Considerations in Designing a Bulk Bag Unloader

An IEDCO White Paper

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Industrial Equipment & Design Company

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Introduction

Many food, chemical and pharmaceutical facilities like the idea and convenience of receiving their bulk powders in FIBCs (bulk bags/super sacks). There are obvious advantages to bulk bags. They eliminate the handling of multiple pallets of bags or drums, and all of the containment and disposal issues are correspondingly minimized.

If you are preparing to use bulk bags you will need to invest in the appropriate equipment to permit you to handle the bags in a safe, efficient and clean fashion. The purpose of this paper is to outline the various considerations that should be made when evaluating the design of the equipment necessary to allow you to handle bulk bags.

Bulk bags are available in a variety of different sizes, shapes, and styles, but the general requirements in handling them are common. Operators have to get the bag off of the pallet it arrrives on and onto an unloading device where an operator can access the bottom discharge spout to permit the flow of material to out of the bag and into the process.

Significant Bulk Bag Unloader equipment design considerations include the following:

- Relative Location of Bulk Bag Unloader to Warehouse
- Method of Lifting the Bulk Bag
- Size(s) of Bulk Bag to be Handled
- Retaining the Liner of a Bulk Bag
- Accessing the Bulk Bag Discharge Spout
- Obtaining Reliable Flow from the Bag
- Containment/Dust Control during Discharge
- Dedicated Unloaders or Removing Partially Discharged Bags
- Transferring Powder from the Bag
- Batching from the Bag
- To Sieve or Not to Sieve
- Removing and Disposing of the Empty Bag

Relative Location to Warehouse

Obviously, the closer the Bulk Bag Unloader is to the warehouse the more efficient the material handling considerations can be. There is a lot to be said for the simple use of a pallet jack to bring the raw ingredients, only a few feet to the Unloader. In reverse, the empty bulk bags only have a few steps to go for disposal.

All of this is much more preferable than having to use powered fork lifts or walking stackers in a crowded hallway over a long distance to the dispensary (and then back again with the empties).

Lifting the Bulk Bag

Lifting the bag and positioning it on a support frame of some kind can be accomplished in several ways:

FORKLIFT

A separate bag lift frame is fit to the forks of a forklift which is then positioned over the bulk bag and the bag lift hooks attached. The forklift elevates the frame with bag and places it on a support frame. The operator withdraws the forklift and forks, leaving the bag in place. This is the least expensive option; however, it requires a forklift or stacker, thus making it dependent upon the availability of a forklift and qualified operator. Forklifts also offer a number of safety and hygienic issues to be considered, not to mention potential damage to the support frame if the operator is hurried or unskillful.

DEDICATED/INTEGRAL HOIST

An electrically (or pneumatic) operated hoist permits a bag lift frame to be maintained on the lift hook. The lift runs on an I-Beam which extends to a point in front of the bulk bag unloading structure where the bag is staged for lifting. After the bag hooks are attached to the lift frame the operator uses a pendant to elevate, traverse (we recommend a powered trolley), and lower the bag onto the support frame.

The hoist can be a chain or wire rope hoist, but we recommend wire rope as it is much more hygienic. The I-beam that the hoist runs on can be supported from the bulk bag unloading structure itself, making it more expensive. It can also be supported from the building structure above, assuming it is adequate. Integrating the beam into the building ceiling makes for a cleaner, nicer looking installation.

COLUMN LIFT

This is perhaps the most expensive option, but can also be the most hygienic, flexible, and conducive to the floor layout. This system is comprised of a vertical column extending from floor to ceiling with an extended lift arm with the lift frame built into it. The bag is staged in front of the column lift, the bag hooks attached, the bag is lifted and slewed to the unloading station.

A column lift can be used to support multiple unloading stations, provided only one bag is handled and unloaded at a time.

Size of Bulk Bag

The size or sizes of bulk bags to be handled should be defined. The height of the bag, and the extent to which it sags and stretches when lifted, is very important to confirm before the design process. If a forklift is used, the support frame may have to be adjustable to accommodate different heights of bags.

In any case, it is imperative to confirm that there is enough clearance between the ceiling and the bag support structure to fit the lift mechanism and tallest bag (fully stretched).

Retaining the Liner

Many, if not all, bulk bags have liners which are tied off and accessible from the top of the bag (through the filling spout). If this liner is allowed to slip down during the unloading operation it can bind and block the flow of material. For this reason, it is imperative to clamp or retain this liner so this cannot occur. A simple clamp system on the side of the bulk bag lift frame is easy and effective. Other, more involved, spring loaded tension systems are also available. No matter the style, retain the liner if you have one.

