New Isolated Pressure Sensor Design Negates Zero Shift Due To Torquing

Provides better protection from cavitation to blending and high-pressure fracing pumps.

VIATRAN

Overview

Hydraulic fracturing (fracing) is an effective extraction process that involves bursts of aggressive but closely monitored and scientifically controlled subsurface treatment activities under high pressures. The expensive pumps used for the high pressure fracturing and blending of the chemical constituents of the fracing fluid are critical to the success of this process.

One of the greatest threats to maintaining consistent high-performance from these pumps is the cavitation in the pump rotors that occurs when air becomes entrained in the media. To prevent cavitation, pressure transmitters are located in pressure ports on the suction side of the pumps. When the transmitter detects a pressure drop, the controller idles the pump until an acceptable operating pressure has been re-established.

At most fracing operations, one of these pressure transmitters is installed on the blender pump, and a number of others (typically 12 or 24) on inlets to the high pressure fracing pump. Unfortunately, many of the transmitters currently in use for these applications are susceptible to a shift in the zero reading when they are torqued into the pressure fitting on the pump. This zero shift causes a proportional distortion of the output signal throughout the entire pressure range of the device.

This problem has been researched extensively by Viatran, which recently developed a new pressure transmitter to address this problem, as well as several other significant issues related to pressure transmitters found on blending and high-pressure fracing pumps.

What is Zero Shift due to Torquing?

In the factory, conventional 4 - 20 mA pressure transmitters used on the suction side of blending and high-pressure fracing pumps are calibrated to transmit a 4 mA signal at zero pressure. However, in the field, torquing the transmitter into a threaded port (tapered such as 1/2" NPT or parallel such as G1/2 and 3/4" - 16) in the pump's inlet can cause a shift as high as 2% to 4% in the zero reading. The direction of that shift may be in either a positive or negative direction.

If, for example, a 500 Psi transmitter after installation produces a 4.5 mA signal at 0 psi pressure, the instrument is off by 0.5 mA or ≈ 1/30 of the transmitter's range. In this case, 350 psi of pressure in the line will produce a signal that falsely indicates more than 365 psi of line pressure. When the zero shift is negative, the problem is similar, only in the other direction.

Consequences of Zero Shift

Zero shifted pressure transmitters that have not been compensated in the field can deliver unreliable readings that are off by 2 - 4% of the instrument's full range in either a positive or negative direction. This can result in an inadequate control response to pressure drops, caused by entrained air that inflicts cavitation on pump rotors. This, over time, results in degraded pump performance and a premature need to take expensive pumps off-line for repair.

The problem can be corrected by using a data acquisition system to detect and correct zero shift after the transmitter is installed. However, "taring out" transmitters in the field after installation, and prior to each new operation, adds another time-consuming procedure (as much as 1 hour per transmitter) to processes that are already under tight time constraints.

Causes of Zero Shift

Standard NPT fittings have a slight taper which allows them to create a tight seal between the threads by using Teflon® tape during installation of the unit. Torquing the unit into the tapered port creates stresses in the walls of the transmitter pressure fitting. In conventional units, the sensing diaphragm is welded to the pressure fitting where the stresses of torquing are transferred directly to the sensor. This causes a zero shift even if the installer torques the unit carefully.

The direction of the zero shift depends on an interplay of stresses between the tension gages mounted in the middle of the sensing diaphragm and the compression gages on the outside. In general, the direction of shift is likely to be positive, but neither the direction nor magnitude of the shift is predictable.

Preventive Measures During Installation

Sensing Installation technicians generally have a feel for how much torque is necessary to create a tight seal without over-torquing. Carefully installed transmitters will exhibit less zero shift but will not eliminate it. What's more, it is not possible to predict how much careful installation will reduce the zero shift or influence its direction.

When fracing operations consider accurate pressure readings to be indispensable to maintaining the performance of expensive pumps and reducing their maintenance costs, operators spend a considerable amount of time "taring out" the pressure transmitters when they are installed and when starting a new operation.

New Isolated Sensor Design Negates Zero Shift

Realizing the importance of the zero shift phenomenon to fracing operations, Viatran set out to design a unique pressure transmitter that would essentially eliminate the probem. Zero shift is the result of torquing stresses that are transferred from the pressure fitting to the pressure sensing diaphragm. Viatran engineers have created a design that isolates the sensor by suspending it from the back of the unit's pressure port so that torque induced zero shift is essentially eliminated.

This new design, the Viatran Model 385 Flush Tip Sensor (available in pressure ranges from 0 - 50 to 0 - 500 psi) was thoroughly tested by installation at 25 and 50 ft. lb. of torque. In both instances, zero shift due to torquing was less than 0.1%. This is also true for pressure ports that utilize parallel threads such as G1/2 and 3/4" - 16.

This means that Model 385 Flush Tip Sensors are interchangeable. They can be installed in the field and used immediately without any special measures needed to ensure the accuracy of their reading. Hours of time required to "tare out" multiple transmitters during installation are eliminated. As a result, expensive pumps are better protected from cavitation by responsive control schemes that depend on consistently accurate pressure data to detect entrained air and respond appropriately.

Other Sensor Benefits

The Model 385 Flush Tip Sensor has several other benefits for pressure transmitters used on fracing and blending pumps:

- Flush Tip: When installed, the sensor's diaphragm is flush with the line to eliminate any possibility of clogging the pressure inlet of the sensor. This ensures continuous high performance of the unit.
- High Proof Pressure: Can withstand pressure spikes up to 5x the unit's pressure range and provide continuous service without performance degradation.
- High Burst Pressure (20x the unit's pressure rating): Ensures that transient pressure spikes will not compromise the integrity of the hydraulic line at the transmitter.
- Rugged Stainless Steel Diaphragm: Minimizes wear on the sensor for a prolonged useful life with high data integrity.

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