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Containment of Basket Filtration Centrifuges

ABSTRACT

In the pharmaceutical and fine chemical industries, new products are becoming increasingly potent. Operator exposure to the potent product and the solvents must be minimized. Basket filtration centrifuges are commonly used as a means of filtering potent compounds, and are an effective way to separate and purify solid products. As the demands to minimize operator exposure to the products increase, and as the exposure limits to solvent vapors decrease, the challenge with basket filtration centrifuges is to maintain contained transfer of the caked solids during discharge into downstream processing equipment. In addition to minimizing operator exposure, it is also important to minimize handling of the product to avoid contamination. Basket centrifuges have been developed with systems which maintain this containment. Three approaches to containment of basket centrifuges have been developed and implemented successfully, and each will be discussed in this white paper.

SOFT-SIDED, BAG-OUT CONTAINMENT

This system consists of a flexible, plastic envelope that isolates the solids while being processed with the centrifuge, and is a design that has been implemented with vertical basket top unloading centrifuges. The flexible containment envelope is band-clamped to the centrifuge casing, and is band-clamped to an overhead rail or to the centrifuge cover.

For laboratory scale and small pilot scale vertical basket centrifuges, the containment envelope is attached to the centrifuge cover and casing using band clamps and O-rings. During the centrifugation steps, the envelope is compressed loosely outside the centrifuge. When the centrifuge cover is opened, the envelope unfolds and isolates the inside of the centrifuge from the ambient environment. There are three sleeves in the envelope. One sleeve is used by the operator to dig out the product, and remove the filter bag. The second sleeve is where the product and the filter bag are collected. The third sleeve is used for any tools, waste material, or cleaning materials, etc. Refer to figures 1 and 2.

The solids inside the sleeve are double tie strapped and the sleeve is cut off from the envelope. The solids are transferred to the next unit operation, maintaining containment inside the sealed sleeve. During solids discharge, the inside atmosphere of the containment envelope can be nitrogen blanketed at a slightly positive pressure [0.5″ W.C.

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above atmospheric]. This type of containment system can be advantageous if the materials are sensitive to ambient air.

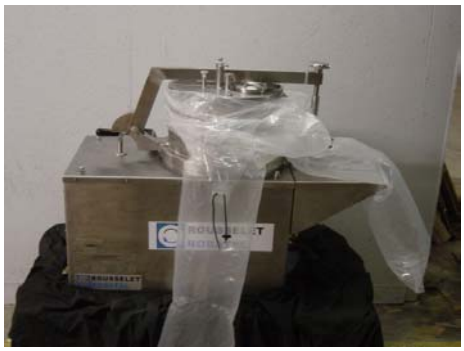

Figure 1: Centrifuge closed during processing

Figure 2: Centrifuge open for solids collecting

After the solids have been collected, the centrifuge is cleaned in place with the cover open to remove residual material from the inside of the containment envelope. The cover is closed, and the centrifuge is cleaned in place a second time to remove residual material from the centrifuge surfaces.

For larger pilot scale and production scale vertical basket centrifuges, the containment envelope is attached to a table, which isolates the upper portion of the centrifuge from the ambient environment. There is an opening in the table and a conical hopper. A solids receiving container is connected to the solids discharge port. Refer to figure 3.

For pilot scale centrifuges, a continuous liner can be used for discharging several product batches, if this is necessary.

The containment method for the solids receiver can be a band clamped containment bag, or an alpha / beta container. The type of container is determined based on the product potency and containment level desired. The table has a low point drain for easy cleaning.

