APPLICATION IN LIQUID MEASUREMENT USING CLAMP-ON ULTRASONIC TECHNOLOGY

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INTRODUCTION

Clamp on ultrasonic flow meter technology (COUSMT) offers the advantage of providing a non-custody transfer, non-intrusive method to obtain the pipe flow rate. The distinct advantage of the technology is; there is no need to present access to the fluid flowing in the pipe. The method is quite robust and simple to implement. More and more measurement practitioners are looking to this technology to fulfill that aspect of the metering requirements in their company.

DISCUSSION

Clamp on Ultrasonic Flowmeters have been commercially available for more than 45 years and have become an accepted method of measuring flow. Over the past 15 to 20 years several improvements have moved the technology forward.

1. The first technological change was from analog transducers to Piezo ceramic (digital) transducers.
2. The second change to follow was the digital change in methodology from analog timing to digital timing.
3. The third change was made regarding the transit time to a differential transit time methodology.

All three of these improvements in methodology have greatly improved the meters ability to measure fluids more accurately. Typically one can now expect volumetric uncertainty values of xx.xx% tp xx.xx%.

Hardware and software improvements (signal processing) are continually be implemented.

There are two different types of ultrasonic flowmeters: Transit-Time and Doppler. Although there have recently been significant advances in Doppler technology, this paper will focus on Transit-Time flowmeters which are much more widely adopted for the Oil and Gas Industry, and is a de facto “industry standard”. **Figure 1 – COUSMT** basic principle, provides an indication of the typical installation on any giving fluid pipeline application.

As the industry wide acceptance and utilization of clamp-on meters have increased, so have the customers’ expectations of what the technology can do.

To overcome summer /winter temperature swings and the rapid diurnal temperature swings; the use of a temperature element (RTD) is used to compensate for these changes in measurement conditions that are compensating for transducer expansion / contraction due to ambient temperature conditions. This compensation ensures the meter is using the correct beam angle to compute the flow.

