BULK BAG UNLOADERS – HOW TO ACHIEVE TRUE DUST CONTAINMENT

BULK BAG UNLOADERS

Bulk bag unloaders (BBUs) have been a staple in the manufacturing process for 40 years. The original designs were simplistic frames with little attention paid to dust control or operator safety. Over the past 15 years the focus has shifted towards better dust control and operator safety.

With that said, design varies greatly from manufacturer to manufacturer. Some still offer a simplistic, no frills frame, while others offer an extremely high level of sophistication to meet the most demanding application requirements. The system, features and benefits required vary from application to application. There are numerous aspects that define a Bulk Bag Unloader: Bag Agitation, Complete Discharge, Product and Dust Control, as well as complete, integrated system solutions. This paper focuses on the various mechanisms available to properly protect operators, contain product and minimize transient dust and spills.

FACILITY REQUIREMENTS

For most plants in North America dust free bulk bag unloading is no longer an option, but a requirement in protecting operators, meeting OSHA standards and maintaining plant cleanliness. While many larger corporations have voluntarily adopted high level operator protection standards, entire industries are being forced to implement more stringent standards to ensure operators are fully protected. Standards such as **"Respirable Crystalline Silica"** and **"Zinc Borate Closed Loading"** require plants to implement truly dust tight bulk bag unloading systems, minimizing or eliminating operator exposure to these products.

ACCESSING THE BULK BAG

This paper is focused on bulk bags that incorporate an outlet spout, which requires an operator to manually access the bag spout. Generally, an outer, bottom bag seal, must be opened, which then allows for access to the actual bag outlet spout. The spout must be 'pulled down', manipulated and untied for product to flow to the process. This interaction is the topic in focus.

As different designs are reviewed, the following is provided:

- Overview of the Design.
- The Sequence of Operation.
- Positives and Negatives, in relation to Dust Control/Operator Protection

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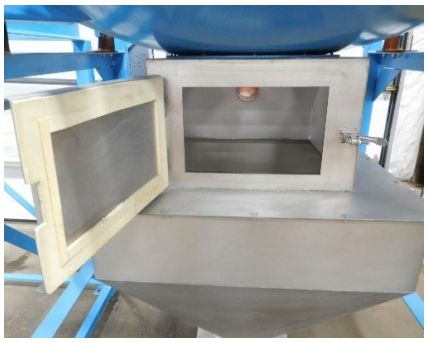
DUST CONTROL - LEVEL 1 THROUGH 5

LEVEL 1
EXTERNAL HOPPER/ TUBE DISCHARGE WITH ACCESS DOOR

This design incorporates an access door, on the side of a hopper or tube, to untie the bulk bag. It is important to note, that with this design, the access door is an integral part of the storage hopper. So, when opening the door, the operator is actually opening the vertical side of the hopper, which is a potential hazard. Some designs incorporate an iris valve on the inlet side of this hopper/tube.



Operation:

1. The door is opened, and the bulk bag spout is pulled down, into view.
2. The iris valve (if provided) is closed, preventing product flow.
3. The bag spout is untied/ opened.
4. The door is closed, and the iris valve is opened, allowing product to flow only when the door is closed.
5. When the bag is empty, the door is opened, the spout is tied, and the bag is removed.

Iris Valve on Bulk Bag Unloader

Note: If an iris valve is not included, the door is shut immediately upon untying the spout, to minimize exposure/ spillage.

Positives:

- The bulk bag frame includes a platform of some type, thereby preventing operators from accessing a bag without bag fall protection.
- A level of product control is provided when an iris valve is included – when opening the bag.
- Low cost.

Negatives:

- As the access door is part of the storage hopper/ material flow path, when opening the door, the inevitable spill occurs:
  - Minor spill when product falls off the inner ledge of the door/spout.
  - Major spill when the door is opened, while product is backed up, past the door.
- If and when there are flow issues (bag spout is twisted; the inner liner blocks the outlet) the door must be opened to access the bag spout creating further and more significant product spills and operator exposure as there is no way to close the bag spout while working IN the product to recreate proper flow.
- Removing half empty bags can expose your plant to a major spill. While iris valves can close off the product flow, to allow a half emptied to be retied and removed, in ALL cases, product must be flowing to close the iris valve. Once closed, the hopper is full of product. Opening the access door now creates a major spill/ exposure issue.
- Units without an iris valve requires the access door to be closed as quickly as possible to minimize exposure.

