Choosing the right paddle for your rotary paddle level sensor

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The rotary paddle level sensor is popular in bulk solids storage equipment for its straightforward design, low cost, and versatility in sensing a wide range of materials. This article explains how to choose one with the right paddle type for your material's characteristics and your installation location.

The rotary paddle level sensor (also known as a *rotary paddle level switch, rotary paddle point* (or *bin*) *level indicator,* or *paddlewheel level indicator*) indicates a material's presence or absence in a vessel at a high, intermediate, or low point. Common applications include maintaining a predetermined material level in a vessel, preventing vessel overflow, and signaling a low (or material-reorder) level in a vessel.

The rotary paddle level sensor consists of a rotating paddle (also called a *paddle assembly*) and a power pack and is installed through the vessel wall, as shown in Figure 1, with the paddle protruding into the vessel and the power pack mounted outside it. The paddle — which can have any of various designs — is mounted at the end of a drive shaft connected to a gear-and-motor assembly in the power pack. When no material is present at the paddle, it rotates freely. When material is present, the paddle stops rotating, which activates an output switch (or switches) in the power pack and indicates the material's presence.

Common paddles, including multiple-vane, single-vane, and specialty types, are shown in Figure 2. As we'll explore later in this article, each paddle type is suited to different applications, and its shape and size dictate how it can be mounted on the vessel.

Figure 1

Rotary paddle level sensor installed on vessel wall

Selecting the right paddle is key to ensuring that the rotary paddle level sensor can accurately detect your material levels. Whether you're in the market for a new rotary paddle level sensor or you have an existing one that's just not performing the way it should, you'll need to start by identifying your material's characteristics.

Your material's characteristics

Your material's bulk density and flow properties are important paddle-selection factors because they determine the material's *amount of resistance to displacement by a moving object (the paddle).* Why is this information important? Because the paddle you select must have the surface area to provide just enough resistance to stop the paddle rotation when it contacts your material and trigger the sensor's *material present* indication. While no "standard" quantitative measurement exists for a material's displacement resistance, identifying your material's bulk density and flow behavior can help you determine the displacement resistance a paddle will encounter in contact with your material. Most suppliers offer paddle selection guides based on material bulk density ranges.

Bulk density. As a general rule, the lower your material's bulk density, the larger the paddle's surface area must be to stop paddle rotation and trigger the sensor's *material present* indication. In contrast, a material with a higher bulk density will be more difficult to displace, so a smaller paddle with minimal surface area is best for such an application.

Equipped with the appropriate paddle type, a rotary paddle level sensor can be used with materials in these bulk density ranges:

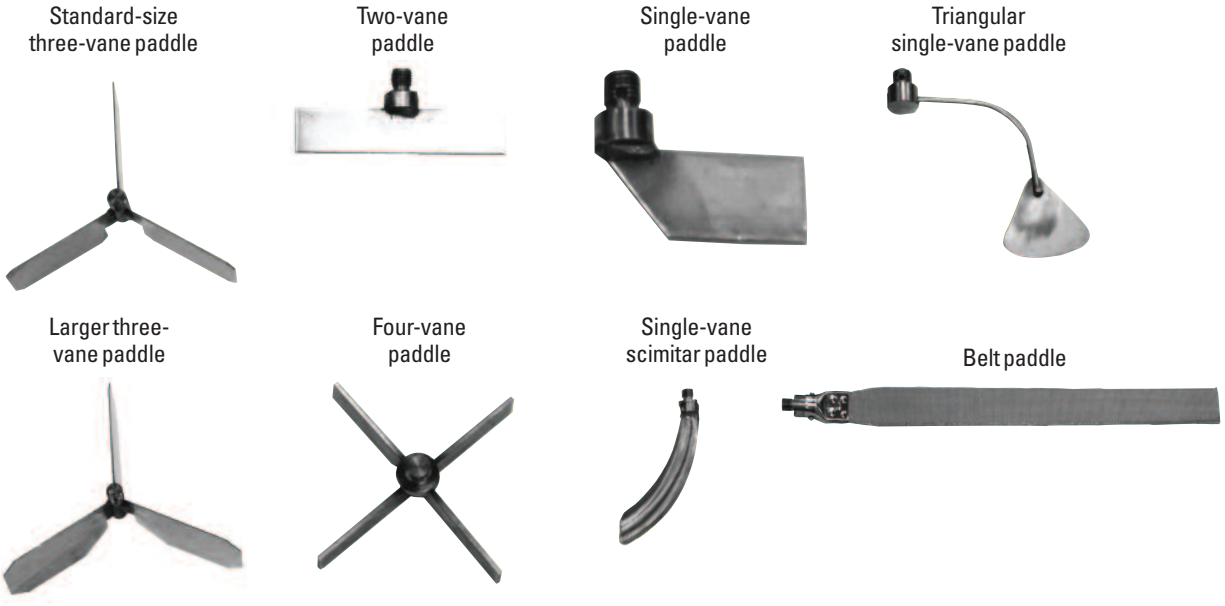
- High: Greater than 65 lb/ft^3 (1,041 kg/m^3), such as powdered cement and glass beads.
- Average: Between 25 and 65 lb/ft^3 (400 and 1,041 kg/m^3), such as granulated sugar and plastic pellets.
- Low: Between 5 and 24 lb/ft^3 (80 and 384 kg/m^3), such as carbon black and cereal flakes.

