schenck process

CONVEYING IDEAS 4

- Managing refills for a loss-in-weight dry materials feeder
- Comparing standard vertical cyclones versus new horizontal cyclone technology
- Supplied air extruder reduces contamination possibilities in extrusion processes

we make processes work

Managing refills for a loss-in-weight dry materials feeder

How measuring, timing and planning your refills can help you stay accurate

There are two philosophies: to design the feeder for less frequent, larger refills, or to design for more frequent, smaller refills. Both philosophies have their merits; however, I would be hesitant to design a TIO2 feeder with a large refill. Large volumes of TIO2 coming into the feeder could easily aerate the remaining material in the feeder and flush everything out of the discharge end.

This means that the answer depends on the materials used, but here is a good place to start: keep a head of material on the feed screw so that the incoming material does not flush out during a refill. As a starting point, I like to use 20–30 percent of the total hopper volume. Next, the need to account for the material's natural angle of repose, which is the descent angle of the material when piled on a flat surface, must be completed. Due to the angle of repose, the feeder hopper typically will not be filled to the top. I recommend using 80–90 percent of the total hopper volume to account for the material's natural angle of repose. For example, if we have a feeder with a total hopper volume of 10 cubic feet, 20 percent of 10 cubic feet equals 2 cubic feet, and 80 percent of 10 cubic feet equals 8 cubic feet. So our total refill amount then becomes 6 cubic feet.

At a rate of 1,200 pounds per hour, with the material weighing 20 pounds per cubic foot, the flow rate would be 60 cubic feet per hour. With a refill amount of 6 cubic feet, refill would need to take place approximately 10 times per hour or about every six minutes.

Before going any further, the consequences of putting material back into a continuous gravimetric feeder while it is feeding must be considered. The controller thinks that there is no material coming out of the feeder and would then try to speed up in order to compensate for this. Therefore, the controller will need to ignore the material going into and out of the feeder. This is called the controller's refill mode. Each manufacturer will have a name for what their controller does during a refill, but the important thing to know is that the controller cannot control while it is in refill. The consensus is that the quicker you refill the feeder and get the controller to come out of refill mode, the more accurate your system is going to be.

Looking again at the 6 cubic feet of material that is required for refilling the feeder and going with a best-case scenario where the refill system can supply exactly 6 cubic feet of material each time the feeder needs it, I recommend operating in refill mode no more than 10 percent of the hour or six minutes total for all of the refills. This provides one minute to accomplish a refill in the example, but before confirming a one-minute refill, settle time needs to be taken into consideration. Settle time allows a scale (or load cells) time to stabilize after material has been either added or taken away from the feeder. Typically, five seconds is enough to allow the scale to settle, so that actually leaves 55 seconds to refill the feeder with 6 cubic feet of material.

Refilling a continuous gravimetric feeder takes careful timing and measuring of materials.

When doing the math that means in 55 seconds the refill system will need to fill the feeder with 120 pounds of material (6 cubic feet × 20 pounds/cubic feet) at a rate of 7,848 pounds per hour (120 pounds in 55 seconds = 2.18 pounds/second = 130.8 pounds/minute = 7,848 pounds/hour.)

Remember to ask an applications engineer for advice or to answer any questions when it comes to refilling your gravimetric feeder. They are knowledgeable in providing guidance on proper feeder refill methods.

About the author
Todd D. Messmer has been with Schenck Process located in Whitewater, Wisconsin, for 16 years; 10 years as a Senior Applications Engineer and 6 years as an Applications Engineering Manager

