Kuwait 4th Flow Measurement Technology Conference

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Measurements in Leak Detection system

KOC Consumer Fuel Pipelines-Challenges
LDS monitored KOC Consumer Fuel Pipelines - Services

- **Fuel Gas** - Subiya PS, Doha PS, Al-Zour PS, Shuaiba PS, Shuwaikh PS, Shuaiba Industrial Area
- **Gas Oil** - Subiya PS, Doha PS, Al-Zour PS
- **LSFO** - Subiya PS, Doha PS, Al-Zour PS
- **Crude Oil** - Subiya PS
LDS in KOC Consumer Fuel Lines Covers:

- Pipelines of Size 4” Up to 52”
- Pipeline sections of Length 6 KM Up to 120 KM
- Combined pipeline sections of 177 KM
Leak Detection system: Methods

- Non Continuous:
  - Routine Inspections
  - Intelligent Pigging

- Continuous:
  - External type: Acoustic Systems, Fiber Optic Cables, Video Monitoring...
  - Internal type: Mass Balance, Pressure Point Analysis, Statistical Systems, Real Time Transient Model...
Measurements in Leak Detection system - RTTM Typical Block Diagram

- Flow (F)
- Pressure (P)
- Temperature (T) of Fluid
- Temperature (T) of Ground

**Inlet**

**Outlet**

**Instrument Error Analysis**

**Pipeline Observer**

**Leak Signature Analysis**

- **Leak-Test:**
  - Leak-Alarm yes/no
  - if yes: leak flow, location
- **Sensor-Test:**
  - Sensor-Alarm yes/no
  - if yes: leak flow, location
Measurements in Leak Detection system - Software Modules

**Head Station Monitoring**
- **Pumping/Shut in Conditions**
- Compares Measured flow at Inlet & Outlet Vs Calculated Flow based on RTTM and Performs Leak Pattern Analysis
- Leak Alarm

**Intermediate Station Monitoring**
- **Pumping/Shut in Conditions**
- Similar to above. Additionally for longer pipelines with sectionalizing valves and pressure sensors
- Leak Alarm

**Statistical Line Balance**
- **Pumping Conditions**
- Combines Mass Balance, RTTM and Statistical Methods
- Leak Alarm
Measurements in Leak Detection system - Software Modules…

Leak Location

Gradient Intersection Method

Wave Propagation Method

\[ \hat{s}_{\text{Leak}} = \frac{1}{2} \cdot (L - c \cdot \Delta t) \]
Measurements in Leak Detection system - Typical Dashboard
# Measurements in Leak Detection system - Performance Criteria as per API 1155 for 40” Fuel Gas Line

<table>
<thead>
<tr>
<th>Metric</th>
<th>Steady state</th>
<th>Transient state</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensitivity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum detectable leak rate</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Response time for 100% leak rate</td>
<td>≤ 1 min</td>
<td>≤ 1 min</td>
</tr>
<tr>
<td>Response time for 10% leak rate</td>
<td>≤ 4 min</td>
<td>≤ 5 min</td>
</tr>
<tr>
<td>Response time for 5% leak rate</td>
<td>≤ 8 min</td>
<td>≤ 11 min</td>
</tr>
<tr>
<td>Response time for 1% leak rate</td>
<td>≤ 12 min</td>
<td>N.A.</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorrect leak alarm declaration rate (overall)</td>
<td>≤ 1 / year</td>
<td>≤ 2 / year</td>
</tr>
<tr>
<td><strong>Robustness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of functionality due to instrument outages</td>
<td>see below*</td>
<td></td>
</tr>
<tr>
<td>Loss of function due to pump state changes</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Loss of function due to valve state changes</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Loss of sensitivity due to pump state changes</td>
<td>none**</td>
<td></td>
</tr>
<tr>
<td>Loss of sensitivity due to valve state changes</td>
<td>none**</td>
<td></td>
</tr>
<tr>
<td>Start-up stabilization period</td>
<td>none**</td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leak localisation for 100% leak</td>
<td>≤ 1%</td>
<td></td>
</tr>
<tr>
<td>Leak localisation for 10% leak</td>
<td>≤ 2%</td>
<td></td>
</tr>
<tr>
<td>Leak localisation for 5% leak</td>
<td>≤ 3%</td>
<td>≤ 5%</td>
</tr>
<tr>
<td>Leak localisation for 1% leak</td>
<td>≤ 5%</td>
<td>N.A.</td>
</tr>
<tr>
<td>Leak Rate error</td>
<td>≤ 1%</td>
<td>≤ 1%</td>
</tr>
</tbody>
</table>
Measurements in Leak Detection system - Data Transfer Issues
Measurements in Leak Detection system
Modified RTU Communication
Measurements in Leak Detection system - Modified Metering Skid Communication
Measurements in Leak Detection system - Tuning Phase Issues

- Mandatory Tuning while pipeline is in operation
- Require to be Tuned for all Flow profiles
- Involves Multiple stake holders and their requirements
- Practically difficult to achieve
Measurements in Leak Detection system - Operational Issues

- Generate false alarms if operating in a flow region which has not been tuned
- Operating in lower flow rates may generate false alarms
- Process upsets and subsequent transients in upstream/downstream facilities
- Well trained operator is required to identify false alarms
THANK YOU