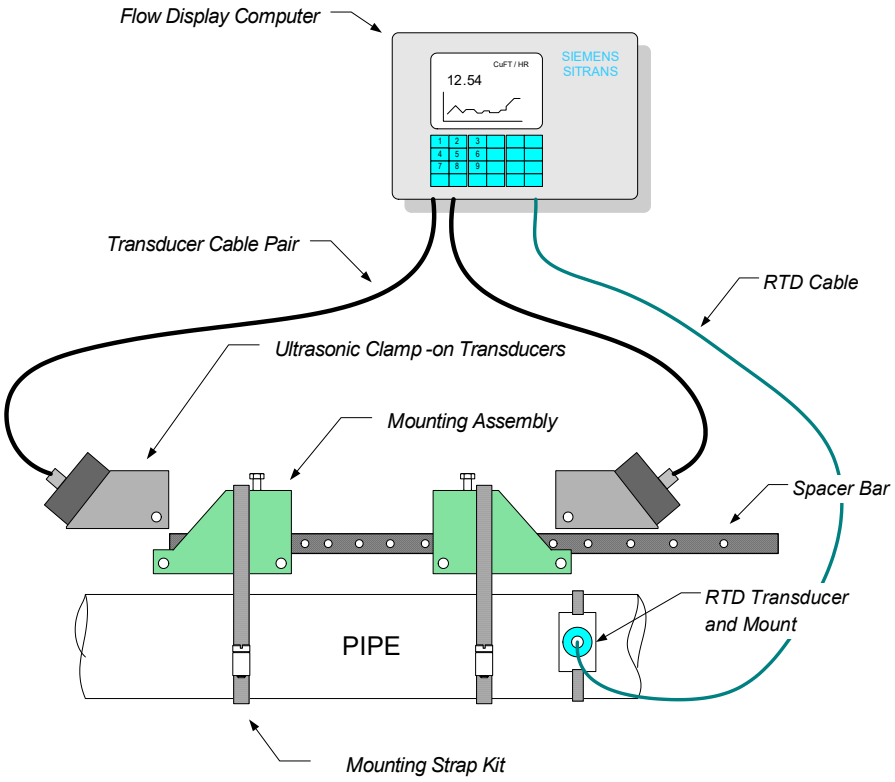


Figure 1 –Basic Meter

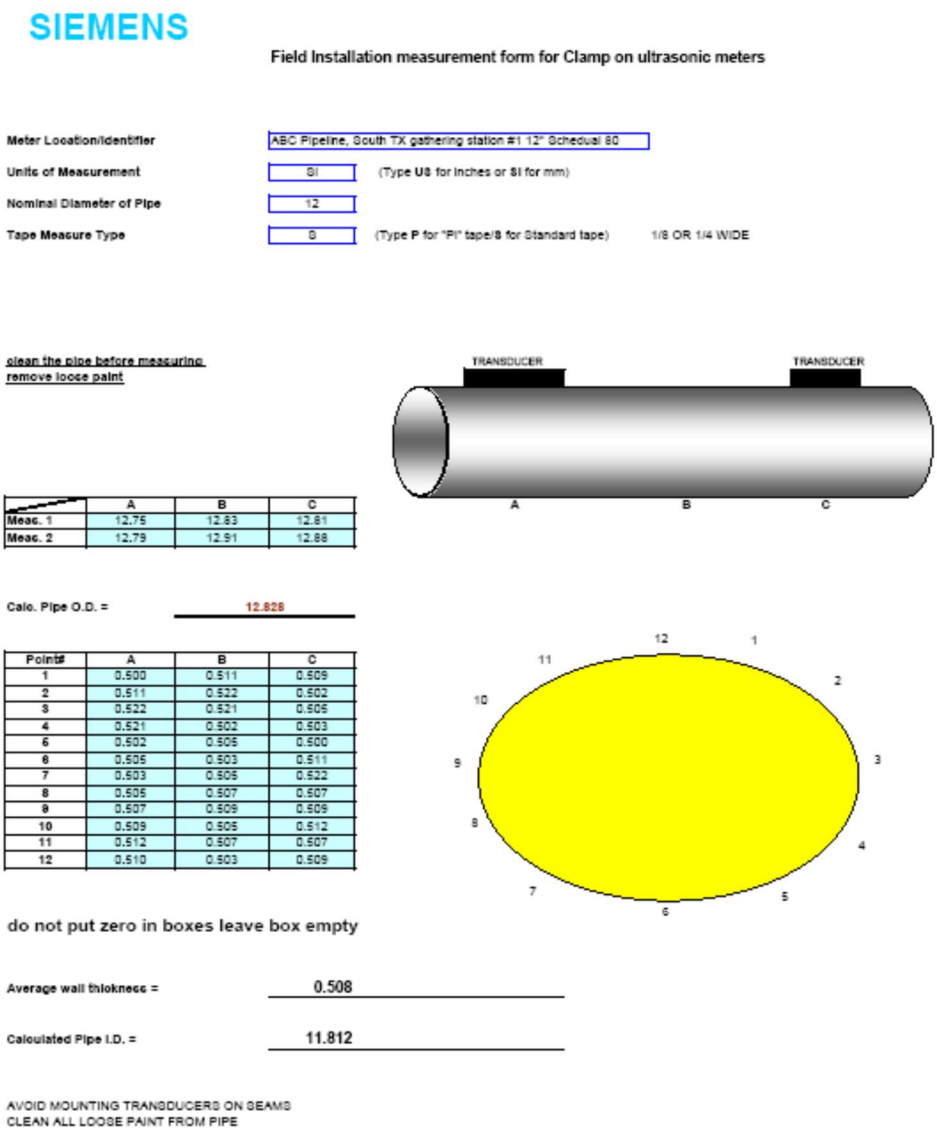
Important factors in a meter

- Internal diameter
- Transducer angle
- Path length
- Wall thickness

Working with many end users and standards organizations in the industry; we have carefully developed procedures to ensure uniformity in installation and error minimization in pipe errors.

From the first clampon meters being installed, little or no consideration was given the actual pipe geometry, and the resulting parameters were often taken from the Crane pipe book.

