If you use a volumetric feeder, you’re probably concerned that material flow interruptions during feeding can affect the feeder’s accuracy. This article explains how using a flow detector can help you maintain volumetric feeding accuracy. Sections describe how a volumetric feeder operates, how material flow can be interrupted, and types of flow detectors.

A volumetric feeder delivers material to a process at a certain volume per unit time at a given motor speed, and the feedrate is stated in units of volume per unit time (such as cubic feet per hour). But the volumetric feeder has a major disadvantage: It can’t recognize material flow interruptions.

Other feeders are more accurate, including a gravimetric feeder, which measures material by weight, and an impact weighing feeder, which measures material by sensing the instantaneous force of material as it hits an impact plate. Because both feeders can sense fluctuating flow, they can more accurately feed materials that flow inconsistently.

But the volumetric feeder is usually less expensive, easier to install, and requires less headroom than the gravimetric or impact weighing feeder. Because of these advantages, the volumetric feeder is often used even with a difficult-to-flow material.

Such a material doesn’t flow consistently without assistance. For instance, the material can be cohesive or compressible with a small particle size, which can cause the material to bridge or ratheole, producing inconsistent flow. Other factors, such as changing operating and material conditions (for instance, humidity changes that affect a hygroscopic material’s moisture content), can affect the relationship of the feeder’s speed to its conveying capacity (the amount of material that’s contained in the feeder, such as between a screw feeder’s pitches).

To counteract the effect of inconsistent material flow, especially flow interruptions, and maintain the volumetric feeder’s accuracy, you can use a flow detector (also called a flow holster or a motion detector), which measures the flow to detect interruptions. Installing such a detector not only can help you meet your production and quality standards, but can help your plant meet the International Standards Organization (ISO) 9000 quality standards. These standards seek to certify that manufactured products meet the highest quality standards to satisfy both manufacturers and customers. To be ISO 9000 certified, an ISO-recognized auditing organization must certify your quality assurance program. This includes monitoring your volumetric feeder’s accuracy.

Before discussing types of flow detectors, it will be helpful to look at how a volumetric feeder operates and how the feeder’s material flow can be interrupted.

How a volumetric feeder operates

The volumetric feeder is part of a feeding system (Figure 1) that consists of a supply hopper located above a flow control device (such as a slide-gate valve). The flow control device is linked to the volumetric feeder, which can be a screw, rotary, vibratory, belt, or bucket elevator device. The feeder includes an electronic drive and connects to a chute or a drop pipe leading to the process.

In operation, the supply hopper provides short-term storage for the material to be fed and sometimes includes an agitator to condition a fine material, such as a pigment or diatomaceous earth, to a uniform bulk density. The flow control device releases material from the supply hopper to the feeder. The flow control device can also condition the material for feeding — for instance, by injecting air into the material via an aerator or by agitating the material with a vibrator to ensure the material has a
A volumetric feeder failure.

A plug or a jam in the chute or the drop pipe leading to the process (Figure 1).

In a properly designed system, these problems generally don’t occur. But because your material’s cohesiveness and compressibility can fluctuate and your operating conditions can change, you can’t always prevent the problems. Installing a flow detector can help you detect a flow interruption so you can correct the problem and maintain an accurate feedrate.

Types of flow detectors

While several devices (called level indicators) are available for detecting the material level in the supply hopper, there are fewer devices for detecting a no-flow condition in the volumetric feeding system. A flow detector is one of two basic types: intrusive, which inserts directly into the chute or the drop pipe after the feeder and contacts the material flow, or nonintrusive, which installs outside the chute or the drop pipe and doesn’t contact the material flow.

An intrusive flow detector is typically an electrically powered level switch that’s been adapted for use as a flow detector. When the detector senses a no-flow condition, it causes a switch to relay an output to signal the no-flow condition. One common version is a rotary paddle wheel (Figure 2). A rotary paddle wheel consists of a vane-type paddle wheel mounted on a rod and inserted into the material flow. The impact of flowing material rotates the paddle wheel; when the flow stops, the paddle wheel stops rotating and the device signals the no-flow condition.

Another version is a vibrating fork sensor, which consists of a probe with two prongs, shaped like a tuning fork. When material is flowing over the fork, the prongs vibrate; when flow stops, the prongs stop vibrating and signal the no-flow condition.

How material flow can be interrupted

The material flow can be interrupted at any of several points before the material reaches the process, creating an error condition that impairs the feedrate. The most serious error condition is when the electronic drive signal exists, indicating the feeder is operating, but no material is flowing to the process. This can result from any of several problems:

• A malfunction in the system filling the supply hopper.
• An error in detecting the supply hopper’s material level.
• A bridge or a rathole in the supply hopper.
A radio-frequency capacitance probe is another version and consists of a rod inserted into the material flow. By sensing capacitance changes caused by flow fluctuations, the probe can recognize and signal a no-flow condition.

Because an intrusive detector contacts the material flow, it can be subject to dust buildup, corrosion, and wear. Dust buildup can impair the flow-detecting accuracy. Corrosion and wear can cause metal to break off the detector and contaminate the material stream; thus, if you use an intrusive detector, you may need to install a magnetic separator downstream.

The intrusive detector's moving parts (such as the paddle wheel) require maintenance, including regular wear inspections and lubrication. And if any moving parts fail, the detector can signal a false no-flow condition. Most intrusive detectors aren't designed for high-temperature applications and don't adjust well for pulsating flowrates (such as from a bucket elevator feeder).

The nonintrusive flow detector (Figure 3) typically consists of a Gunn diode, an amplifier, and an electrical power supply enclosed in a housing equipped with a sensitivity and time-delay adjustment. (For a very high temperature application or if space is limited, the power supply can be located in a separate housing.) The detector is typically installed outside a nonconductive (microwave-permeable) window in the chute or drop pipe wall. The window can be a hole, a plastic cover, a sight glass, or a pipe stand-off. (No window is required if the material drops through the air rather than through a chute or a drop pipe.)

The detector's operation is based on the Doppler effect. The Gunn diode transmits a safe, very high frequency microwave signal through the window into the material flow, and the signal is reflected back to the detector. When the material is flowing, the returned signal's frequency is higher or lower than the transmitted signal. When the material isn't flowing, the returned signal is at the same frequency as the transmitted signal, and the detector relays an output to signal the no-flow condition.

Because the detector installs outside the material flow, the device can be used in almost any operating conditions. The detector also requires almost no maintenance because it has no moving parts and isn't subject to corrosion or wear from mate-
This nonintrusive microwave flow detector is installed in a drop pipe (light-colored pipe at upper right) below a screw feeder that delivers diatomaceous earth to a slurry tank. Other materials feed to the tank through the other pipes (lower left).

Material contact. Because microwaves can pass through a nonconductive material, the detector can operate despite dust buildup.

The detector’s sensitivity can be adjusted so that the detector focuses on the chute or the drop pipe and doesn’t sense motion farther away. The detector’s time delay can also be adjusted so that it can correctly sense pulsating flowrates. For instance, if your volumetric feeder is a bucket elevator, the material will pulse rather than flow steadily through the chute or the drop pipe. By adjusting the detector’s time delay, you can prevent the detector from signaling a no-flow condition between pulses.

Editor’s note
For more information about volumetric feeders, see the following Powder and Bulk Engineering articles:


Michael Geis is solids flow product manager at Endress & Hauser, 2350 Endress Place, Greenwood, IN 46143; 317/535-7138. He holds BS and MS degrees in mathematics from Ohio University, Athens, Ohio.