A material with a bulk density less than 5 lb/ft^3 (80 kg/m^3) is too light to adequately resist a rotary paddle level sensor's paddle rotation; a vibratory level sensor or radio-frequency capacitance sensor would be better suited to such an application. [***Editor's note:*** See the later section "For further reading" to find more information on these and other types of level sensors.]

Flow properties. Next, identify whether your material is very free flowing (such as coffee beans or dried grains), generally free flowing (such as plastic pellets or fly ash), or slower flowing or sluggish (such as charcoal or wood chips). It's important to know both the bulk density and flow behavior of your material, because a material with a low bulk density but sluggish flow will provide greater resistance to paddle rotation than a low-bulk-density material that flows very freely. This information can also influence the mounting location you select for the sensor.

Figure 2

Common paddle types for rotary paddle level sensors



Mounting location and method

Where your rotary paddle level sensor will be located on your vessel and how it will be mounted also influence your paddle choice.

Mounting location. The rotary paddle level sensor can be located at various points along the vessel side or top, depending on the paddle type and whether you need to monitor a low, intermediate, or high material level. A sensor located on the vessel side is mounted horizontally (Figure 1), and one at the top is mounted vertically.

To protect the paddle from damage, you also need to keep it out of the direct flow of incoming and outgoing material.

Figure 3

Typical paddle applications

a. Vertically mounted two-vane paddle in cement-mix batching plant

b. Horizontally mounted single-vane scimitar paddle indicating low level of plastic pellets

Whether the sensor is horizontally or vertically mounted, you must ensure that the paddle is located at a point in the vessel where the normal flow of incoming material will reach and cover the paddle, and where, during vessel discharge, material will flow evenly away from the paddle as the material recedes. To protect the paddle from damage, you also need to keep it out of the direct flow of incoming and outgoing material. This is even more important when your material is lumpy. Various accessories, including flexible couplings, shaft extensions, and shaft guards are available from sensor suppliers to help you install the sensor at a suitable vessel location and protect it from damage from flowing material.

Mounting method. Some paddles with larger sizes and shapes must be installed from outside the vessel through a hole cut into the vessel wall and then mounted on an adaptor plate that fits over the hole. Certain smaller paddles, called *insertable paddles,* can be inserted into the vessel through a 1¼-inch (31.75-millimeter) welded half coupling mounted on the vessel wall. Some applications require variations of these mounting methods; for instance, a rotary paddle level sensor in a batching application is often installed inside the vessel with a pipe extension and U bolts to allow the sensor to be easily repositioned for different high material levels in various batch recipes.

Choosing the right paddle

Now let's look at some common paddle types (Figure 2) and details about their sizes, common applications, and mounting methods. Unless otherwise indicated, each paddle is typically constructed of stainless steel.