Cleanable compact cyclone

Comparing standard vertical cyclones versus new horizontal cyclone technology

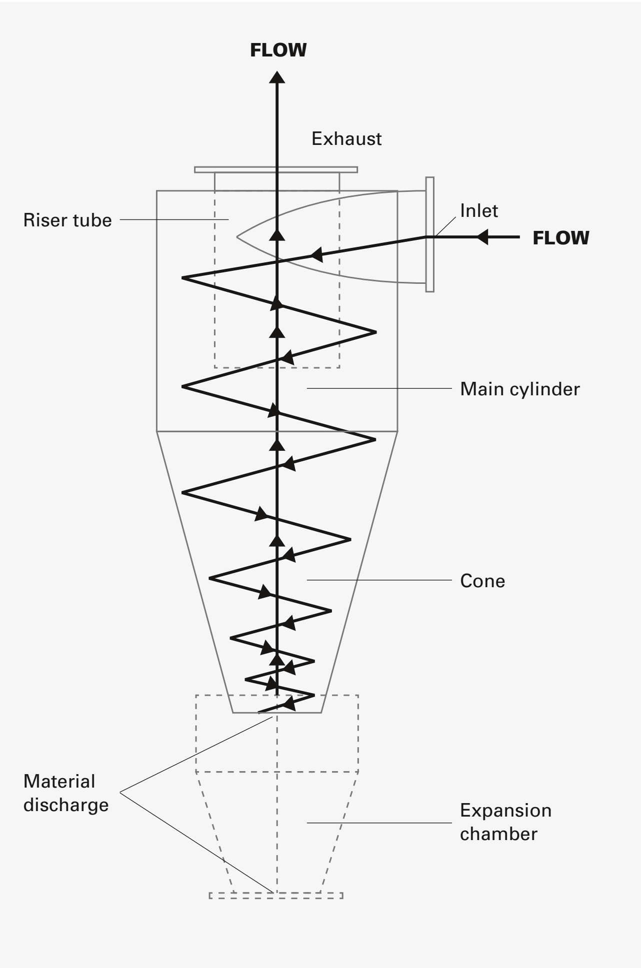


Figure 1.1: Flow pattern for a standard vertical cyclone

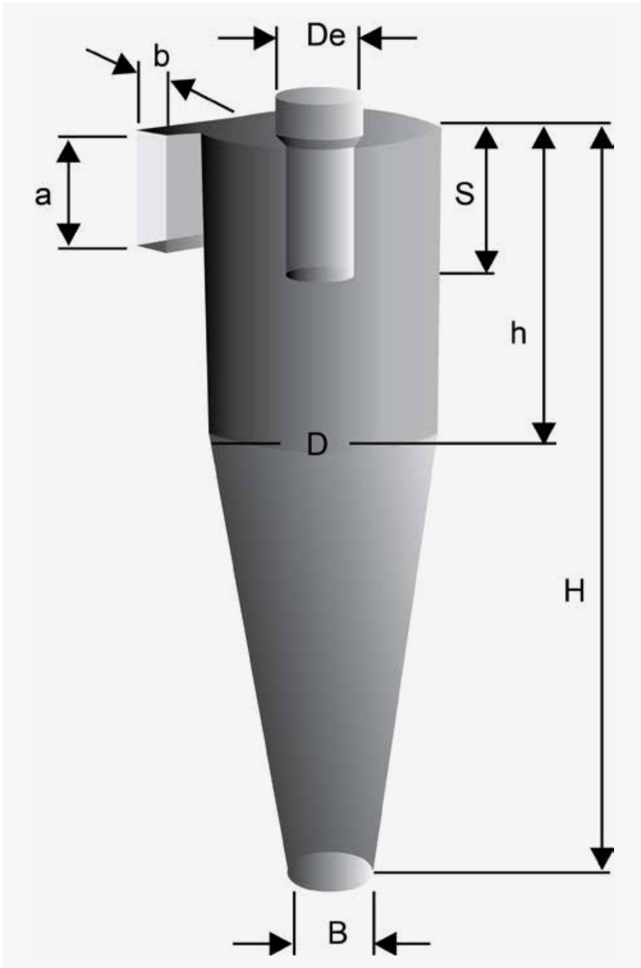


Figure 1.2 Typical dimensions

When we think of cyclones, the majority of us picture a standard vertical reverse-flow cyclone with tangential inlet (see Figure 1.1). These cyclones are commonly used to separate particles from a mixture of gas and solids. They are simple constructions with little to no moving parts, low cost and low maintenance and operate with a moderate pressure drop. This is why they are used in a wide range of applications and processes across many different industries. The operation of a cyclone may be simple, but the fluid dynamics are very complex. The gas-solid mixture enters the cyclone through a tangential inlet and is forced to the interior wall of the cyclone. The centrifugal force created by the swirling flow separates particulate matter from the gas. Inertial and gravitational forces drive the mixture downward as the gas starts peeling off and exiting up through the cyclone's exhaust.