Installation Template



SIEMENS

Field Installation measurement form for Clamp on ultrasonic meters

Meter Location/Identifier	ABC Pipeline, South TX gathering station #1 12" Schedual 80	
Units of Measurement	SI	(Type US for Inches or SI for mm)
Nominal Diameter of Pipe	12	
Tape Measure Type	S	(Type P for "PI" tape/S for Standard tape) 1/8 OR 1/4 WIDE

clean the pipe before measuring
remove loose paint

TRANSDUCER TRANSDUCER

A B C

	A	B	C
Meas. 1	12.75	12.83	12.81
Meas. 2	12.79	12.91	12.88

Calc. Pipe O.D. = 12.828

Point#	A	B	C
1	0.500	0.511	0.509
2	0.511	0.522	0.502
3	0.522	0.521	0.505
4	0.521	0.502	0.503
5	0.502	0.505	0.500
6	0.505	0.503	0.511
7	0.503	0.505	0.522
8	0.505	0.507	0.507
9	0.507	0.509	0.509
10	0.509	0.505	0.512
11	0.512	0.507	0.507
12	0.510	0.503	0.509

12 1 2 3 4 5 6 7 8 9 10 11

do not put zero in boxes leave box empty

Average wall thickness = 0.508

Calculated Pipe I.D. = 11.812

AVOID MOUNTING TRANSDUCERS ON SEAMS
CLEAN ALL LOOSE PAINT FROM PIPE

Figure 2 – Installation Template

By using the above excel template, you can establish the actual OD and by first using a pi-tape and then using a thickness gauge to determine the actual and average pipe wall thickness. From that you can establish the exact I.D.
Example on a 12" pipe 0.1 "represents a 1.65% error in volume

Tools you will need to accomplish these measurements include:

Figure 3 – Level

A **Level** is required to ensure transducers are in line with the flow

Figure 4 – Thickness Gauge

A **Thickness Gauge** is required to establish pipe wall thickness.

Figure 5 – Pi Tape

A **Pi Tape** measure is required to establish pipe wall thickness. Using this procedure for the installation has greatly reduced the errors in the reported flow measurement. When you install a clampon meter on existing pipe this procedure must be followed to insure correct and accurate measurement.

APPLICATIONS

Applications for clamp on meters can include:

- Leak detection
- Meter verification
- Liquid identification
- Pacing samplers
- Water measurement
- Aviation hydraulic testing

Figure 6 – Clamp On Meter Used to verify Existing Multi Path Ultrasonic

Figure 7 – Clamp On Meter Used at New interconnects for Pipeline Balance

IMPROVED METHOD OF INSTALLATION

Having had good success in installing on existing pipe it was decided to fabricate spools for new installation to even further improve the results.

Figure 8 – Clamp On Meter Used with Meter Spool

Several customers are using fabricated spools with clampon meters on new installations to minimize the errors associated with pipe irregularities.

Custom spool based meters are also available.

These meters can be flow calibrated as shown below:

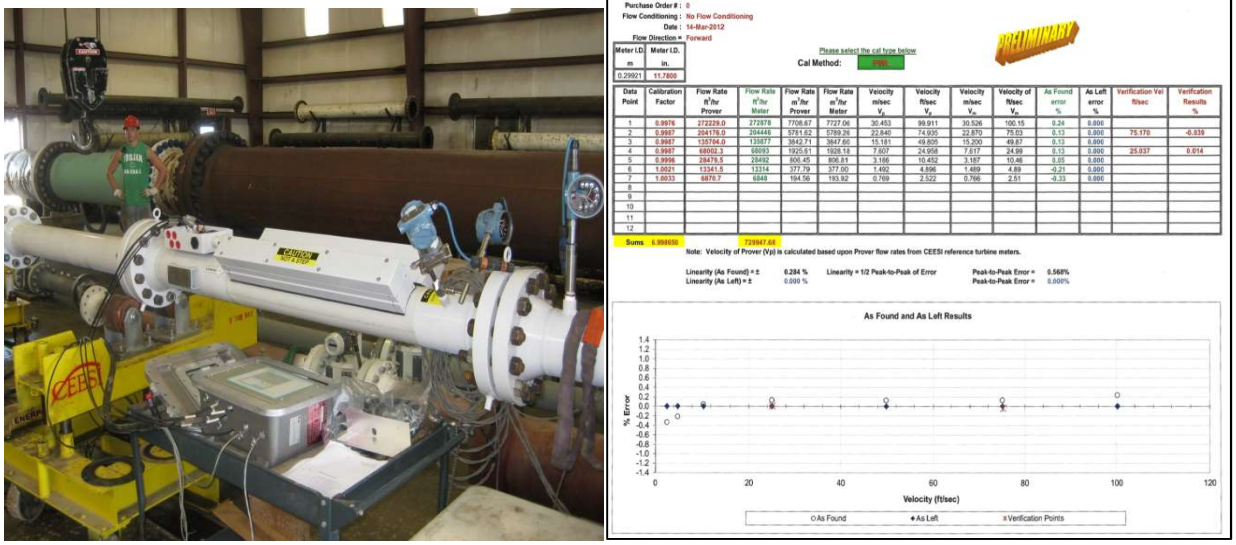


Figure 9 – Spool clamp-on/nonintrusive meter at CEESI

Examples of various field implementations.

Figure 10 – Permanent Field Installation for Balance – Example 1

Figure 11 – Permanent Field Installation for Balance – Example 2

Figure 12 – Permanent Field Installation for Balance – Example 3

BAD INSTALLATIONS

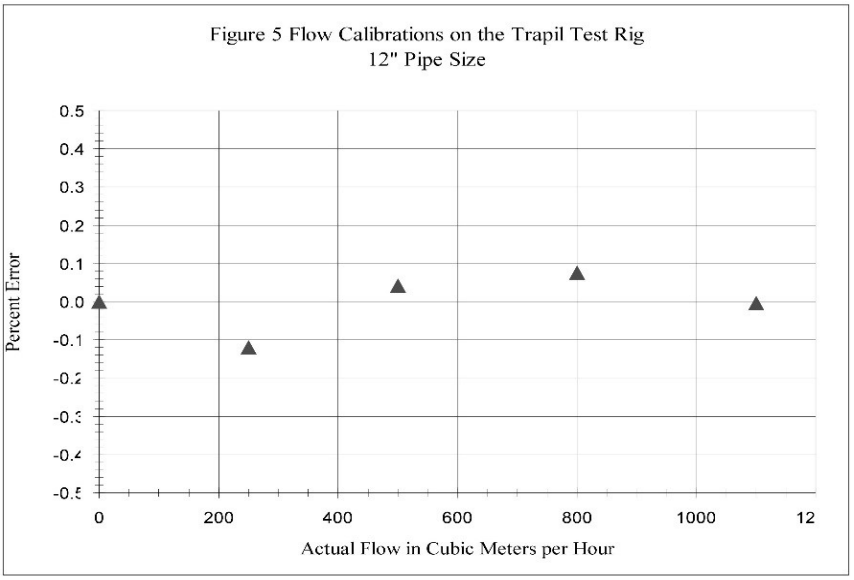
This installation had about 1-D Up & 1-D down, from the meter . After four months of running a wide veriaty of flow rates it was deturmined the meter had a constant +2.5% bias from the system balance . The meter was using the pipe anomily table but we still needed to do an adjustment.

Resultant; the user is very happy with the measurement.

