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An Orifice Meter Verification System

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DP Diagnostics

Monitor, Verify, and Trust your DP meter
Introduction

Orifice meters are simple, relatively inexpensive, reliable and don’t require calibration.

One orifice meter development is an automated validation tool (powered by a diagnostic suite).

A validation system is desirable for several reasons:

- verifies performance reducing exposure to error
- allows CBM instead of RSM
- avoids unnecessary exposure to danger
- makes technicians far more efficient
A verification system checks performance so as the meter’s uncertainty statement is known to be true.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Uncert %</th>
<th>S</th>
<th>(U95*S)^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge Coefficient</td>
<td>Cd</td>
<td>0.44</td>
<td>1</td>
</tr>
<tr>
<td>Expansibility</td>
<td>Y</td>
<td>0.03</td>
<td>1</td>
</tr>
<tr>
<td>Orifice Diameter</td>
<td>d</td>
<td>0.05</td>
<td>2.13</td>
</tr>
<tr>
<td>Inlet Diameter</td>
<td>D</td>
<td>0.25</td>
<td>-0.13</td>
</tr>
<tr>
<td>Differential Pressure</td>
<td>DP</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Inlet Pressure</td>
<td>P</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Compressibility</td>
<td>Z</td>
<td>0.1</td>
<td>-0.5</td>
</tr>
<tr>
<td>Temperature</td>
<td>T</td>
<td>0.25</td>
<td>-0.5</td>
</tr>
<tr>
<td>Relative Density</td>
<td>RD</td>
<td>0.6</td>
<td>0.5</td>
</tr>
</tbody>
</table>

sum of squares: 0.4401

% orifice meter uncertainty: 0.663
The Orifice Meter ‘Prognosis’ Methodology

Extra Pressure Tap Downstream
The Orifice Meter ‘Prognosis’ Methodology

- 1 DP Integrity Check
- 3 Flow Rate Comparisons
- 3 Read vs. Baseline DP Ratios
- Turbulence Diagnostics

\[ \Delta P_t = \Delta P_r + \Delta P_{PPL} \]
Pattern Recognition

backwards plate

geometry? blockage? disturbed flow?

wet gas

D_P_t & D_P_ppl  \(\triangle\) D_P_r & D_P_ppl

D_P_t & D_P_r  \(\square\) D_P_t & D_P_t,inf

WWW.KUWAIT-MEASUREMENT.COM
4”, 0.5β Paddle Plate Orifice Meter Test
4", 0.5 β Meter with Orifice Bore Keypad Entry Error

-2.6% bias > -$28.5K / quarter
4", 0.5 β Orifice Meter Buckled Plate

-7% bias > -$57K / quarter
Disturbed Flow: 4”, 0.5β Meter (HMOP at 2D upstream)

-5.8% > -$47K / quarter
4", 0.4 β Orifice Meter with Trapped Debris

+118% > +$1e6 / quarter

WWW.KUWAIT-MEASUREMENT.COM
Central Area Transmission System, UK

Pipe ID 13.738”, 0.596 β
201.5 MMSCFD ≈ $518K/day
CATS Reversed Orifice Plate Test

-15% > -$77K/day
or > -$6.9 million / quarter
Plate deliberately worn, -2% error induced

-2% > -$910K / quarter
CATS - Saturated DP Transmitter Test

Tradition DP transmitter Spanned 15.0 kPa

$\Delta P_t = 17.5 \text{ kPa}, \quad \Delta P_r = 6.2 \text{ kPa}, \quad \Delta P_{ppl} = 11.3 \text{ kPa}$

-8% flowrate bias, > $3.5$ million
Field Ex 1: 12” Sales Orifice Meter to Power Station

Problem found by diagnostics during commissioning.

DP transmitter wiring problem:
+1.6% DP bias
+0.8% flow bias.
Field Example 2: Meter with Contamination
Field Example 3: Meter with Wrong $\Phi$ & Contamination
Field Ex 4: 12” Orifice Meter North Sea Platform

Wet gas flow identified and liquid loading monitored.
Do you want to be a Meter Mechanic or Operator?
Conclusions

1. Orifice meters have a comprehensive validation tool (Prognosis™).
   1. Prognosis assures: correct meter operation,
   2. reduces exposure to mismeasurement,
   3. facilitates CBM,
   4. increase technician productivity, and
   5. reduces needless technician exposure to danger

1. Latest developments:
   1. automated prediction of associated flow bias magnitude
   2. reduces correct operating meters uncertainty
THANK YOU