Kuwait 4th Flow Measurement Technology Conference
3-5 December 2019
Hilton Kuwait Resort
OFFICIAL SPONSOR
Clamp-on Mass Flow Measurement
FLEXIM

- FLEXIM: a specialist in Clamp-On Ultrasonic Flow Measurement
- Metering solutions for Liquids and Gases as well as Process Concentration Analytics
- Headquartered in Berlin, Germany, with more than 400 employees worldwide
- International presence with offices in Europe, United States, Middle East, and Asia, etc.
- Strong investment in R&D and in-house production facilities
- Huge installed instrumentation base (>100,000 units worldwide) + over 8,000 new meters per year
Clamp–on Transit Time Ultrasonic Flow Measurement

Calculation of Volume Flow \([Q]\)

\[
Q = K_{RE} \times A \times k_a \times \frac{\Delta t}{2 \times t_t}
\]

- \(Q\): Volume Flow
- \(K_{RE}\): Fluid Mechanical Correlation Factor
- \(A\): Cross-Sectional Area of Pipe
- \(k_a\): Transmitter-Constant
- \(\Delta t\): Transit Time Difference
- \(t_t\): Transit Time in Medium
Components of the mass flow measurement

- **FLEXIM FLOW METER**
  - Always Dual Beam (min)
    - Quad Beam Option
  - Always has a Temp input (min)
    - Could have Pressure as well
- **TRANSDUCERS**
  - Lamb Wave for some Multi-Products
  - Lamb Wave for most Crudes
  - Shear Wave for most Refined Products
How to get the mass flow

1. Measurement of Sonic Velocity
2. Measurement of Temperature
3. Measurement of transit time difference
4. Calculation of API grade and standard density
5. Calculation of actual density and actual viscosity
6. Calculation of Reynolds number
7. Actual volume flow
8. Mass flow
Multiple Product Standard Volume + Mass Compensation and Interface Detection Algorithm
– Providing Temperature Compensated Volume Algorithm as per ASTM 1250, TP25, D4311 standard volume correction different liquids

Multi Product HPI meters must apply correct liquid characteristics (Algorithm, Viscosity, & Density) to ensure an accurate flow measurement.

**Background**

![Image of a graph showing speed vs. temperature with different colored lines for various liquids.](image-url)
**Product Standard Volume Compensation** – Providing Temperature Compensated Volume Algorithm as per ASTM 1250, TP25, D4311 standard volume correction.

**Implemented Standards:**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Commodity</th>
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<tbody>
<tr>
<td>ASTM D1250</td>
<td>Crude oils, Gasolines and Naphthalenes,</td>
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<tr>
<td></td>
<td>Jet fuels and Kerosenes,</td>
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<td></td>
<td>Diesels, heating oils and fuel oils</td>
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<td></td>
<td>Lubricating oils</td>
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<tr>
<td>TP25</td>
<td>Light Hydrocarbons</td>
</tr>
<tr>
<td></td>
<td>(Ethen, Butane, Propane, etc.)</td>
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<tr>
<td>ASTM D4311-04</td>
<td>Asphalt</td>
</tr>
</tbody>
</table>
WHERE DO WE USE THESE METERS

**Refinery Applications:**

- Check Metering – Typically checking stability/accuracy of a different technology/CTM
- Leak Detection – Usually short segments with meter to meter balance
APPLICATIONS

**Check Metering Applications:**
FLEXIM HPI Meters can be used to verify other types of Custody Transfer Meters or vital metering locations.

Application – Third Party Verification for Ethylene; Pipeline Terminal near Orange, TX
Leak Detection Applications:
FLEXIM HPI Meters can be used as a stand-alone leak detection system or used in conjunction with a Leak Detection System.

Point to Point Stand Alone System:
- FLEXIM to FLEXIM
- FLEXIM to CTM

FLEXIM to FLEXIM Leak Detection
2.5 miles from Tank to Tank at a Refinery
APPLICATIONS

FLEXIM to Custody Transfer Leak Detection
0.5 miles from Tank Farm to Tank Farm
APPLICATIONS

Point to Point with Leak Detection System

FLEXIM to Custody Transfer Leak Detection
12.5 miles from Tank Farm to Tank Farm
used in conjunction with a proprietary LDS
that uses Flow, Pressure and Temperature inputs
INFLUENCE FACTORS

FACTORS FOR ACCURATE MEASUREMENT:

- Uncertainties – Pipe and liquid
  - Pipe Geometry
  - Accurate information for liquid
- Reynolds Correction for Viscosity
  - For Crude Oils, extremely important
- Correct Liquid Identification
  - Customer input necessary
  - Optimization of Meters

Heavy Crude

Light Crude

Gasoline
This mounting arrangement is ideal for large pipes / limited straight run installations. This metering solution not only mitigates the affect of poor upstream piping conditions and large pipe profile influences but also provides for built-in redundancy in case of a signal path interruption.
TEST AT CEESI 2016

4-Channel Results had average errors below +/- 0.125% and a maximum error of 0.192% on both test fluids. The FLEXIM Meters were compared to custody type flow meters that were proved.
2-Channel Results had average errors below +/- 0.30% and a maximum error of 0.4% on both test fluids. The FLEXIM Meters were compared to custody type flow meters that were proved.
Conclusion:

For added accuracy and repeatability, the 4 Channel, Quad Beam meter delivers an average error that is over 2 times better than a 2 Channel, Dual Beam meter. For accuracy, the Quad Beam FLEXIM HPI Meter can do the job (FROM OUTSIDE THE PIPE).
Conclusion

- Standard volume flow measurement is achievable, and field proven with clamp-on devices

- Possible additional calculated outputs from clamp-on Mass Flow meter:
  - Density
  - API Grade or density @ base conditions for the medium
  - Viscosity

- Main Component to total uncertainty is the volume flow measurement with the clamp-on device. 1% is typical achievable with multi channel installation and fully developed turbulent flow regime.

- Uncertainty from ASTM 1250, TP25 or D4311 calculation for density is significant lower.

- During the set up of the meter the density of the medium must be known for field adjustment of Sound Speed Measurement and for a reliable reference point for calculation. The accuracy of this information determines the accuracy of the calculation.
Questions?