The efficiency of a cyclone is a function of particle distribution, velocity of the air stream, and geometry of the cyclone. The dimensions of the cyclone parts shown in Figure 1.2 are typically presented in a dimensionless ratio form. This method allows for an easy comparison

Duty	High efficiency (Swift 1969)	General purpose (Swift 1969)	High throughput (Swift 1969)
a/D	0.44	0.5	0.8
b/D	0.21	0.25	0.35
De/D	0.4	0.5	0.75
S/D	0.5	0.6	0.85
h/D	1.4	1.75	1.7
H/D	3.9	3.75	3.7
B/D	0.4	0.4	0.4

Table 1.1 Example of various standard cyclone design ratios

of different cyclone designs without using actual sizes. High-efficiency cyclones typically have a smaller diameter and taller main cylinder section, increasing both velocity and the number of turns made by the gas-solid mixture. A list of different cyclone geometric ratios can be found in Table 1.1. Cyclones are typically designed based on the type of application or process that is being used for high efficiency, general purpose, or high throughput.

Standard cyclones with a vertical orientation have been a very effective piece of equipment for many years, but recently a few inherent flaws have surfaced:

1 Interior accessibility
2 Vertical footprint
3 Explosion venting

Some of the difficulties experienced with standard cyclones are due to tighter regulations being enforced by the FDA and NFPA. The implementation of the Food Safety Modernization Act (FSMA) has created a need for the interior of a standard cyclone to be easily accessible for cleaning to reduce downtime. Doors can be added to the standard cyclone to provide better access, but they increase the cost and still do not provide complete access. The most costly disadvantage is the large vertical footprint required by the standard cyclone. Many of these cyclones are being used above dryers, coolers, coaters, and other equipment that already have large vertical footprints. In order for a manufacturer to accommodate the standard cyclone, holes are being cut in floors and ceilings, with some cases requiring a penthouse to be built and eliminating any cost advantages the cyclone once had. Another area of consideration with many industries is explosion protection. The current method for protecting a cyclone is very costly whether it is venting, suppression, or containment – all of which require reinforcement. There is an alternative the industry is starting to embrace: the horizontal cyclone.

Horizontal cyclone

The horizontal cyclone design works much like a standard cyclone, but the main housing is turned 90 degrees with both ends of the cylinder capped (see Figure 1.3). A transition cone is then attached to the underside of the cyclone main housing, acting as the drop-out point. The gas-solid mixture still enters the cyclone through a tangential inlet, but comes over the top rather than from the side, which allows the mixture to fan out across the main housing. As the mixture follows the contour of the cylinder, most of the solid particles fall out of entrainment on the first quarter downward turn, where gravity and inertia take over and deposit the material in the cyclone's cone section. Some particles closer to the center of the vortex are able to make a full turn. They are then deposited in the cone on the second downward turn as the air expands and escapes through the exhaust stub on the end cap.