Accessing the Bulk Bag Discharge Spout

The discharge spout of the bulk bag is tied and tucked up into the base of bag. When the bag is lowered on its support frame, this spout should be accessible so that it can be accessed, pulled straight down, and untied. The support frame will have an opening at its center to provide this access which often has a rubber seal to help contain dust during unloading.

Access is often provided through a simple “tie-box” which has a hinged door. The operator reaches in, pulls the spout down, unties it, and closes the door. This method is simple and relatively inexpensive; however, it obviously exposes the operator’s arms and face to the material during its initial discharge and can often challenge him to close the door quickly enough to prevent spillage.

Alternatively, there are both mechanical and inflatable seal systems which permit you to attach the bag spout and/or liner to a discharge tube before you actually untie the spout of the bag and permit flow. This offers a much better level of safety and containment. This type of spout attachment can be accomplished without the confinement of a surrounding enclosure but an enclosure can be provided for additional precaution relative to containment or a potential spill.

Obtaining Reliable Flow

Many powders are less than free flowing and/or have compacted in the bag during transit and storage. There are two primary methods of agitating the bottom of the bag to initiate flow and/or to provide continuous reliable flow.

Pneumatic Agitator Paddles

The bag support structure can be designed with two or more pneumatically operated paddles to massage the bottom of the bulk bag. Massage arms can also be mounted to agitate the sides of the bag, if proven necessary. While this method can be effective, there are cylinders, regulators, and moving parts which can represent maintenance and safety issues.

Vibratory Base

The support frame can have a fabricated square or dished head type of pan on which the bag is placed. This pan can be mounted on vibration isolators and an electrically powered vibrator attached to the pan. When activated, flow is induced like a traditional “live bin bottom”. This method is clean and effective. In addition, if there is any residual dust or material that falls from the bag or spout during removal, the pan catches it, providing some house keeping benefits. If a vibrator is used, its controls should be designed so that the vibrator is only activated when the down stream process is calling for material.

Containment/Dust Control

If a “tie box” is used then a dust collection port is usually provided and connected to an existing remote dust collector. This keeps this area under a negative pressure which prevents dust from escaping the box. However, this vent port should be baffled to keep from pulling any product.

If a mechanical or pneumatic spout seal system is used, the spout connection can be considered fully contained and no dust collection may be necessary.

Removing Partially Discharged Bags

If multiple ingredients are going to be received in bulk bags, we recommend that dedicated Bulk Bag Unloaders be utilized to the greatest extent possible. Otherwise, partially discharged bags will have to be removed and replaced. This leads to numerous issues in the form of additional handling, cross contamination, cleaning, staging, and storing.

If the removal of a partially discharged bag is necessary, there are options available in the form of mechanical chokers or even iris valves. These permit you to choke off the bag discharge spout and re-tie it. However, because the spout is full of material this operation is not very easy and can often require you to actually discharge material to get the material moving (it is easier to choke off material which is moving than static material).

Obviously, after removal of the bag, there will be residual material below the spout which will have to be cleared/cleaned out before handling another material - making this all a very user unfriendly operation.

Transferring Powder from the Unloader

Ideally, it is desirable that the bag spout access be no higher than head level (approximately 66”). This eliminates access platforms, stairs, etc. On the other hand, it means that whatever you are discharging to needs to fit within this space constraint, be below the floor level, or be some kind of conveyor to elevate and transfer the powder to the specific target.

If material is being discharged into a drum, small IBC, or other container, platforms and stairs can be eliminated. Otherwise, the use of a screw conveyor or vacuum conveying system can readily interface with the discharge of the bulk bag and be designed to make the appropriate transfer.

In general, gravity is best if it can be used. The next best thing in terms of hygiene and simplicity is a vacuum transfer system with a pneumatically driven vacuum pump. However, these can be more expensive than flexible screws (but are much more hygienic and trouble-free).

Vacuum Transfer

The most common reaction to the use of vacuum transfer is “NO”. Their minds conjure up pictures of PD blowers, large vessels, many filters, isolation valves, motors and starters, and lots of tubing to clean. However, vacuum conveying is a much more attractive option when you realize that it is possible to convey up to 3,000 pounds per hour using only 25 scfm of compressed air (which doesn’t see the product), with a light and modular vessel with washable/disposable filters. Add to that the notion of using a disposable hose and the possible benefits of vacuum transfer become clear.

This method of vacuum transfer can permit much lower profile stack-ups and economy compared to drum lifts and inverters. It is completely quiet, has no moving parts, and is very easy to clean. The fact that there are no motors or electrical controls makes its installation very simple and inexpensive. Further, all raw materials can be kept on the lower floor.

As with every other aspect of a Bulk Bag Unloader design, there is no one right or best way to accomplish product transfer. The pros and cons, in combination with the other considerations, must be weighed and evaluated in the context of the developing design.