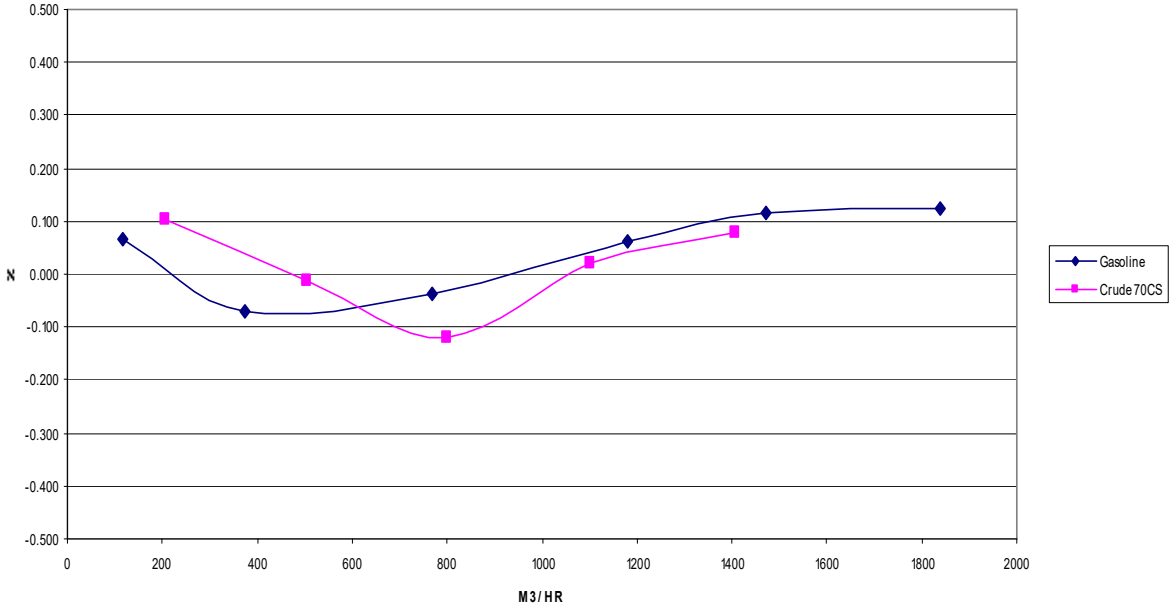
Figure 12 – Water Measurement

Figure 13 – Aviation Hydraulic Measurement

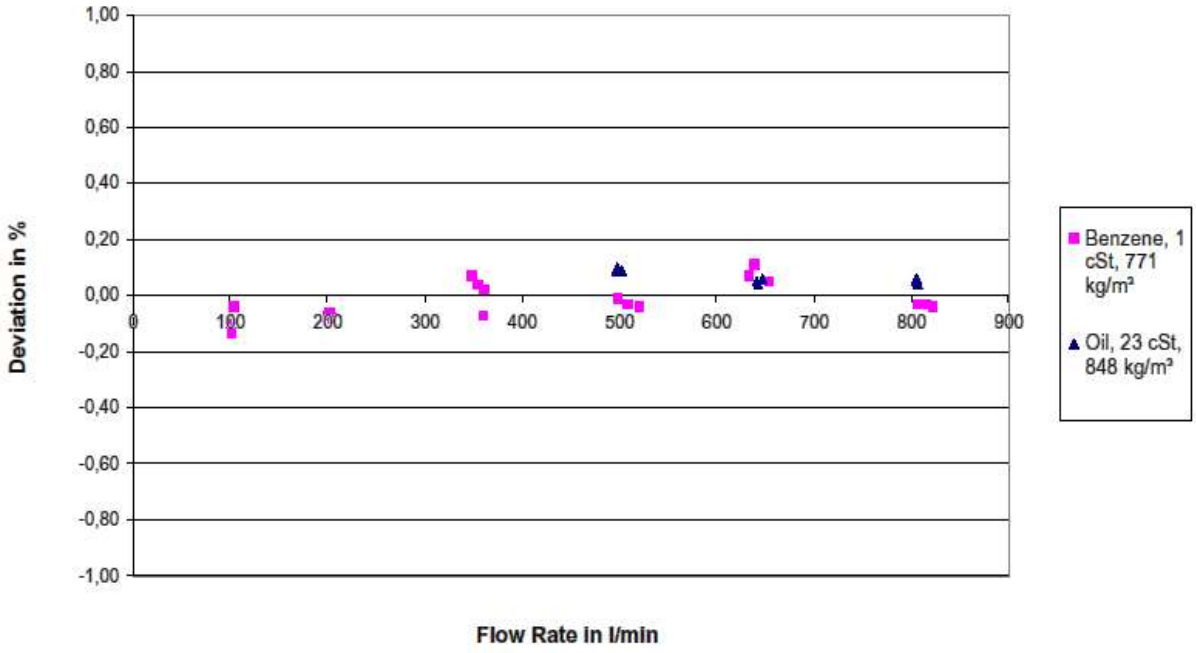