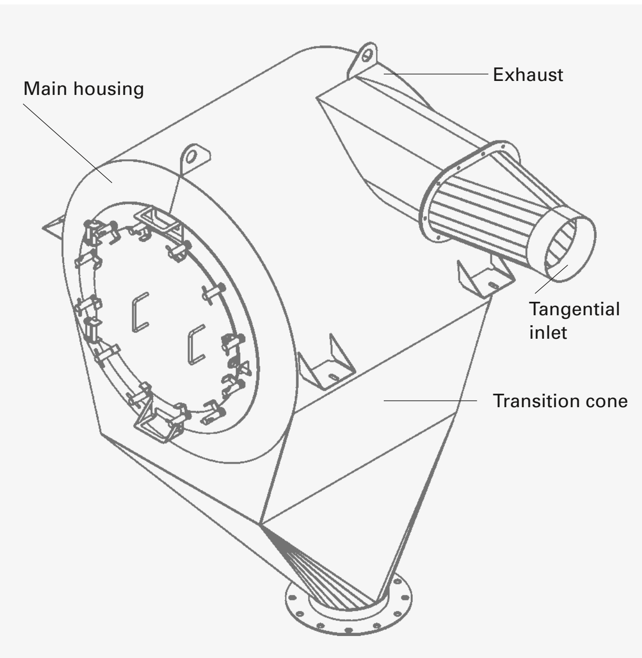


Figure 1.3 General diagram showing horizontal cyclone design

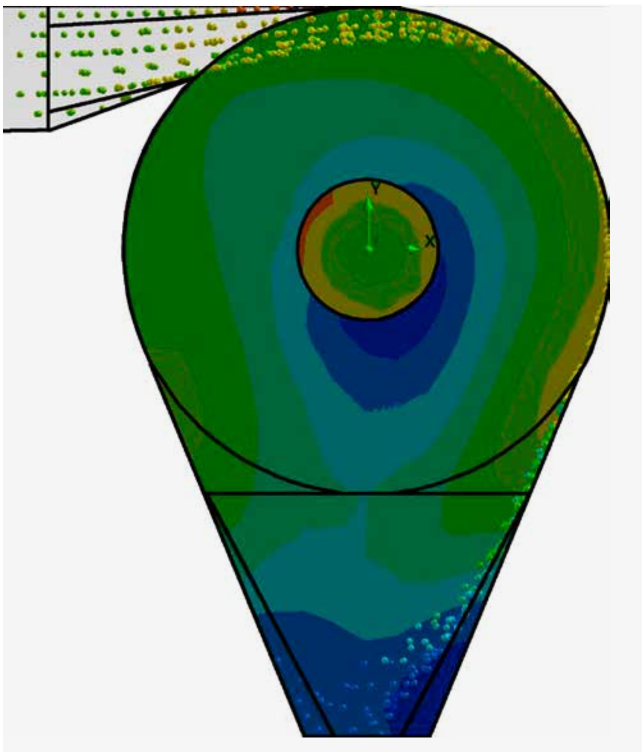


Figure 1.4 Gas and solid flow simulation for horizontal cyclone design

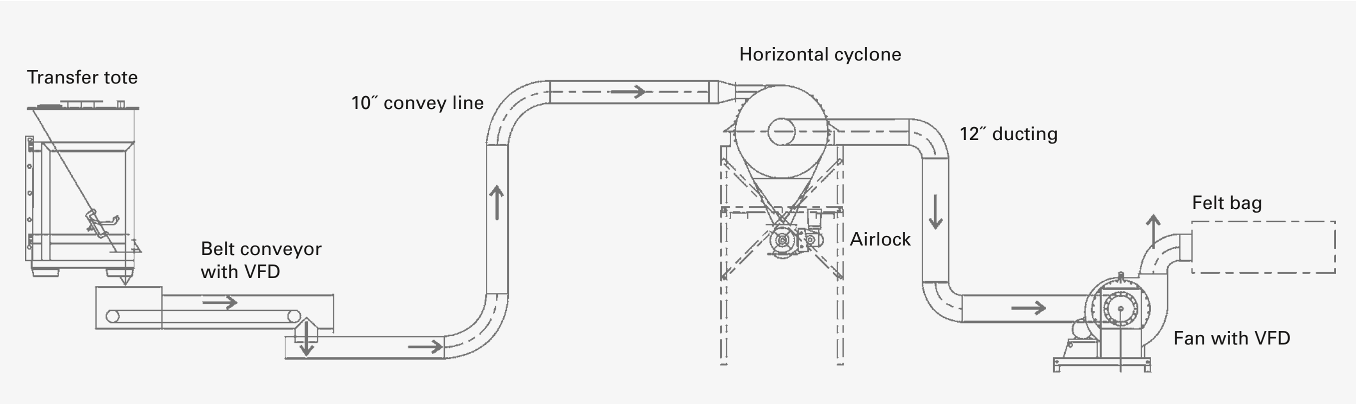


Figure 1.5 Flow diagram for full scale testing (negative airlift system)