LEVEL 2
EXTERNAL CLAMPING SYSTEMS (ECS)

ECS's allow for the clamping of the bag outlet spout to a discharge tube/material flow path, creating a positive seal, directing product from the bag directly into an enclosed flow path. ECS are manually operated. With all clamping systems, the length of the spout and tie point are critical in ensuring a reliable seal.

Note: Some ECS implement a double, tube-within-tube design, which offers a higher level of dust control than a single tube design.

Operation:

1. The bag spout is pulled down and over the top of the discharge tube.
2. The clamp is activated by manipulating the left and right clamps, creating a positive seal.
3. The bag is untied, allowing product to flow through the discharge tube to the process below.
4. When the bag is empty, the spout is tied, the clamp is lifted, and the bag is removed.

Positives:

- The clamping device provides an active seal between the bag spout and the discharge tube.
- Product flow directly from the bulk bag, through discharge tube, to the process, minimizing dusting.
- Double walled discharge tubes 'catch' the product that spills over the clamp and puts in either back into the process or is removed via dust collection, minimizing spillage when the bag is removed.

Negatives:

- As the bag spout is placed over the discharge tube, product builds up on the ledge of the discharge tube, flowing into the plant environment when removing the bag, dusting the area at a minimum.
- Any problem with the bag seal can cause large scale spills and exposure.
- As the spouts are sewn into the bottom of the flat bulk bag, product seepage occurs (product filters through the bag itself).
- Seepage is magnified when coupled with paddle agitation systems, that continually move the bulk bag while the spout is connected to the discharge tube.

LEVEL 3
CONTAINMENT CHAMBER (CC) w/ ENCLOSED DISCHARGE TUBES

This design places the discharge tube within an Access Chamber and utilizes an access door to manipulate the bag spout. The access chamber is not part of the hopper or discharge tube, but is a controlled environment, to contain any spills while accessing the bulk bag spout. The chamber does not store product and is completely sealed: Five sides are welded steel and the bulk bag seals the top, sixth, side of the chamber, when set in place

The bag outlet spout is placed within the discharge tube/material flow path, creating a passive seal, directing product from the bag directly into an enclosed flow path.

Operation:

1. The access door is opened.
2. The bag spout is placed inside the discharge tube. The door is closed.
3. The bag is untied, allowing product to flow through the discharge tube to the process below. When the bag is opened, it expands, sealing against the discharge tube, creating a passive seal.
4. When the bag is empty, the door is opened, the spout is tied, and the bag is removed.

Positives:

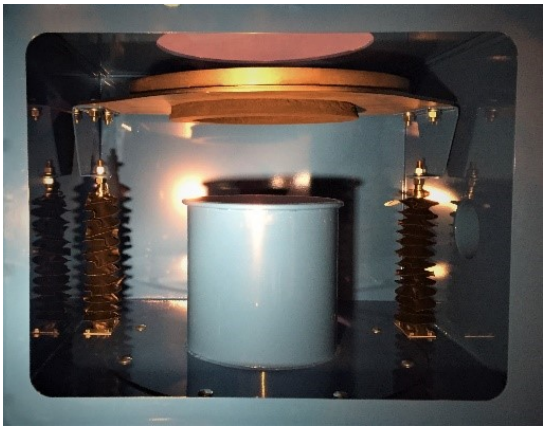
- Product flow directly from the bulk bag, through discharge tube, to the process, eliminating dusting.
- Containment. Any spills from handling a bulk bag: operator error/ problems, holes in the bag spout, seepage all are contained in the chamber.
- When dust collection is added:
  - An enclosed chamber allows for directed dust collection, as opposed to collection of an entire area, as required with external systems.
  - Minimal CFM is required (300CFM) as it is pulling only on a chamber.
  - Dust collection pulls all dust away from the operator when the door is open.

Negatives:

- Additional height required to implement.
- Small chambers cannot contain large spills, creating exposure hazards.
- Higher costs.

LEVEL 4
CONTAINED CLAMPING SYSTEMS (CCS)

This design incorporates features from both External Clamping System and Containment Chambers. Similar to ECS, the CCS allow for the clamping of the bag outlet spout to a discharge tube/material flow path, creating a positive seal, directing product from the bag directly into an enclosed flow path.



CCS are generally air actuated - automatically operated and can only be actuated with the access door being closed. With all clamping systems, the length of the spout and tie point are critical in ensuring a reliable seal.

