Title: Interpreting Length of Stain Tubes by Ron Roberson

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Topic "Interpreting Length of Stain Tubes"
" 6LLP Texas Field Testing Results"
"6LLP Louisiana field Testing"

New Low Range Pipeline Dew Point
Detector Tube
By Ron Roberson, Sensidyne, Inc.

Background

For years detector tubes have been used to monitor for low level contaminants and odorizing additives in natural gas pipelines. The most difficult pipeline application for the detector tube development engineers has been the seemingly simple measurement of water vapor levels.

Water vapor levels in natural gas pipelines must be minimized in order to Prevent corrosion in the gas transport and utilization equipment and to maintain the gas quality specifications. Gas is typically wet when extracted from the wells and must go through a drying process. A typical dehydrator consists of a contact tower that removes the water by direct contact with triethylene glycol (TEG).

It is the glycol that causes problems with water vapor detector tubes. Glycols and alcohols are similar to water chemically, because they all contain an –OH group (glycols have two). It is this common feature that makes glycols and alcohols soluble in water and makes TEG a good media to remove water. It is also this feature that makes glycols and alcohols interfere with the detector tube. The TEG becomes entrained in the gas stream and is carried into the pipeline. The entrained TEG will cause water vapor detector tube and most instruments with electrochemical cells to read high if not filtered out or otherwise controlled.

In the early 1980's several gas transport companies began using water vapor detector tubes to monitor levels of water in gas pipelines. The tubes were generally use in conjunction with electrochemical analyzers as a screening tool to prevent sensor damage from high water levels or to serve as a second opinion. The tubes were also used in remote locations to save time over portable analyzers that have a long stabilization period.

At first a standard water vapor tube that had been designed for air monitoring was used along with a conversion chart to convert units from milligrams of water per liter of air (mg/L) to pounds of water per million cubic feet of gas (Lb/MMCF). Then in 1896, we produced tube NO. 6LP, which was calibrated directly in those units.

We began to get feedback from the field regarding two color stains. The correct end color was purple, but many users would see a green band beyond the purple. Gastec indicated that the green was caused by an incomplete reaction, and

sometimes a small green band would appear at the maximum tip of the stain. We assumed this to be the cause in the gas also, and instructed users to include the green band in the reading. This assumption was incorrect.

The problem was two-fold. First Gastec is located in Japan, and Japan imports liquefied natural gas that has already been dried. They don't make the water vapor field measurement in Japan at all, and Gastec had no first hand experience using the tubes in natural gas. Second, with our limited experience in the industry we didn't know that glycol could produce a color other than purple. Some customers disagreed with the cause of the green stain, reporting long green stains (not just short green bands) and claiming that the TEG appeared to be the cause.

We asked Gastec to test the tubes in the presence of glycol to qualify the two-color stain. They reported a two color stain in the presence of glycol (they tested with ethylene glycol which was available in their lab. The detection principle of tube 6LP involves the -OH side of the molecule so theoretically the testing with EG or TEG should make little difference other than the length of the stain). The tube produced a purple stain that corresponded to the water vapor level and a green stain beyond it. Identical purple stains were produced without the green when the glycol was removed from the test stream. But to further confuse things, the tube produced only green with or without glycol when the water level was at or below Lb/MMCF. This information was relayed to the field by letter, and we began to work on an improved tube.

Tube No. 6LLP was the result of the efforts to improve tube 6LP. The goal was to produce a tube with a lower measuring range without the glycol interference. Tube 6LLP has a range of 2 to 10 Lb/MMCF, and it will normally produce a green stain as a response to water. If the tube is exposed to higher levels like 20 Lb/MMCF, it will go off scale and produce a purple stain, but within the tube's normal range it produces only green. Tube No. 6LLP has no interference from TEG, which solves the major problem in interpreting tube 6LP.

Field Testing Results

The tube was tested in the field with some very promising results. The first set of data was collected at five sites in Texas. Tubes 6LP and 6LLP were compared to each other, and glycol entertainment was monitored using ethylene glycol tube No. 165L. Tube No. 165L is calibrated for ethylene glycol, but also responds to TEG. Gastec could not supply a correction factor because of TEG's high boiling point. The range of tube 165L was too low to properly quantify the TEG levels, but served as a semi quantitative indicator of TEG. All pipelines tested used TEG in their dehydrators. The results are below.

6LLP Texas Field Testing

| Location | 165L | 6LP | 6LLP |
|---|---|---|---|
| 1 | Maxed | 6-76-7 | |
| 2 | Maxed | 2016 | |
| 3 | N/D | 54 | |
| 4 | Maxed | 6-76-7 | |
| 5 | Maxed | 2016 | |

N/D = None Detected

The results were encouraging, but we never really saw high enough glycol levels to document the advantage of tube 6LLP. Sites 2 and 5 produced higher readings on tube 6LP than on 6LLP, which suggested that the glycol interference was being controlled in tube 6LLP. But the difference between the tow tubes was small. It

was the second round of field testing, conducted in Louisiana that illustrates the tube's advantage. Those results are below.

6LLP Louisiana Field Testing
Loc.165L6LLP6LPBOMELEC
1Maxed4.5-55-5.5-5
2Maxed 3 sec4.45103.83.9-4

At Site 2, the glycol intrusion was very high, maxing out the 165L ethylene glycol tube in about three seconds. Other samples took 10 to 15 seconds to over range the tube, indicating that the TEG level was much higher in this line. Tube 6LLP agreed with the electrochemical unit (which incorporated a glycol removal filter) and with the Bureau of Mines (BOM) chilled mirror test, but the 6LLP tube is not influenced by the high level of TEG.

## Conclusion

In conclusion, the new water vapor detector tube No. 6LLP for natural gas pipeline monitoring is much improved over our previous tube No. 6LP in that it provides a lower measuring range and sensitivity, and it eliminates the glycol interference and two color stain. It is recommended that tubes 6LLP and 6LP be used together as follows. Use tube 6LLP first. If the reading is within the tube's range, record it as the water level. If tube 6LLP over ranges (i.e., goes full scale) then repeat the reading using tube 6LP. In readings below 10 lb./MMCF, use tube 6LLP over 6LP. Always use a flow through sampler in accordance with ASTM d-4888 taking care to ensure that ambient air does not intrude. For further information, contact Sensidyne at 1-800-451-9444.

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