The smaller, compact horizontal cyclone allows for a large access door to be mounted on the end of the main housing, providing full access to the interior for cleaning and inspections. This design uses 50 – 58 percent less vertical footprint than required by a standard cyclone. The height of a horizontal cyclone does not increase as fast as that of a standard cyclone since the housing diameter is the main dimension driving the overall height. Having the main housing on its side also lends itself to explosion venting. Past cyclones have been governed by the diameter of the internal riser tube, but now an explosion vent can be mounted opposite the exhaust, eliminating the restriction.

Horizontal cyclone development

Once a concept was decided on, a model was developed for the purpose of flow simulation (see Figure 1.4). Airflows and convey rates representative of negative airlift systems were entered into the flow simulation software. Through an iteration process of the cyclone's dimensions, an optimum design started to reveal itself. The values analyzed during the simulation were velocity, pressure drop, smooth flow, and particle entrainment. The results were encouraging enough to warrant further research in a real-world application.

A prototype of the horizontal cyclone would be built and used for a full-scale test to confirm the result of the flow simulation. The test setup included a variable speed conveyor belt used as the feed device, emptying into an open 10-inch convey line. The convey line was then connected to the inlet of the horizontal cyclone. The outlet of the horizontal cyclone was connected to a fan with 12-inch ducting. The airflow for the system was produced by a 20HP fan with an adjustable damper. The fan was attached to an inverter so that the airflow could be adjusted. A large felt collection bag was fitted to the exhaust of the fan to capture any carryover from the conveyed material. The bottom of the cyclone was fitted with a small airlock that discharged into a collection device (see Figure 1.5).

Results and discussion

The data collected during the full-scale test showed similarities to the flow simulation results, but were surprisingly better in some areas. A range of different dry materials was tested with varying particle sizes, bulk densities, and high/low airflows. Negative airlift systems like the test setup are designed to handle wet material, but dry material was used due to lab limitations. It is also important to note that the material-to-air ratio was light for this test and could be increased.

Material	**Bulk density** (lbs/hr)	**Particle size** (micron)	**Feed rate** (lbs/hr)	**Airflow** (CFM)	**Differential pressure** (" w.c.)	**Efficiency** (grams)
Large kibble	26	8000	7200	1950	5	< 5
				2550	9	< 5
Small kibble	22	3500	7600	1950	5	< 5
				2550	8	< 5
Large flake	9	10000	2300	1950	4	< 5
				2550	9	< 5
Fish feed	33	735	4080	1950	6	< 5
				2550	8.5	< 5

Table 1.2 Information captured during full-scale test

Prior to testing, feed rates were predetermined by capturing weight on a scale at different conveyor belt RPMs. The minimum pick-up velocities were determined by dialing back the fan until build-up was observed, then stepping the fan speed up just above the minimum. As material was fed into the convey line, data was collected using a pitot tube, differential pressure gauge, Lexan windows in the cyclone housing, and carryover in the filter bag. The material was recycled over a period of 10 – 20 minutes, generating a small percentage of fines. The results illustrate the effectiveness of the horizontal cyclone conveying kibble (large and small), light flake material, and fish feed (see Table 1.2). The same test was run on a standard cyclone and then compared to the horizontal data.

Conclusion

The horizontal cyclone developed during this research study proved to function as well as, if not better than a standard cyclone. Prior to testing, some assumptions were made that there would be a percentage of carryover on light or smaller particles, but as the results show, there was almost zero carryover in the filter bag, even with fine generation and dry material.