Like CC, this design places the discharge tube within an Access Chamber and utilizes an access door to manipulate the bag spout. The access chamber is not part of the hopper/discharge tube, but is a controlled environment, to contain any spills, while accessing the bulk bag spout. The chamber does not store product and is completely sealed: Five sides are welded steel and the bulk bag seals the top, sixth, side of the chamber, when set in place

CCS are generally air actuated - automatically operated and can only be actuated with the access door being closed. With all clamping systems, the length of the spout and tie point are critical in ensuring a reliable seal.

Operation:

1. The access door is opened.
2. The bag spout is pulled down and over the top of the discharge tube. Close the door.
3. The clamp is activated (air), creating a positive seal.
4. The bag is untied, allowing product to flow through the discharge tube to the process below.
5. When the bag is empty, the access door is opened, the spout is tied.
6. The door is closed, the clamp is lifted, and the bag is removed.

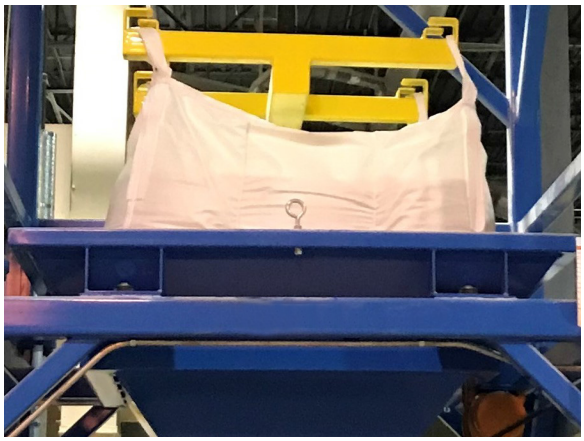
Positives:

- The clamping device, whether manual or pneumatic, provides an active seal between the bag spout and the discharge tube.
- Product flow directly from the bulk bag, through discharge tube, to the process, minimizing dusting.
- Containment. Any spills from handling a bulk bag: operator error/problems, holes in the bag spout, seepage all are contained in the chamber.
- When dust collection is added:
    - An enclosed chamber allows for directed dust collection, as opposed to collection of an entire area, as required with external systems.
    - Minimal CFM is required (300CFM) as it is pulling only on a chamber.
    - Dust collection pulls all dust away from the operator when the door is open.

Negatives:

- As the bag spout is placed over the discharge tube, product builds up on the ledge of the discharge tube, flowing into the chamber. Double walled tubes eliminate this issue. Small chambers cannot contain large spills, creating exposure hazards.
- Additional height required to implement.
- Small chambers cannot contain large spills, creating exposure hazards.
- Higher costs.

LEVEL 5
CONTAINED CLAMPING SYSTEMS with FULL SLOPED PLATORM DESIGN (FSP)



This design incorporates features from the Contained Clamping System, marrying this to a FSP. Full platforms or 'pans' are used to support and agitate the bulk bag, to ensure proper flow. A vibrator, of some type, is implemented to ensure product flow.

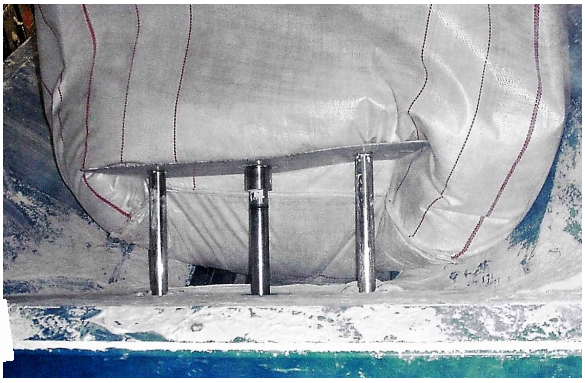
Note: For proper flow of most powders, a 60-degree slope is required

With 60-degree platforms, the bulk bag is shaped, when loading, to this angle. The vibrator is generally cycled on and off to ensure flow. FSP collect all product leaking from the bag as the bag sets inside this sloped platform, thereby providing another degree of product containment.

