

Understanding Flexible-Sleeve Pressure Sensors

... what they are, how they work, where they fit

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Reliable, accurate pressure readings are often difficult—or even impossible—to obtain on pipelines carrying heavy, abrasive, or corrosive slurries. For example, solids may clog conventional Bourdon tubes or chemical seals in gauges to prevent effective pressure sensing and gauge performance. And standard pressure taps drilled into a point on a pipeline read pressure at only that point. The small tapped hole is vulnerable to blockage by debris or deposits, Fig. 1. The standpipe, which connects to a gauge, must also be free of air to ensure accurate readings.

Enter Flexible-Sleeve Sensors—Recently developed

pressure sensors that operate on an isolating rubber ring principle have helped solve such problems. Pipeline pressure is sensed by a flexible rubber sleeve that covers the pipe's inside circumference, Fig. 2. The sensed pressure is then transferred by a hydraulic fluid to a gauge for readout. The need for direct taps into the pipe is eliminated.

Fluid moving past the rubber sleeve keeps it clean and flexible. Because there are no blind ends or dead spots, sediment cannot settle and pack. Sticky deposits are dislodged by the sleeve's flexing action and carried away by the flow. *(Turn page)*

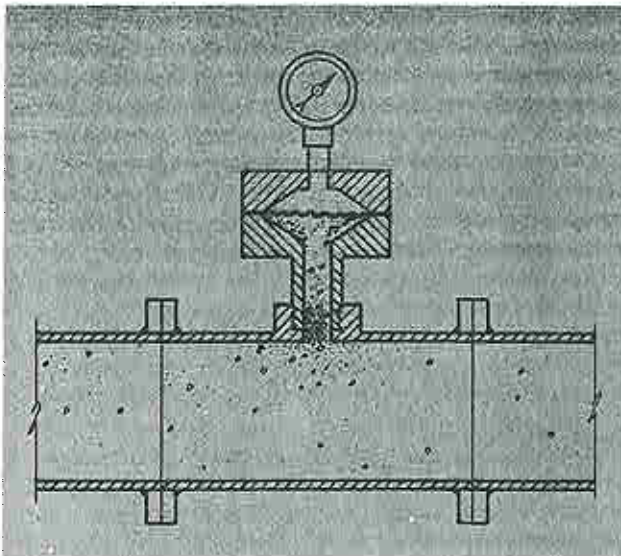


Fig. 1. Tap holes serving chemical seals on conventional pressure gauges are vulnerable to plugging, which may make pressure readings on slurry pipelines difficult.

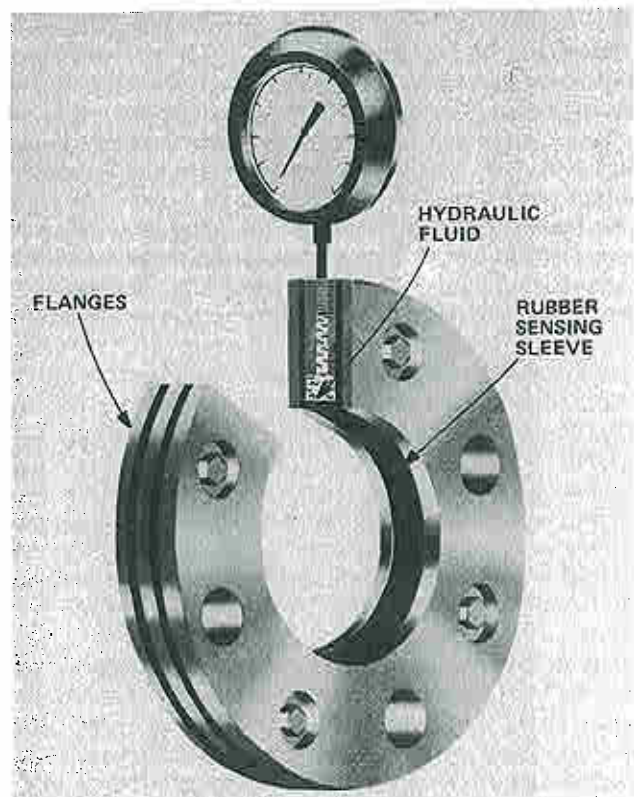


Fig. 2. Pipeline pressure is sensed by self-cleaning, flexible rubber sleeve that covers pipe's inside circumference. Sensed pressure is transferred to gauge by hydraulic fluid.