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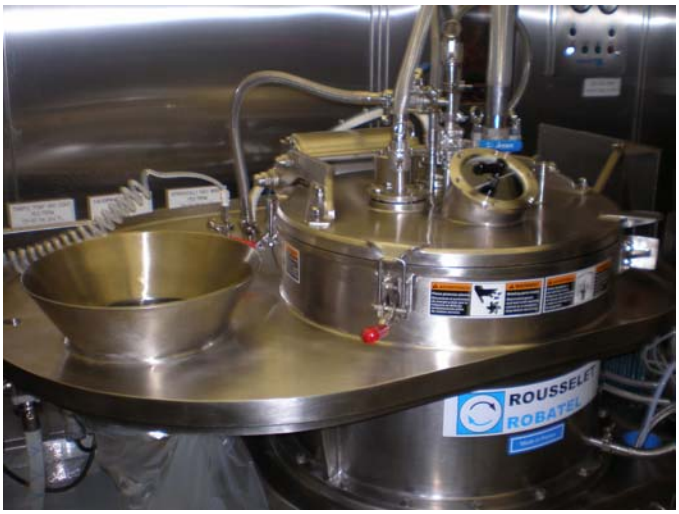

Figure 3: Pilot scale centrifuge with table for containment envelope, showing solids discharge hopper and low point drain [on left hand side of table]

The soft-sided containment approach is frequently implemented when it is desired to provide a level of enhanced containment versus traditional manual discharge. This has proven to be a practical approach to minimizing operator exposure to solvent vapors and minimizes the potential for contamination of the product from the ambient environment. Containment levels of 10 $\mu g/m^3$ or less can be achieved with this approach.

The soft-sided system is the least cost intensive approach, and the containment envelopes are frequently used for a single campaign and disposed of after one use. The envelopes can be manufactured from a variety of clear vinyl and vendor proprietary clear plastic materials. Static dissipative materials are available for solvent processing and for minimizing dust adhesion to the inside of the envelope.

The centrifuge can be used without the containment envelope for non-potent products, and is easily portable with skid or cart installation.

HARD-SIDED CONTAINMENT: GLOVE BOX INSTALLATION

The hard-sided containment system consists of a laboratory or pilot scale vertical basket top unload centrifuge installed inside a glove box barrier-isolator. This is an approach that is used for highly potent, cytotoxic, or biologically active products that require a high level of containment. Refer to figure 4.

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The centrifuge casing is integrated with the isolator using a flexible bellow which allows for the transmission of vibrations. To prevent the potential for contamination into the ambient environment, the centrifuge's bearing assembly has a pressurized dual lip seal that maintains a pneumatic barrier between the process zone and the mechanical zone.

During processing, the glove box isolator is operated under a slightly negative pressure. The centrifuge can be nitrogen blanketed and is operated at a positive pressure. The solids are manually discharged from the basket by an operator. Alternately, the centrifuge basket can be equipped with a removable rim to allow for ergonomic solids discharge. When the solids are ready for discharging, the basket rim is disengaged from the rotor. There is a monorail with a hoist that lifts the removable basket rim and filter bag from the centrifuge. When the filter bag is in position, the filter bag is inverted and the solids discharge into a container.

Centrifuges installed in a glove box frequently have a tray dryer as part of the installation. In this case, the solids are discharged from the filter bag into the dryer trays. This approach is often taken to avoid the transfer of the caked solids into a separate dryer.

Alternately, the solids can be discharged directly into an alpha beta canister, and this canister is used to transfer the solids for further processing.

