Flow Rate Measurement Using the SPIDR® Gauge

We have recently been approached by several operators around the world who are curious about non-traditional applications for our SPIDR® surface pressure gauge. For many years the Halliburton has been used to collect high quality surface pressure data. This has always been the primary purpose of our tool. Occasionally the SPIDR® gauge is also used to gather additional data on wells while it is at the wellsite gathering tubing pressure data. Some of these additional data sources include liquid injection rates, casing pressure, temperature, and gas flow rate. The ability to accurately record gas flow rates is the most frequently requested additional measurement.

We have seen that in many locations it is difficult to get an accurate measurement of flow rates. This can be due to failure of existing hardware or an inadequacy in the hardware that is installed. The SPIDR® gauge can be used as a simple and portable tool for very accurately measuring flow rate information on these wells. Quite often this information will be used as an input into our overall SPIDR® Well Testing System to allow the most accurate conversion of flowing surface wellhead pressures to bottomhole conditions.

The SPIDR® gauge can simultaneously record up to 3 data streams, via two external transducers and our high resolution/high frequency internal pressure transducer. One of the two external sources can be a differential pressure cell (d/p cell). Installing a d/p cell across an orifice plate, allows gas flow rate to be calculated using the following formula.

\[
\text{FLOW} = K \sqrt{\frac{d}{p} \times P}
\]

In the above formula K is a coefficient which considers ten different correction factors including gas composition, gas density and temperature, line I.D., orifice I.D. and non-ideal gas behavior. The term d/p is the pressure drop across the orifice plate and P is the line pressure. For many applications, assumptions can be made about some of the correction factors without sacrificing the accuracy required for that application. The SPIDR® surface pressure gauge system may be used in three different modes for flow measurements across an orifice plate. Each of these three modes is described below from least accurate to most accurate.

1. **Gas Flow Approximation:**
   This method assumes that the line pressure and flowing gas temperature are fairly constant. A SPIDR® gauge is installed at the well-head and a d/p cell is installed across the orifice plate taps. The formula for flow now includes constant line pressure and temperature values in the coefficient as follows:
   \[
   K' = K \times \sqrt{P} \quad \text{FLOW} = K \sqrt{\frac{d}{p} \times P}
   \]

2. **SPIDR® gauge OR External Transducer used to monitor line pressure:**
   This method uses the SPIDR® gauge’s internal transducer or an external pressure transducer to measure the line pressure on the high-pressure side of the orifice plate and a d/p cell connected across the orifice plate taps. Here line temperature is still assumed to be constant. By measuring changes in the line pressure, a more accurate value can be obtained for the flow rate.

3. **High Precision Method:**
   This method utilizes a d/p cell connected across the orifice plate, the SPIDR® gauge’s internal transducer to monitor the line pressure and a temperature probe to monitor the flowing gas temperature. This is the most accurate method to monitor flow rates.
Our free Flowcom software that is used to interface with the SPIDR® gauge and download data from the SPIDR® gauge, can also be used to calculate not only instantaneous rates but also cumulative production. An example plot of pressure and flow data gathered by the SPIDR® gauge during the first 27 days of a well’s production is shown below. Here the blue line represents wellhead pressure the green line is instantaneous gas flow rate and the red line is cumulative production.

The SPIDR® gauge’s ability to record multiple data streams and at once and incorporate all the data in an easy to use format makes it an excellent tool for measuring flow rates. The SPIDR® gauge can record up to 10 million samples in the standard mode (option 1) and up to 5 million samples in high precision mode (options 2 and 3). The portable nature and large memory capacity of the SPIDR® gauge makes it especially useful for gathering flow rate information at remote locations where it can be difficult to obtain more conventional flow monitoring equipment.

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