PipePatrol – Leakage Detection and Localisation System

Introduction

E-RTTM is a technique that KROHNE uses for PipePatrol, their Leak Detection and Localisation System. Without going into mathematical details, we explain how the model works and why this modern leak detection system is more than a theoretical exercise; it does work and does this without false alarms.

PipePatrol, KROHNE’s Leak Detection and Localisation System

During the development of PipePatrol, reliability was one of the key design elements. To overcome the limited performance of traditional systems in transient conditions, KROHNE decided to base PipePatrol on RTTM technology (Real Time Transient Model). To guarantee the absence of false leak alarms a leak recognition algorithm was incorporated and as a result the model behind PipePatrol is called an E-RTTM (Extended Real Time Transient Model).

RTTM, the Real Time Transient Model

RTTM uses measurements of flow, temperature, and pressure at the inlet and outlet of a pipeline. The flow is measured by flowmeters and simultaneously calculated from the pressure and temperature readings. The RTTM algorithms that are used to calculate flow from pressure and temperature readings are not further described in this article but a simple (and limited) analogy can be made to a differential pressure or orifice flowmeter, where the flow is calculated from two pressures.

Comparing the calculated flow (from P and T readings) with the measured flow (from the flowmeters) results in the flow residuals at inlet and outlet. This is best explained with the graphs below. Figure 1 shows what happens with the RTTM approach. The left-hand graph shows 4 lines, the blue line shows the measured (also called estimated) flow at the inlet, the green line shows the corresponding calculated flow at inlet. On the outlet side the measured outlet flow is given by the red line, the calculated flow by the brown line. When the measured flow at the inlet is subtracted from the calculated flow at the inlet the result is the blue line in the top graph on the right. Similarly the result for the outlet side is the red line in the graph below.

![Graphs showing RTTM approach](image)

Figure 1: The RTTM approach: The graph on the left shows measured and calculated flow at the inlet (ingress) and outlet (egress). The graphs on the right show the difference between measured and calculated flow at the inlet (blue line) and outlet (red line).

The two graphs on the right show the ‘true’ leak flow at the inlet and outlet. Both lines are around zero since there is no leak in this line. A leak near the inlet will create a significant shift from zero in the blue line. A leak near the outlet will have a similar effect on the red line; leaks in between will show in both graphs. For example, if the pipeline is 10 km long and there is a leak at 8 km, the leak effect will show for 80% in the outlet graph and 20% at the inlet graph. Using RTTM therefore not only allows leak detection, but also leak localization.
Introducing a leak recognition algorithm – differentiating between a sensor failure warning, and a true leak alarm

KROHNE decided to extend the RTTM model with a leak recognition algorithm. If a predefined threshold is exceeded, PipePatrol first analyzes the leak pattern. A spontaneous leak will show a specific leak pattern (see figure 2). A sensor drift will not show this specific pattern and will manifest with a slowly increasing leak rate. After the leak pattern has been analyzed, the E-RTTM model will either set off a leak alarm or a sensor warning. The system makes a clear and unmistakable difference between a warning that a sensor needs attention and an alarm for a true leak.

Figure 2: The red line indicates a predefined threshold. Both the magenta and the blue flow imbalance lines exceed this threshold; however, only the blue line shows a typical leak pattern and will set off a leak alarm. The magenta line is typical for a sensor drift and will raise a sensor failure warning – not a leak alarm.

Conclusion

PipePatrol leak detection system works and does this without false alarms. Through state-of-the-art E-RTTM, KROHNE have overcome the limitations that more traditional systems have under transient pipeline conditions. Today KROHNE can boast many proven leak detection applications, varying from multi-product liquid pipelines to sub-critical ethylene (a non-ideal gas!) pipelines.

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