- Performed extremely well across the range of products
- No kibble found in filter bag
- Advantages realized:
  - ›› Better interior access for cleaning
  - ›› (50 – 58 percent) lower stack-up height

Some questions still remain as to what the limitations are for the horizontal cyclone. Future tests are scheduled for smaller, lighter particles (granular and powder), higher line loadings, and wet pick-up systems. The horizontal cyclone is proving to be an even better separation device than a standard vertical cyclone, while being cleanable, compact, and safe.

About the author

Russell Heinen has been with Schenck Process located in Kansas City, Missouri, for 10 years, 3 years in R&D and 7 years in design and manufacturing. He currently holds the title Senior Technical Engineer and has a master's degree in engineering management.

Spotlight: new technology

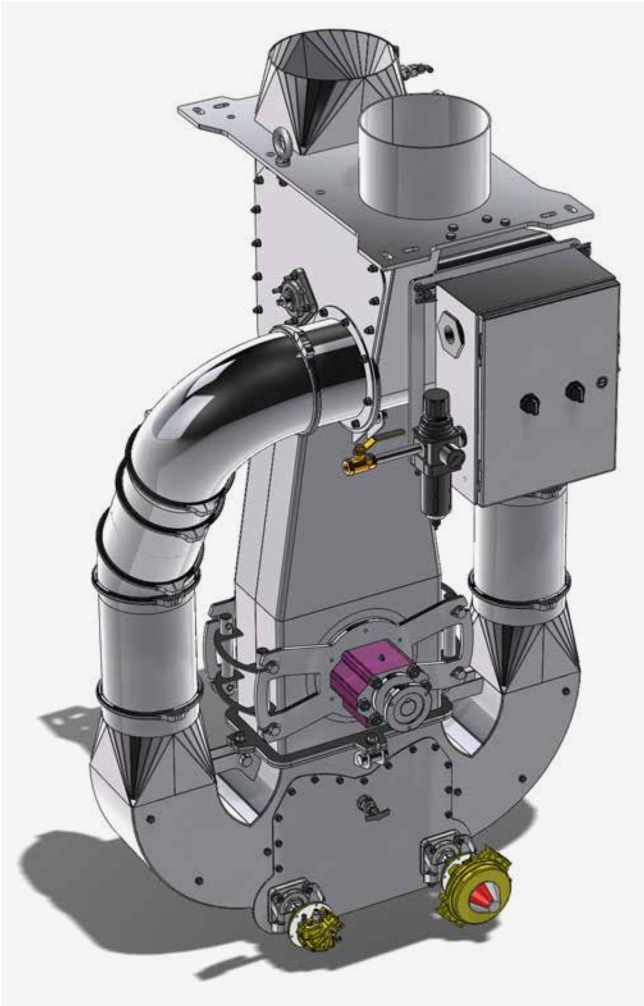
Supplied air extruder reduces contamination possibilities in extrusion processes

The new supplied air extruder hood is a key component of the Schenck Process high feature supplied air negative airlift. This conveys extrudate from extruder to dryer with HEPA-filtered or treated convey air instead of potentially contaminated air from the extruder room floor. It's important to pet food producers concerned with avoiding finished product bacterial contamination after the extrusion kill step.

Other important features of the supplied air extruder hood include:

- Airflow patterns within the hood are nearly identical to standard updraft hoods.
- The production sampling procedure is the same as for standard updraft hoods
- Gasket-free, machined mating surfaces for particle tight, low maintenance operation
- The small footprint design allows for close extruder spacing.
- Compatible with existing dies and knife drives
- Suitable for heat or chemical sanitation processes
- The internal moving parts protect operators from pinch points.

The package of features and benefits offered by the supplied air extruder hood were a direct result of input from customers in pet food manufacturing processes. From those ideas a user-friendly and safely designed airflow system for extrusion production processes was realized.



Supplied air extruder hood safely conveys pet food

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