TESTING



10" Spool Reference To Ball Prover

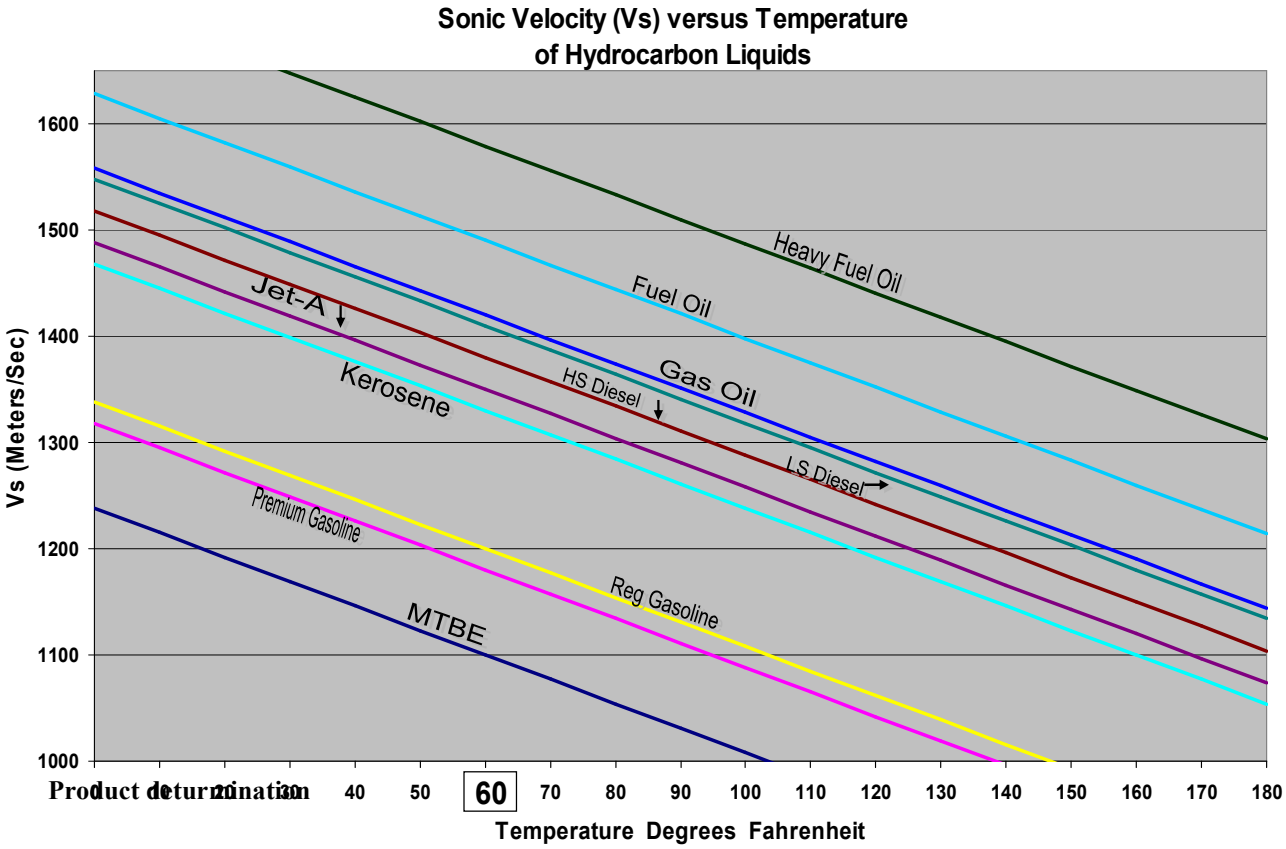


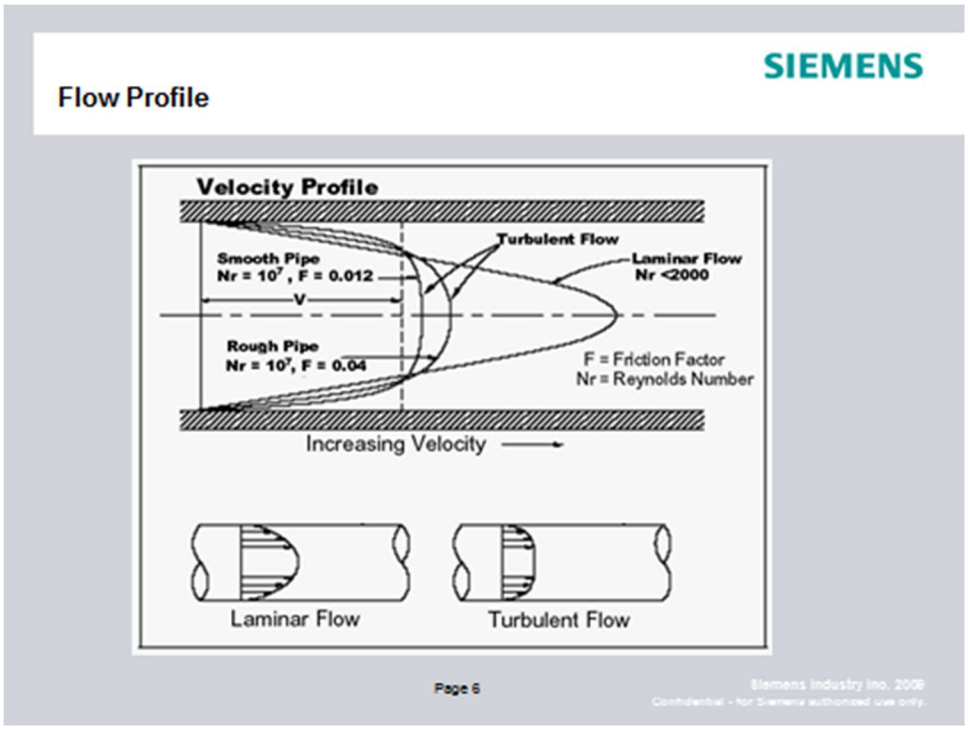
Deviations Controlotron 990DVN versus PTB Reference
Test Liquids : Benzene (1cSt) and Oil (23 cSt) / 3" Pipe with UltraHighPrecision Xdcrs