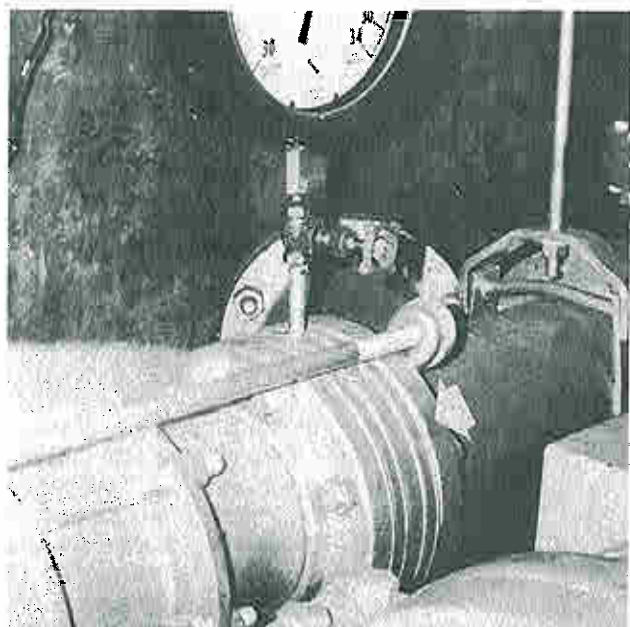


Fig. 3. Flanged-end, wafer-type pressure sensor (arrow) occupies minimum space and is especially useful where space is limited. Units are made in diameters to 24 in.

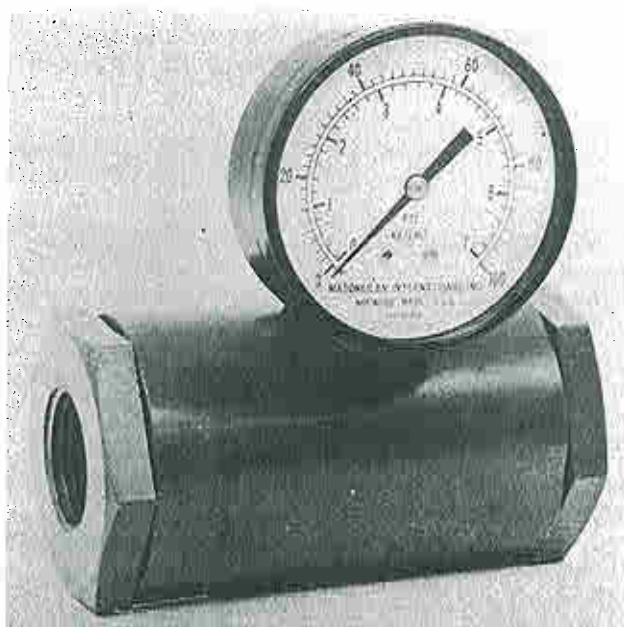


Fig. 4. Threaded-end pressure sensors are designed for 1/2 in. to 2 in. dia pipe. Typical applications are lime systems, coal-sampling lines, and ore-flotation equipment.

The pressure readings that are obtained represent the circumferential average of the pipe's internal pressure distribution. Solids buildup at any given point in the pipe does not affect reliability because flexing always occurs on some area of the sleeve. Air trapped in the fluid also has no effect because the sleeve isolates the air from the gauge.

Sensor Types—Flexible-sleeve pressure sensors are available in various styles and designs from several manufacturers.

The *slim-wafer sensor*, which has face-to-face dimensions equal to those of butterfly valves, is the most common. The slim design is especially suitable where space is limited, Fig. 3. Units are made in diameters to 24 in.

Threaded-end sensors are commonly used in 1/2 in. to 2 in. NPT pipe sizes, Fig. 4. Typical applications are in lime systems, coal-sampling lines, and ore-flotation equipment where conventional pressure gauges frequently have short service lives.

Flanged-end sensors are available in diameters to 6 in. The flange design is popular in applications that require 1/2 in. to 1 in. NPT gauge bases. Flanged units have sufficient mounting surface to permit a number of pressure pickups to be installed on one sensor.

Hysteresis and sensitivity vary with sensor types and the kind of rubber used by a manufacturer. Hysteresis

of 5 in. w.g. is common for sensors with a 1 psi gauge sensitivity reading at 1 in. w.g. Better results can be obtained with special rubber materials. In general, the pressure sensors are as accurate as the gauges and instruments that can be mounted on them.