Three-vane paddles. A three-vane paddle is one of the most common because of its versatility: It can be used to indicate low, intermediate, and high material levels in vessels. The standard-size version has a turning circle (that is, total diameter, from vane tip to vane tip, when the paddle is rotating) from 5 to 7 inches (127 to 178 millimeters) and vane height of 1.5 to 2 inches (38 to 51 millimeters). This paddle works well with average- and high-bulk density materials. The greater surface area on the larger version, with a turning circle from 7 to 9 inches (178 to 229 millimeters) and vane height of 2 to 2.5 inches (51 to 64 millimeters), makes it more suitable for low-bulk-density materials. While this paddle will work with most particle sizes and shapes, it's not suitable for materials with very large particle sizes, such as large rocks, or fibrous, stringy materials. Because of its large size and shape, the three-vane paddle must be mounted using an adaptor plate over a hole in the vessel wall.

Two- and four-vane paddles. A two- or four-vane paddle also provides low, intermediate, and high level detection and is most commonly used with high-bulk-density materials, such as aggregate in cement-mix batching plants, as shown in Figure 3a. These paddles have a turning circle of

5 to 8 inches (127 to 203 millimeters) and a vane height of 1 to 2.5 inches (25 to 64 millimeters). Although the two-vane paddle in Figure 3a is mounted with a pipe extension, two- and four-vane paddles are typically mounted with an adaptor plate over a hole in the vessel wall because of their size and shape. A lighter-duty insertable version of the two-vane paddle is also available; its lighter-weight vanes can be folded (or retracted) so that the paddle can be inserted into the vessel through a welded half coupling.

Single-vane (insertable) paddles. Single-vane paddle types include the single-vane paddle and single-vane scimitar (also called *banana, saber,* or *hockey stick*) paddle, as shown in Figure 3b. Their primary advantage is that they're insertable.

The single-vane paddle has a turning circle of about 4.5 to 8 inches (127 to 203 millimeters) and a vane height of 1 to 2.5 inches (25 to 64 millimeters). It provides low and high level detection for high-bulk-density materials with particle sizes less than 1½ inch (38 millimeters), such as aggregate. The single-vane scimitar has a turning circle of about 5 to 7 inches (127 to 178 millimeters) and a vane length of 6 to 8 inches (152 to 203 millimeters). This paddle detects low and high levels of low- and average-bulk-density powders and pellets, as well as some slightly heavier materials, in a range from 10 to 85 lb/ft^3 (160 to 1,361 kg/m^3). Examples include plastic pellets, grains, and cement.

Getting the most out of your rotary paddle level sensor depends on properly matching the paddle to your material and application needs.

Specialty paddles. Two paddles — the triangular single-vane paddle and the belt paddle — are suitable for certain difficult applications.

The triangular single-vane paddle has a turning circle of about 9 inches (229 millimeters) and a total length of about 5.75 inches (146 millimeters). While the triangular single-vane paddle can provide high level detection for low- to average-bulk-density materials, the paddle's distinctive triangular shape makes it ideal for use with stringy, fibrous materials, such as shredded newspaper, reclaimed rubber, and wood bark, because the shape minimizes tangling. As the vessel's material level falls, such particles tend to easily fall away from the paddle. The paddle requires mounting with an adaptor plate, and, to ensure that it works properly, should be used *only* with a vertically mounted sensor.

The belt paddle provides high level detection for high-bulk-density materials with a particle diameter larger than 2 inches (50 millimeters), such as coal chunks and rocks. The paddle is available with turning circles around 1.5 inch (38 millimeters) and a belt from 12 to 20 inches (305 to 508 millimeters) long, about 1.5 inch (38 millimeters) wide, and about 0.25 inch (6 millimeters) thick. Because the paddle is made of a durable, flexible material, such as a combination of canvas and styrene-butadiene rubber (SBR), it can absorb the force of these large, heavy materials without being damaged. Like the triangular single-vane paddle, this paddle requires adaptor-plate mounting and should be used *only* with a vertically mounted sensor.

Making your choice

Getting the most out of your rotary paddle level sensor depends on properly matching the paddle to your material and application needs. While the information here can provide a good start to your selection process, each level detection situation has its own unique requirements. Work with a rotary paddle level sensor supplier to ensure that the paddle you choose helps your sensor provide accurate, reliable level detection for your bulk solids processing or handling operation. **PBE**

For further reading

Find more information on level sensors in articles listed under "Level detection" in *Powder and Bulk Engineering*'s comprehensive article index (in the December 2010 issue and at *PBE*'s Web site, www.powderbulk.com) and in books available on the Web site at the *PBE* Bookstore. You can also purchase copies of past *PBE* articles at www.powderbulk.com.

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