GPA IN BRIEF

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A BETTER VIEW

Paul Stockwell, managing director, IMA, together with co-authors Diane Broomhall and Brian Strugnell of GL Noble Denton, described the testing of a prototype liquid detection system in a paper presented last year in Edinburgh. In his article below, Paul provides the latest update on the project.

Last September, I gave a presentation to the 30th GPA Conference about a project commissioned by National Grid (NG) and DNV GL for IMA to develop a system to provide an alarm when contamination events occur at gas entry points to the National Transmission System (NTS). Since then, testing has continued and we have made considerable progress with a number of developments evolving both inside and outside the scope of the original NG project.

Early in the project DNV GL modelled vapour pressures which indicated that some of the potential contaminants have a low vapour phase, and would be difficult to detect with gas phase analysers. Also, take-off points for gas phase analysers are specifically designed to avoid liquids that may be on the pipe wall, and measurement of gases that are already at saturation with respect to water vapour or hydrocarbon would be unable to quantify the amount of condensate in the pipeline.

The "**LineGate**" system will provide alarms and information on the detection, severity and identity of the liquid contamination event. This will help operators to have a better understanding of their process conditions. The system is designed for installation on export lines and custody transfer points, and will alarm on the detection of liquid or aerosols in the pipeline. It determines the severity of the event and uses a spectroscopy system to identify the liquid present.

Figure 1. Prototype LineGate on test at DNV GL facility at Spadeadam. Note: The long vertical section simulates the distance to a buried pipeline

The device has been designed to integrate into existing infrastructure as easily as possible, both in terms of mechanical hook-up and the ease with which the data can be transmitted and used. The system consists of a sight glass mounted behind a double block and bleed (DBB) valve that allows optical systems, including a spectrometer, to view the floor of the main pipeline. It is important that any window is out of the main flow so as not to be contaminated by liquids in the gas stream, therefore the measurement system does not protrude into the pipeline. This also enables pigging to take place. A prototype under test at DNV GL facilities is shown in Figure 1.

The intention is to provide Modbus alarms for liquid onset, severity and identity.

Discussions with various parties in the oil & gas industry have led to the development of a second product. The "**LineVu**" system will provide a live video stream of activity within the pipeline to provide vital information to enable improvements in operating efficiency and process safety. (A design prototype is shown in Figure 2 overleaf.) Being able to see

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the product will help engineers diagnose process problems, and give a better understanding of process conditions. It is intended to stream the information securely over the clients' network and provide viewing access via a desktop browser, tablet or smartphone, either locally or at remote locations. Overlaying the video with relevant process data e.g. flow rate, pressure, temperature etc. will give a fuller picture of process conditions, and will be beneficial for process engineers in both upstream and downstream applications. With the safety measures we are building into the system (patent applied), we are able to achieve a high functional safety level.

Flow Tests

Flow tests at atmospheric pressure have shown that when low level liquids are introduced into a fast gas flow, the flow regime is very different from a liquid flow caused by gravity. A large majority of liquid hits the pipe wall as soon as it is introduced, and then slowly moves down the pipe, due to a combination of friction with gas flow and gravity.

In a 3" diameter pipe, low liquid flows tend to form a full annular flow: a liquid film is formed around the inner circumference of the pipe wall. With most liquids in full annular flow, the depth of film is still deeper at the pipe floor.

Repeating the tests in an 8" diameter pipe, and using the same velocity of gas and liquid flow, the liquid flows to the pipe floor and a stable state occurs at the bottom of the pipe, with a liquid stream slowly moving through the pipe. Figure 3 shows still shots from a LineVu test video looking vertically down into an 8" horizontal pipe.

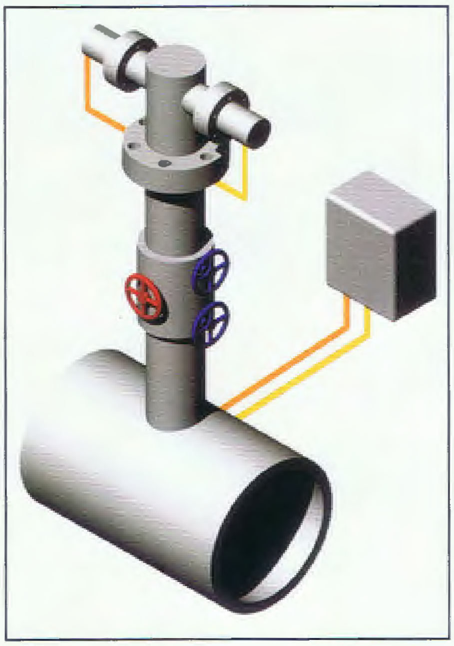

Figure 2. LineVu system installed on top of a pipeline

The stages of the liquid flow are: a) prior to a flow being established at the point of measurement, droplets of liquid are picked up from the main flow and thrown forward. These droplets accumulate and merge until the main flow arrives (b). At (c) a steady state flow regime exists that moves relatively slowly. It increases in width as the liquid flow rate increases up to around 70 ml/min (depending on density and viscosity of the liquid) when "slugged" flow starts (d). With slugged flow, waves of liquid move along the pipe. When the introduction of liquid stops, the width of the liquid stream gradually decreases (e) over a period of several hours, until the stream becomes discontinuous and small drops of liquid move slowly along the pipe floor (f). The nature of the flows lends them to be illustrated more easily on video, and videos of tests can be found on our website at www.ima.co.uk

Testing is continuing to make sure that the liquid quantity and identity can be determined accurately. If you would like to be kept informed of progress or for more information please email info@ima.co.uk or contact us on +44 (0)1943 878877.

Figure 3 (below).
Views down the vertical section to the 8" diameter pipeline below. Gas flow rate 11.5 m/sec.

a) Liquid drops are thrown forward ahead of main liquid flow.
b) Start of main liquid flow.
c) Stable liquid flow at 60 ml/min.
d) Slugged flow starts at around 80 ml/min.
e) Oil injection stops and liquid level drops slowly.
f) After several hours liquid level drops further to form slow moving drops