

Paddle Wheel Flow Technology: When Do You Use It?

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Paddle wheel flow sensing devices have been showing up in industrial applications since the late 1960's and the technology is still strong—and growing.

There are good reasons. Paddle wheel flow sensors offer the lowest cost per sensing point of any flow measurement technology. You can save money on purchase, installation and maintenance. To fully exploit the price/performance benefits of paddle wheel flow sensors, though, you should know how they work, where they work well, and a few environments where you may want to consider other options. Here are some pointers:

You get the benefit of simplicity

Paddle wheel flow sensing is elegantly simple. Install a paddle wheel in a pipe. The faster the fluid flow, the faster the paddle wheel turns. Know the rotational speed of the paddle wheel and you know the fluid velocity. Know the velocity and the area of the pipe, and you know the flow rate. Paddle wheel sensors work past embedding magnets in the tips of the paddles. As the paddle magnets move by a sensing coil, they generate a sine wave output. The frequency of the sine wave tells you rotational speed.

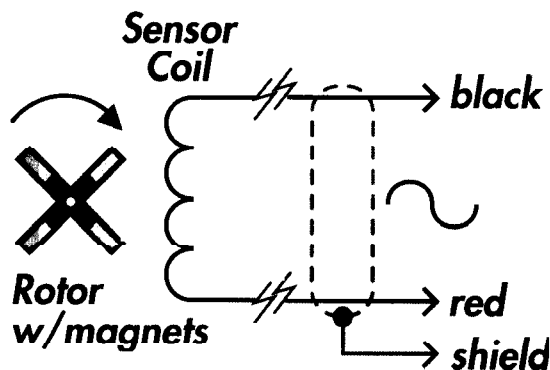


Figure 1: Paddle wheel sensors generate an output with frequency proportional to fluid flow.

Paddle wheel accuracy is well-suited to industrial process applications. You're not running up costs paying for precision you don't use. You can get 1.0% linearity with 0.5% repeatability—and there's no pressure drop.

Drive a meter directly, or use a transmitter

You can use the paddle wheel sensor output to drive a meter directly at distances up to about 200 ft. That gives you a completely self-contained remote-reading flow meter that doesn't even require external power.

If you're going further than 200 ft, or if you want to drive a valve or current-activated monitor, connect the sensor output to a powered transmitter. The transmitter lets

you drive a 4 to 20 mA current loop to PLCs and other control devices. The transmitter can also give you a direct digital local readout.

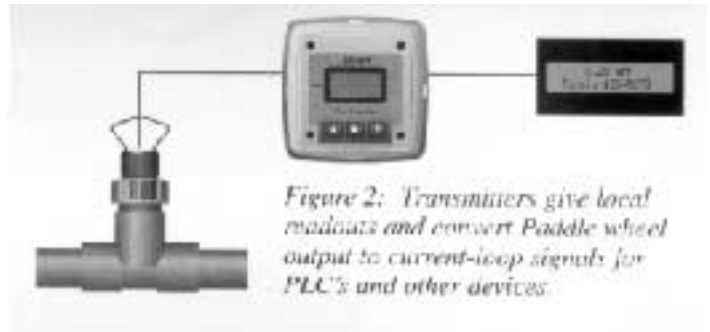


Figure 2: Transmitters give local readouts and convert Paddle wheel output to current-loop signals for PLC's and other devices.

For low flow velocities, tweak the technology

Magnetic paddle wheel flow sensors will handle fluid velocities from 20 fps down to about 0.3 fps. For low flow measurement, you have to modify the technology slightly to accommodate lower paddle wheel rotational speeds. The low-velocity sensors require a power source.

You still have a magnetic paddle wheel, but instead of passing by a sensing coil, the magnets trigger a circuit that's sensitive to magnetic fields. The magnets' fields cause the circuit to conduct current. The powered sensor output is a process-ready square wave pulse train. The pulse repetition rate linearly indicates paddle wheel speed, which tells you flow. Send this industry standard output to PLCs, DCSs, current-loop transmitters or monitors.

Insertion mounting can save money

Paddle wheel flow sensors are typically mounted by inserting them into an existing pipe. Insertion mounting can save money over full-bore designs where 100% of the flow has to pass through the sensor.

Full-bore flow sensors force you to cut the pipe and add flanges or fittings. In large pipe sizes, the pipe fitting operations are expensive. In larger sizes, the full-bore instruments themselves are very expensive.

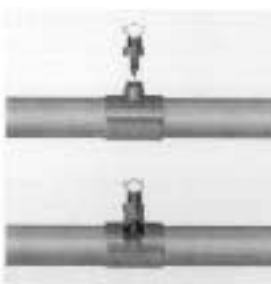


Figure 3: Simple mounting hardware adapts a single paddle wheel sensor to many pipe sizes.

Insertion mounting means not having to cut and fit pipe. Just drill a hole in the pipe, clamp, weld or bolt on a mounting adapter, and you're ready to install the sensor. The operation is especially simple with plastic piping such as the polypropylene or polyvinylidene fluoride (PVDF) systems made by George Fischer.

The installation fitting controls sensor insertion depth, so you get consistent accuracy.

Connect wiring to a frequency measuring device such as a transmitter, a monitor or controller and you're ready to measure. One compact, relatively inexpensive sensor works on many pipe sizes. That

cuts inventory costs. Sensors are easy to exchange or replace, which cuts maintenance costs and reduces system downtime.

Replace and install sensors with filled pipes

Some mounting adapters let you work with fluid in the pipe. "Wet-tap" sensor mountings from Signet have a valve that lets you remove and replace the sensor with pressure on the system—up to 25 psi.