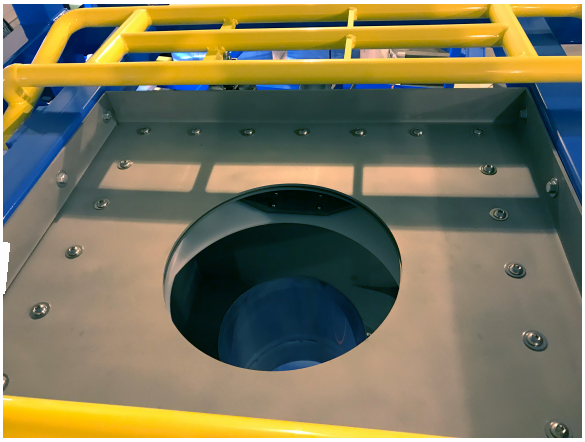
Operation:
The operation is identical, in terms of accessing the bulk bag spout, as outlined in the CCS.

Positives:
- All the benefits of the CCS, as stated above, are realized.
- The bag is not moved nor manipulated, not pulled nor stretched by mechanical massaging agitators, thereby minimizing product seepage.
- Containment. Any spills from the bag itself: holes in the bag or seepage are contained in the platform and flow down into the chamber.

Negatives:
- All the draw backs of the CCS, as stated above, are realized.
- Vibration can only be run when a bag/product is in place. Otherwise weld fracturing can occur.
- Additional height required to implement.
- Higher costs.



Variation in Designs
- Fully sloped platforms, which incorporate paddle agitation built into the platform, move, and stretch bag, causing an entire new set of dust control problems as seen here.
- Flat platforms, typically used with paddle agitators, are about 40% smaller in size than the bulk bag, so it will collect some of the leakage while missing other.



Note: With some paddle agitation designs, no platform is provided, which heightens this issue.

ADDITIONAL DUST CONTROL FEATURES

1. **Iris Valves**. Manually controlled. Typically utilized with Level 1 BBUs as described in that section.
2. **Pinch Bars**. Air actuated.
    a. Similarly, to the manual iris valves, this can be used to close the bulk bag spout completely, prior to untying the spout.
    b. Used to remove a half empty bulk bag. Complete spout closure, cutting through the column of material, is vitally important to remove the bag without operator exposure to the product and major spills.
    c. In addition, air actuated pinch bars can close off the flow of product from the bulk bag if a spill or other issue arises.
    Note: Properly designed pinch bars are critical to close off a full bag spout of material and to stop flow completely.
3. **Bag Collapse/Evacuate System**. If dust collection is available a clamped bag can generally be collapsed (dust is sucked out of the bag), at the end of the unloading cycle. This generally requires the addition of 1-2 valves and/or controls. Also, product must be below the evacuation port for this feature to operate properly. This cannot be done with an unclamped bag.
4. **Dust Collection**. Adding dust collection to any system will decrease operator exposure in all systems, and improve plant cleanliness, especially on external based systems, with or without clamping devices.
5. **Bag Compactors.** A little considered aspect of bulk bag unloading is the handling of the empty bulk bags. Plant cleanliness is affected dramatically by the handling of the empty bulk bags. Advanced compactors are available that keep continued pressure on the bags during the compaction cycle, while removing dust via a collector.

TWO ADDITIONAL DESIGNS

1. **Knife design** for flat bottom bags. This design was not included as it is nearly impossible to control dust, even when adding dust collection, rubber membranes and other features. At the end of the cycle the “cut open bottom section of bag” is lifted and removed spilling the product and dust left in the bag everywhere in the plant. This cannot be used where dust control or operator protection is required.
2. **Glovebox design**. This is an excellent dust control design as long as the operators will use the gloves and can reliably open a bag spout with the gloves. As the operator uses the fixed gloves, mounted to the access chamber, he never touches the product. Dust collection can be added to remove dust from the chamber. Unfortunately, since bag spouts can be difficult to untie, open and manipulate, generally, sooner than later, the operator /plant cuts the gloves out of the system, then accessing the bag directly through the two holes, or modifies the chamber with a door. Due to the high difficulty of use very few are successfully implemented in the field.

TESTING

Finally, to ensure you can achieve your desired results, send your product to a few manufacturers to review how their system controls dust with your product, your bag, based upon your specific application requirements. All reputable manufacturer's offer a no obligation testing service.

ABOUT THE AUTHOR

Scott Dahlgren is the founder and CEO of 3Sigma Systems, who provides bulk bag unloaders and turnkey unloading systems, specializing in dust tight designs. Scott's career in the bulk material handling field spans over 33 years, previously being employed by Schenck-AccuRate and Peabody SolidsFlow. Scott has worked in roles as Test lab Technician, Customer Service, Field Service, Regional Sales Manager and National Sales Manager.

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