Sensing Element Materials—A variety of rubber materials are used to make the flexible-sleeve elements. Most units are injection molded. Butadiene and neoprene synthetic rubbers are the most popular materials. These products perform well with slurries containing oil or grease contaminants. Chlorosulfonated polyethylene sleeves are used for acidic and basic fluids. Fluoroelastomer and butadiene sleeves are used for hydrocarbons. Natural rubber is recommended for highly abrasive slurries.

A nylon-reinforced rubber is available for use under elevated pressure conditions. The nylon-ply construction is very similar to that of an automobile tire. The ply reinforcement reduces sensitivity, but fine sensitivity is not usually required at high pressures. Sensor manufacturers should be consulted to determine which material is best for a particular application.

Sensor bodies are made from various metals and plastics. Steel, aluminum, stainless steel, and polyvinyl chloride are common. Because the rubber sleeve does not cover the unit's flanges, the correct metal must be picked to ensure chemical compatibility in corrosive

environments. Carbon-steel bodies with butadiene rubber sensing rings are used in the majority of applications. Special metals are required for extremely severe environments.

Pressure Transfer Fluids—Hydraulic fluids used to transfer the sensed pressure from the sleeve to the indicating gauge include ethylene glycol, glycerin, distilled water, and various food-compatible liquids. A 60 percent aqueous ethylene glycol solution is popular. The glycol solution has an operating temperature range of -60 to +220 F, which closely matches that of commonly used rubber sleeve materials.

Higher temperatures may require the use of silicone oils in combination with ethylene propylene terpolymer (EPT) or butyl rubber sleeves. Mineral and vegetable-base oils paired with silicone rubber sleeves can also be used.

The sensors are normally filled with fluid at the manufacturer's plant. However, the fluids can be added in the field. The liquid must be charged into the sensor cavity and the Bourdon tube. A hypodermic needle is recommended for filling the tube. Entrapped air is removed by tapping the components while they are being filled. Once full, the components are simply screwed together and are ready for use.

Because the sensors measure pipeline pressure directly, field calibrations usually are not necessary. Gauges can be removed or replaced without disturbing the sensor in the pipeline. But field adjustments may be necessary if gauges are not mounted directly on the sensors. Some gauges are attached with capillary tubes at various elevations. In such cases, the gauge's needle must be adjusted to compensate for the change in static head.

Other Uses—Although most flexible-sleeve sensors are used for measuring pressure in pipelines carrying heavy slurries, the units are suitable for other purposes too. With proper instrumentation, the sensors can be used as pressure pickups for alarm switches, transmitters, recorders, and capillary tubes.

Pressure alarms are only as reliable as their pressure taps. If the nipple or seal is corroded or clogged, the alarm may not function. Installing an inline rubber ring sensor helps ensure reliability.

The units are also being used to check slurry levels in tanks by measuring head pressure, Fig. 5. Many conventional instruments that determine head pressure rely on electronic or air signals that must be converted to a readable output. Obstructions in the tank's drain line are liable to make conventional systems inaccurate or inoperable. Flexible-sleeve sensors installed in drain lines have sufficient area to prevent clogging or bridging. (The open area on a 6 in. dia unit is 28 sq in.)

Valve throttling is another use for the sensors. For example, air-operated pinch valves are commonly used to control flow in slurry lines. Output from the sensor is relayed to a pressure transmitter that produces a signal to supply the required amount of air to the valve. Continuous throttling occurs as slurry pressures change, Fig. 6.

Fig. 5. Slurry level in tank is measured by flexible-sleeve pressure sensor that monitors head pressure and transmits it to level-indicating gauge.

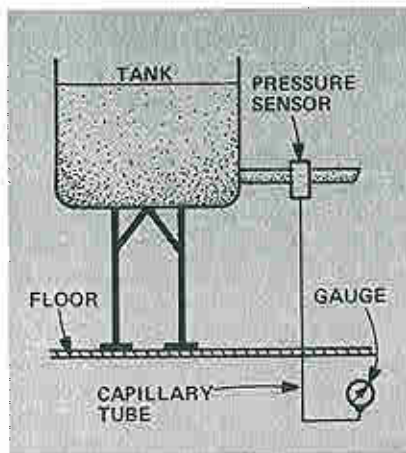


Fig. 6. Pressure sensor used with transducer, transmitter, and booster relay provides simple, effective throttling system for pinch valve in slurry pipeline.