Batching from the Bulk Bag

Batching out of a bulk bag is best accomplished by feeding into a container on a scale system on a "gain-in-weight" basis (although "loss-in-weight" systems can be accomplished, it is much more difficult). The scale can be sized to provide maximum accuracy depending on batch size.

Putting the Bulk Bag Unloader on load cells limits accuracy due to the large gross scale range required, not to mention other negative influences from hoists, massagers, vibrators operators, etc.

As indicated above it would be best to batch out of the bulk bag via gravity right into the container or target, which is on a scale. In any case, a batch feeder device will be necessary. The feeder needs to be accurate, usually hygienic, and ideally simple.

The primary candidates for consideration are usually the following:

Sanitary Rotary Valve – We have found these to be an optimal choice in most circumstances. By means of direct control of the valve vane (which occilates back and forth over 180°), we can control the flow of product during "bulk" and "dribble" modes and achieve great accuracies. It is pneumatically operated and easily disassembled for cleaning.

Sanitary Pinch Valve – These pneumatically operated bladder-style valves are available up to 3" in diameter and a fluidizing feature may be necessary with some materials. Accuracies of 10 grams, scale permitting, can be achieved and its one piece sanitary bladder makes it simple and hygienic.

Vibratory Feeder - Specially designed to feed product horizontally from a discharge hopper to the receiving container, a vibratory feeder is a simple, safe, and inexpensive choice for getting a controlled feed. The tubular or flat tray and vibratory drive motor can be designed from small to large to accommodate nearly any project specific requirements.

Screw Feeder – screw feeders are often considered but are expensive, complex, hard to clean, and potentially dangerous.

In addition to feeding the material into the receiving vessel it is also necessary to provide for dust containment during the batch transfer. Numerous types of fill heads are available and the key considerations are user friendliness, simplicity, and flexibility of the material so as not to interfere with the scale readings.

To Sieve or Not to Sieve

Most users who purchase their powders in bulk bags specify that the product is already sieved to a certain mesh size before being filled into the bag. Only experience or specific quality control standards will dictate whether additional sifting is required.

If additional sieving is required, a few options exist:

- Design the Unloader frame to support and incorporate a vibratory sifter below the bag. Sifters require at least a roughly controlled feed, so a valve or feeder device will be necessary. Obviously, this increases the stack-up of the equipment.
- Material can be vacuum transferred from the Unloader through a vacuum sifter and then discharged to the target by the vacuum conveyor.
- If your experience suggests that your only concern may be an occasional piece of paper (or foreign object) and the material is very free flowing, you might be able to simply let the material choke feed through a screen with the appropriate mesh size. The tray should be removed and cleaned after each bag.

Removing and Disposing of the Empty Bag

Prior to removing the empty bag from the Unloader, the operator should get in the habit of stretching the bag (without removing the spout from its retainer) to minimize any residual material in the bag. The bag spout/liner should then be tied so whatever residual material is left is not spilled. At this point, the handling of the bag can be dusty and awkward. Air is trapped in the bag and folding it up tightly is not possible unless you let the air out by untying the spout, which can cause massive amounts of dust.

One of the best options available is a bulk bag compactor. This is a large auger in a hopper into which the empty bulk bag is lowered or placed. The lid is closed and the auger activated. The auger compacts the bulk bag into a supply of plastic liner which is accumulated on the discharge spout of the compactor with the end securely tie-wrapped. A sausage like extrusion is created with the bulk bags inside.

When the sausage is of a suitable length, the liner is pulled forward, and tie-wrapped in two locations between bulk bags. The liner can now be cut between the tie-wraps permitting the operator to remove the sausage of compacted bags, having exposed nothing to an otherwise dusty and awkward operation.

Materials of Construction

Most companies in the food, pharmaceutical, or fine chemical industries require that all product contact surfaces be stainless steel. As product contact surfaces of a Bulk Bag Unloader are usually small, the cost impact here is relatively insignificant. However, if a Bulk Bag Unloader structure and hoist in all stainless steel construction is required for cGMP or other reasons, it can be a very significant cost premium.

Defining what needs to be stainless or what could be mild steel with “steel-it” (or other epoxy paint) can be a major factor in the total cost of a bulk bag unloading project. It can also influence some of the various options discussed above (i.e. hoist vs. column lift, etc).

In Summary

As indicated at the outset, selecting or designing a Bulk Bag Unloader is a process that involves a great deal of collaboration and discussion between all of the interested parties. There is no one, right way and every facility has its own set of interests, priorities, and space constraints, as well as personal and personnel preferences.

