A rotary valve rotor contact detection system can help prevent tramp metal from contaminating bulk solids products and damaging the valve and downstream equipment, but these systems have limitations. This article describes how a rotary valve rotor contact detection system works and discusses the system’s benefits and limitations.

Rotary valve basics
A typical rotary valve is comprised of a spinning metal rotor with multiple (often 6 or 8) blades (also called vanes) mounted to a rotor shaft installed inside a metal housing with a material inlet at the top and a material discharge at the bottom. The valve is powered by an electric motor, which is typically controlled by the plant’s PLC.

In operation, material flows by gravity from a vessel mounted above the valve through the material inlet and fills the space between the rotor’s blades. As the rotor spins, the material is conveyed through the valve and flows out through the material discharge to the downstream process step below. Preventing gas leakage requires that the valve be precisely constructed and installed to minimize the blade-to-housing gap while preventing contact between the blades and the housing, which can damage the valve and cause metal contamination in the material stream.

How rotor contact detection works
A rotary valve rotor contact detection system uses a low-voltage DC electrical current to monitor whether the valve’s rotor blades come into contact with the housing. This is typically made possible by using ceramic ball bearings or a ceramic coating on the rotor shaft. Since ceramic doesn’t conduct electricity, this electrically isolates the rotor from the housing. Once the rotor is isolated from the housing, the system can measure and monitor the electrical resistance (measured in ohms) between the two components. With the resistance being monitored, if the rotor contacts the housing or if metal bridges the gap between the rotor and housing, a short occurs in the circuit (meaning the electrical resistance drops to near zero). This short
triggers an alarm signal to alert operators of the problem and possibly shut down the process.

To make the system fail-safe, a resistor is typically wired between the housing and rotor to complete the circuit. While the valve is operating, electrical current flows through the circuit, and the controller reads the resistor’s value as a normal condition. If rotor contact occurs, the current bypasses the resistor through the contact point, triggering an alarm signal, but if a wire breaks or some other problem causes an open in the circuit (meaning the electrical resistance becomes infinite), the current stops flowing, triggering a fault signal. This prevents the system from operating if a wire is damaged or if a connector is unplugged.

**How to make a spinning rotor part of an electrical circuit**

One of the biggest challenges of producing a properly functioning system, and where manufacturers spend the most development and manufacturing resources, is maintaining reliable electrical continuity between the detection circuit and the spinning rotor shaft. One method is to use a slip-ring assembly. Slip-ring technology is a well-proven, reliable method for maintaining excellent electrical contact with little to no electrical “noise” (or fluctuations in resistance). Devices that use slip-ring technology tend to be expensive, however, making the cost of some of these systems high. The other method used to make electrical contact with the spinning rotor shaft is to use a carbon copper brush, similar to the brush used on the motor in an electric drill or reciprocating saw. This method is inexpensive and good for conducting electrical current but can be sensitive to heat and contamination, which can cause resistance between the rotor shaft and the brush, interfering with the system’s operation.

**System controls**

The control module for a rotor contact detection system is, in essence, an ohmmeter with alarm outputs and other adjustable settings. With limited exceptions, what you’ll get is a 24-volt DC control module and possibly some connecting cables. You mount the module inside an appropriate panel for your application and wire the detection circuit to the valve and the alarm circuit to your plant’s PLC. The module will send out an alarm to the PLC in the event of rotor contact or circuit fault. Some modules come with software that can be used to adjust settings and track alarm history.

Most systems use simple open or closed switches on the control module for the rotor contact and circuit fault alarms. Some have separate switches for each condition, while others tie both conditions into one output. For troubleshooting, having separate rotor-contact and circuit-fault outputs is helpful.

Some controllers also have a contamination alarm for when the controller reads a low circuit resistance but the measurement isn’t low enough to indicate metal contact. Depending on your application, you can set up the system to simply notify operators of an issue, shut down the rotary valve, or even shut down the entire process in the event of a rotor contact. In any case, the system should be set up to prevent the valve from starting up if an alarm condition is present.

**Rotor contact detection system limitations**

A rotary valve rotor contact detection system won’t solve all of your rotary valve damage problems. It can only alert you to metal contact between the rotor and housing and prevent further damage (if you use the alarm to shut down the valve). The system can’t prevent what caused the metal contact in the first place. If you currently have problems with valves becoming damaged by improper handling and assembly, adding one of these systems will likely increase downtime and maintenance work unless you ensure that operators and maintenance staff are well trained on both basic rotary valve and rotor contact detection system operation. If you’re retrofitting a rotor contact detection system to an existing rotary valve, the valve must be 100 percent damage-free when you install the system. You’ll likely need to have a used valve rebuilt before you can add rotor contact detection.

Also, this system doesn’t turn your rotary valve into a metal detector. If metal from upstream processing equipment passes through the rotary valve without bridging the rotor and housing, no alarm will occur. A metal detector downstream from the rotary valve is still necessary to ensure that no metal contaminates your material.

Another limitation of some rotor contact detection systems is that they won’t function properly with materials that have some level of electrical conductivity. Materials such as clean-in-place fluids, wet materials, or even powders with high moisture content can cause false contact alarms. Some systems have adjustable settings to compensate for these types of materials, but others don’t. If your valve will be handling a conductive material, make sure you select a detection system designed for such a material.

**Common problems associated with rotor contact detection systems**

Troubleshooting metal contact alarms can be one of the most frustrating endeavors that any maintenance technician has to deal with. Sometimes the area of contact inside the valve is so small that you can barely see the spots on the housing and rotor that are making contact. Fixing this type of contact can take multiple repair, reassembly, and testing attempts to resolve. A larger rotor-
housing contact may require that parts be completely resurfaced to remove the damage. Both problems can lead to extended downtime, but, remember, this is all in an effort to avoid catastrophic valve failure, material contamination and damage to downstream equipment.

While these systems are all self-monitoring, a skilled electrical technician familiar with the rotor contact detection system may need to diagnose any electrical problems that arise. Detection system suppliers have generally been slow to provide helpful troubleshooting solutions with their systems. Some suppliers provide software programs enabling you to use a laptop or human-machine interface (HMI) to view troubleshooting screens that show real-time resistance values and allow you to turn alarm outputs off during system maintenance.

A local resistance readout at the valve is the best troubleshooting aid, but this requires the technician to carry a laptop and the control module to be mounted close to the valve. Having the control module in a panel farther away, or having a central HMI display of software only, limits the software’s ability to help when troubleshooting contact and circuit issues.

For assistance selecting a rotary valve that includes rotor contact detection, a supplier with installation and field service experience with various systems on the market is your best resource.

Find more information on this topic in articles listed under “Valves” in Powder and Bulk Engineering’s article index in the December 2015 issue or the Article Archive on PBE’s website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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