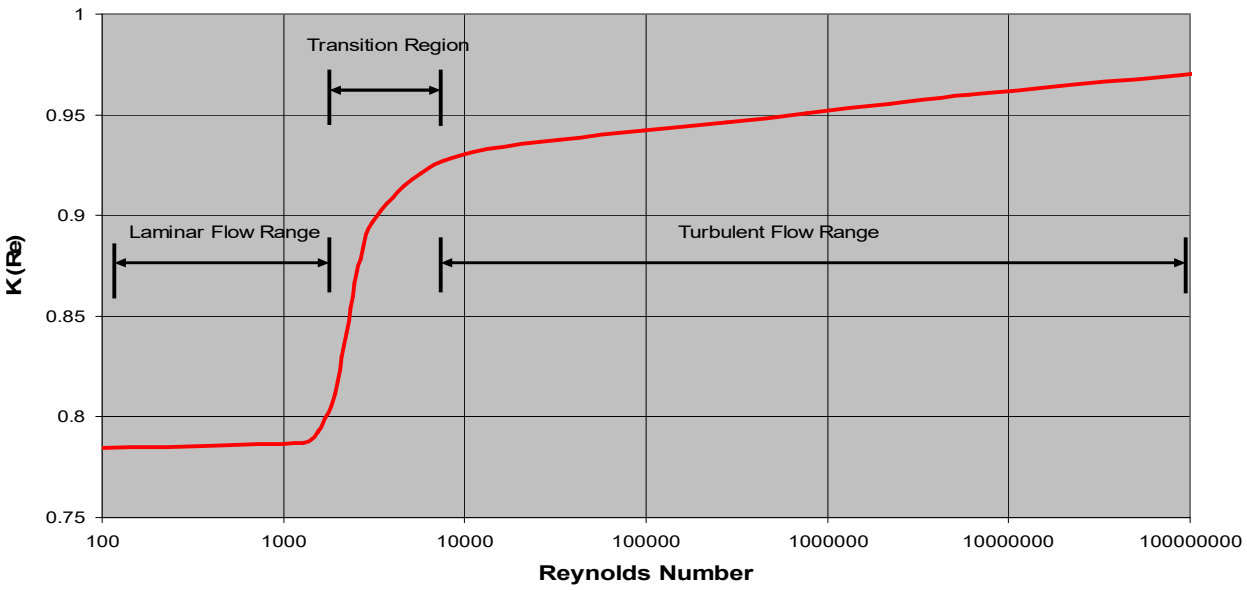
Offshore installations

Using SoS (Velocity of Sound) to determine product.





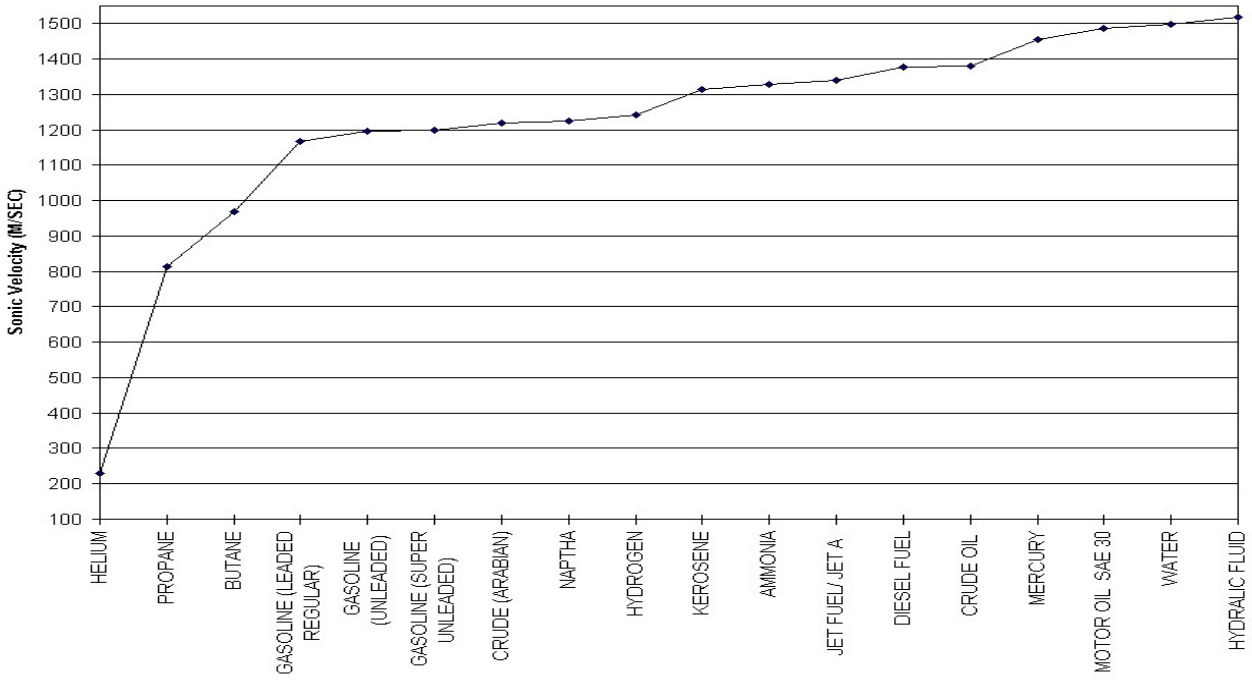
Siemens Standard Reynolds Number Compensation



Always avoid measureing in the transitional zone

Turbulent flow

laminar flow



Sonic velocities of Hydrocarbons

CONCLUSION

With the product improvements in the installation techniques, hardware and software, this technology is rapidly becoming accepted in both liquid and gas applications as an industry standard.

The use of the installation proceedure on existing pipes and spools for new installations has reduced errors and uncertanty, thus allowing tighter control on measurement.