocity (also known as terminal velocity) of larger particles in a blend is typically between 300 ft/min and 1,600 ft/min. The suspension velocity of the fine fillers and starches that are most commonly used today are 50 ft/min to 150 ft/min. If the velocities within a filter are above a given component's suspension velocity, that component will separate and go up toward 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 processing equipment may not have an issue with blinding of filters, but it does have a high potential for separation of blends. Filter and extruder receiver designs with small housing diameters and tightly packed filter media have higher can and interstitial velocities. The common traditional designs minimize space requirements and cost but can have more issues with separation of finer ingredients used in larger percentages within blends. Figure 1.3 shows the differences in well-designed dilute phase transfer systems vs. systems that have a higher potential to segregate products.



| Optimum Dilute Phase Conveying                                         | Conveying Conditions Contributing to Segregation                                                                |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Conveying Velocity is above the worst-case minimum saltation velocity. | Conveying velocity is below optimum for some particles causing “strand” flow or plugging.                       |
| Elbows and bends are kept to a minimum.                                | Elbows and bends cause material to lose velocity and can separate before reaccelerating downstream of the bend. |
| No “back to back” bends or elbows.                                     | If two (or more) elbows are close coupled in a conveying line the product can lose over half of its velocity.   |

Figure 1.3

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 are pulsed 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 it is determined that the separation of blends is occurring in a filter receiver, you must replace the receiver 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 because product will have a velocity trajectory when exiting conveying systems. 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. Avoid blowing product horizontally into the side of a larger silo or bin.

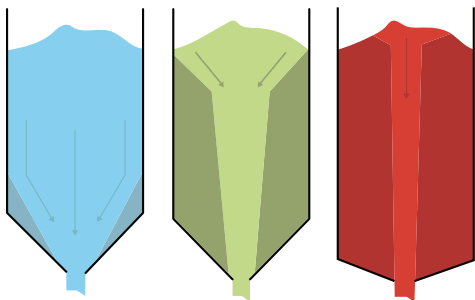
Flow patterns when discharging from larger storage vessels can contribute to separation. There are two kinds of product flow from large vessels. You can see these illustrated in Figures 1.4 and 1.5.

### MASS FLOW

- Causes the entire cross section of product to move at the same rate towards the discharge
- Results in first-in/first-out performance discharging of material
- Results in steep cone angles in hopper slopes and more internal devices to interrupt a funnel flow pattern

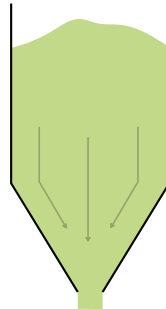
### FUNNEL FLOW

- Pattern where center product in the vessel moves toward the outlet at a higher velocity
- Product on the perimeters of the vessel moves much slower or not at all until the center is empty
- Results in last-in/first-out performance discharging of material
- Can cause separation as product discharges
- May help to remix separated product
- Silos need to be fully or nearly emptied regularly



*Funnel or core flow*

Figure 1.4



*Mass flow*

Figure 1.5





## NEXT STEPS

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Once you've identified separation, it is time to evaluate equipment for functionality and develop operation parameters and design changes to remedy the issue. Horizon Systems' knowledgeable and skilled team of experts can help with these plans, as well as mixer companies and other outside resources. Equipment suppliers can also help determine possible remedies.

Two common remedies to separation and segregation in food blending could even be as simple as identifying if transfer equipment is appropriately sized and configured properly for specific blends, or determining if blend properties have changed enough that current storage designs need to be modified to minimize separation. Remember that blends being handled today are different than what some equipment was originally designed for, but solutions can still be found.

## CONSULT WITH HORIZON SYSTEMS ENGINEERS

If the steps outlined in this book don't help resolve the separation or segregation issues in your food process, it may be time to consult with outside experts. At Horizon Systems, we have more than 40 years of experience diagnosing material separation and segregation issues, and engineering solutions that deliver consistent results.

Contact us at [horizonsystemsinc.com/contact](https://horizonsystemsinc.com/contact) or call 800.842.1600 to get started.



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