"Hot-tap" fittings go a step farther. You don't even have to drain the pipe to install a hot-tap fitting. Weld a fitting onto the side of a steel pipe and install a gate or ball valve. A specially designed, sealed drill bit reaches down through the valve and pierces the pipe. Partially withdraw the drill and close the valve. Take the drill out and slide a paddle wheel sensor into the seal opening. Open the valve and slide the sensor down into the pipe.

You need a straight run of pipe for installation

For best performance, paddle wheel flow sensors should be properly located. In a horizontal pipe run, you will normally mount a paddle wheel sensor vertically, between 10 o'clock - 2 o'clock position. See figure 4. The 6 o'clock position should be avoided since sediment can settle in the bottom of the pipe.

If valves, elbows or fittings are too close to the sensor, disturbances in the flow may make your measured velocity inaccurate. For maximum linearity and accuracy, you should position paddle wheel sensors with a straight run of pipe upstream and downstream of the sensor. This gives you uniform velocity in the pipe. Technically, you're looking for "fully developed turbulent flow," with a Reynolds number above 4,500. See figure 5.

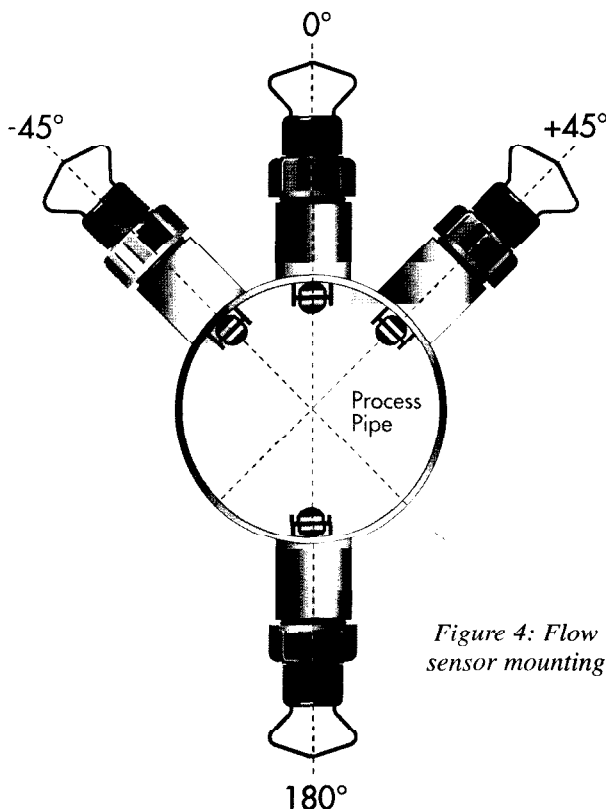


Figure 4: Flow sensor mounting

With highly viscous fluids, or at extremely low flow rates, you're likely to encounter a laminar flow condition,

where fluid velocity at the center of the pipe is higher than the velocity near the wall. That will throw off paddle wheel measurement accuracy if you're measuring a varying flow rate. See figure 6. Since the flow isn't uniform, paddle wheel speed no longer has a linear relationship to fluid volume.

In low-velocity, high-solids applications, you may need to consider an alternate technology, such as an insertion magnetic flow sensor. Signet's magnetic sensors, for instance, cover a range from 0.3 - 20 fps.

Fibers and particulates can cause problems

Paddle wheel sensors may also lose accuracy if the fluid contains a lot of fiber or particulates. The primary problem is that particulates and fibers may restrict paddle wheel rotation. A secondary problem is that some particulates may cause abrasion and accelerated wear. In these applications you may need to consider an alternate technology, such as Signet's insertion-mount magnetic flow sensors.

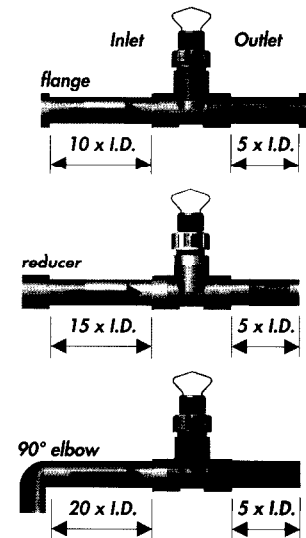


Figure 5: Mount sensor in straight run of pipe

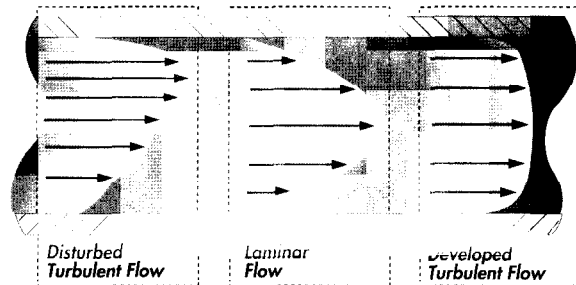


Figure 6: Flow profile

You get long life and broad application choices

With only one moving part, paddle wheel sensors are generally long-lived. Some sensors see 10 to 15 years of service. Paddle wheel sensor manufacturers such as Signet can provide paddle wheel sensors in materials including polypropylene, PVDF, stainless steel and brass. All the wetted parts—even the pins the paddle wheels rotate on—are available in a variety of materials.

If you're designing for plastic piping such as the George Fischer systems, the plastic-based Signet paddle wheel instruments are a natural match. Some Signet designs operate in pressures up to 1,500 psi. Signet can give you advice about compatibility with various water-based liquids. No single technology is the universal answer to all problems, but paddle wheel flow sensing provides cost-effective solutions to many applications.

For additional information, contact Signet Scientific Co., A George Fischer Co., 3401 Aerojet Ave., El Monte, CA 91731-2882, 818/571-2770, FAX: 818/573-2057