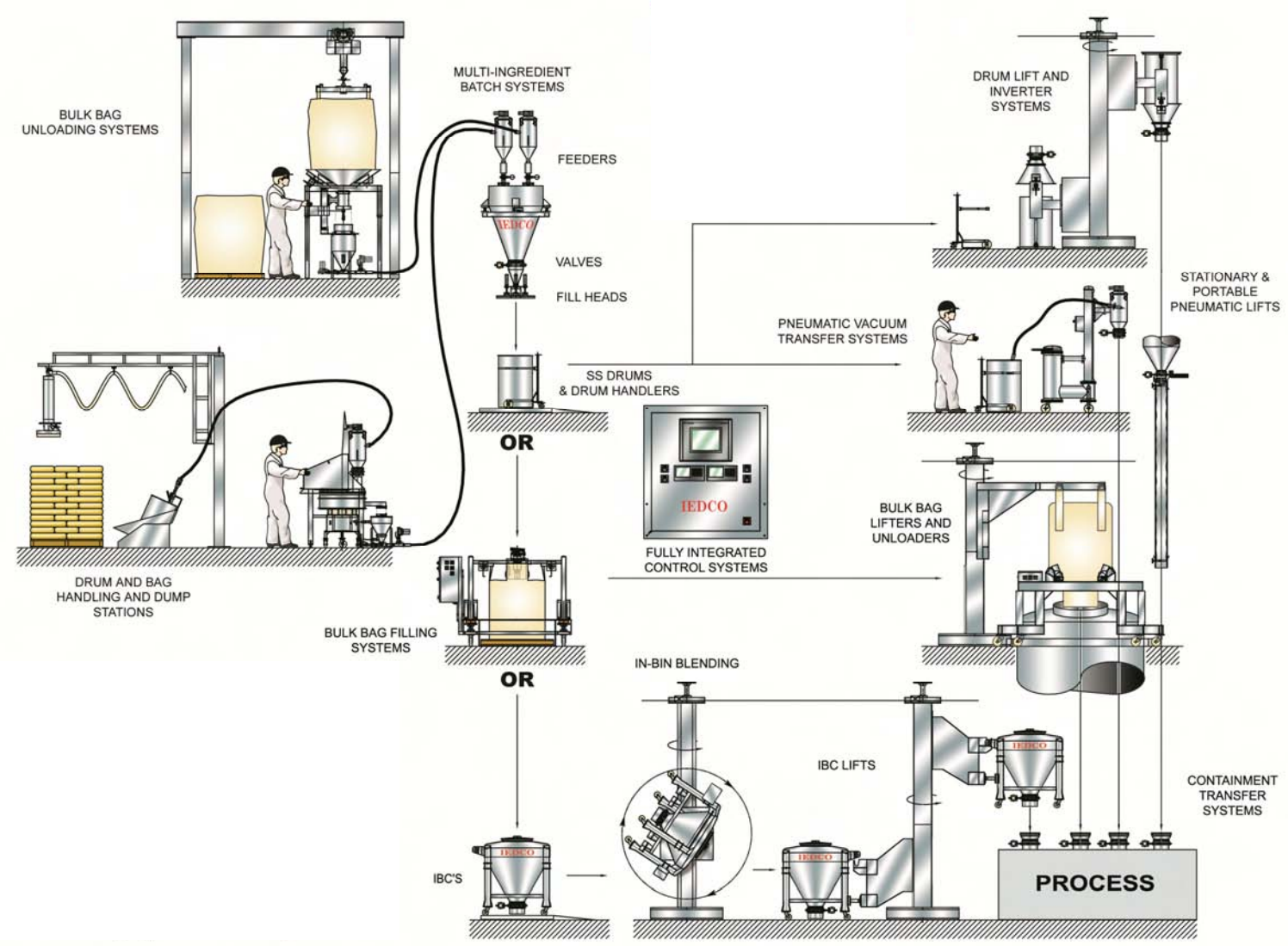
For this reason, designing the perfect Bulk Bag Unloader is a process that must begin with understanding and defining all of these variables so that the designer can incorporate and/or address all considerations in the final design.

IEDCO has quite a bit of experience in this area and would welcome an opportunity to participate in the design process of your bulk bag unloading/dispensing needs.

We look forward to your invitation.

...a world of experience in powder handling

Getting Powder & Tablets From Point "A" To Point "B" Is Our Only Business



IEDCO is dedicated to the engineering, design, manufacture, and installation of powder and tablet handling systems and technologies.

IEDCO's core business is getting powders and tablets from Point "A" to Point "B" in as reliable, as safe, as contained, and as ergonomically acceptable a way as possible.

We are an innovative engineering company that provides our clients with Single Source Engineered Solutions to their specific powder and/or tablet handling application challenges.

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