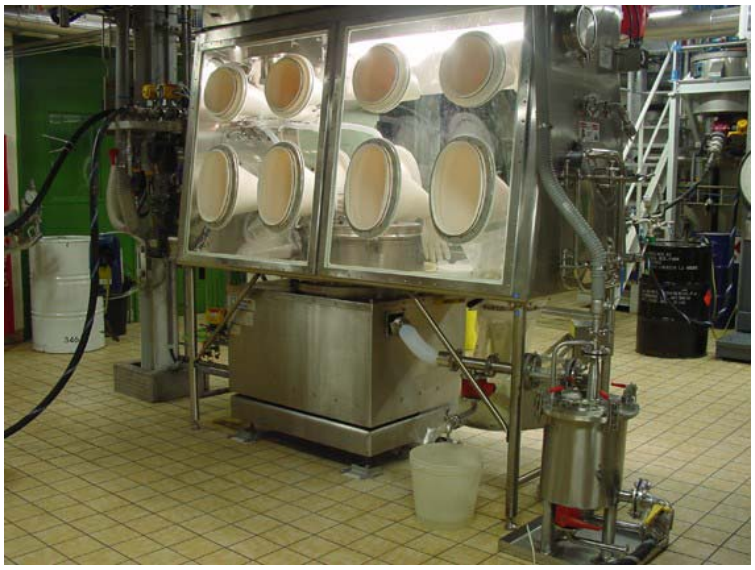

Figure 4: Pilot scale centrifuge installed in a glove box barrier-isolator.

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After the product has been processed, the glove-box isolator is cleaned in place, after which the centrifuge is cleaned in place to remove all residual material.

Glove box isolators can be used for centrifuge sizes ranging from laboratory scale, 1-2 kg solids capacity, up to large pilot scale, 18-35 kg solids capacity. The centrifuge in this case is a permanent installation. Containment levels of 1 $\mu g/m^3$ or less can be achieved with this approach.

CONTAINMENT THROUGH AUTOMATION: HORIZONTAL PEELER BASKET CENTRIFUGES

A horizontal peeler centrifuge includes a scraper that automatically discharges the solids into downstream equipment. After the solids have been washed and dried, the automatic scraper cuts the caked solids and the solids are discharged by gravity through a chute. This automatic discharge eliminates the need for operator intervention during processing, minimizing contamination and operator exposure to the product being processed.

Frequently, on a laboratory and pilot scale, the solids are collected in an alpha beta container, or soft-sided bag-out system. Refer to figure 5. On a production scale, the solids are transferred directly into a dryer for completely contained processing and transfer.

Horizontal basket centrifuges are frequently installed in a clean room that isolates the process zone from the mechanical zone. Refer to figure 6. The centrifuge operates at a slightly positive pressure during processing. The centrifuge can be equipped with a PLC to allow for a completely automated process. The PLC can be integrated with a distributed control system for batch recordkeeping. This type of installation is well adapted to multiproduct use due to the easy cleaning [clean-in-place that can be automated]. Furthermore, the centrifuge casing can be partially filled with cleaning solution to partially immerse the basket for enhanced cleaning, and to aid in removing residual process material. The centrifuge casing is fully opening and allows for complete inspection of all process contact surfaces.

These centrifuges can be used to process highly potent compounds on laboratory, pilot, and full production scale. A horizontal basket centrifuge can be equipped with a soft-sided bag-out containment system, in the event that the centrifuge needs to be opened with product present. This soft-sided containment system is only to be used in the event of an upset condition, such as power loss.

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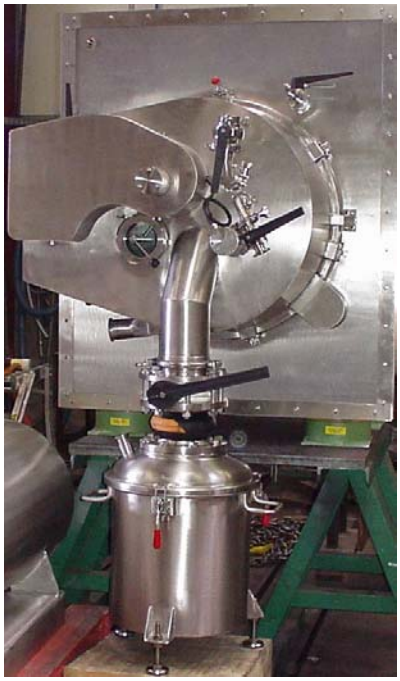

Figure 5: Pilot scale horizontal basket centrifuge with solids discharge into canister.

Figure 6: Horizontal basket centrifuge in a clean room with PLC control

CONCLUSION

There are a variety of methods available to contain a process that uses centrifugal filtration. The type of system that is chosen is based on the level of containment desired, and upon the level of automation required.