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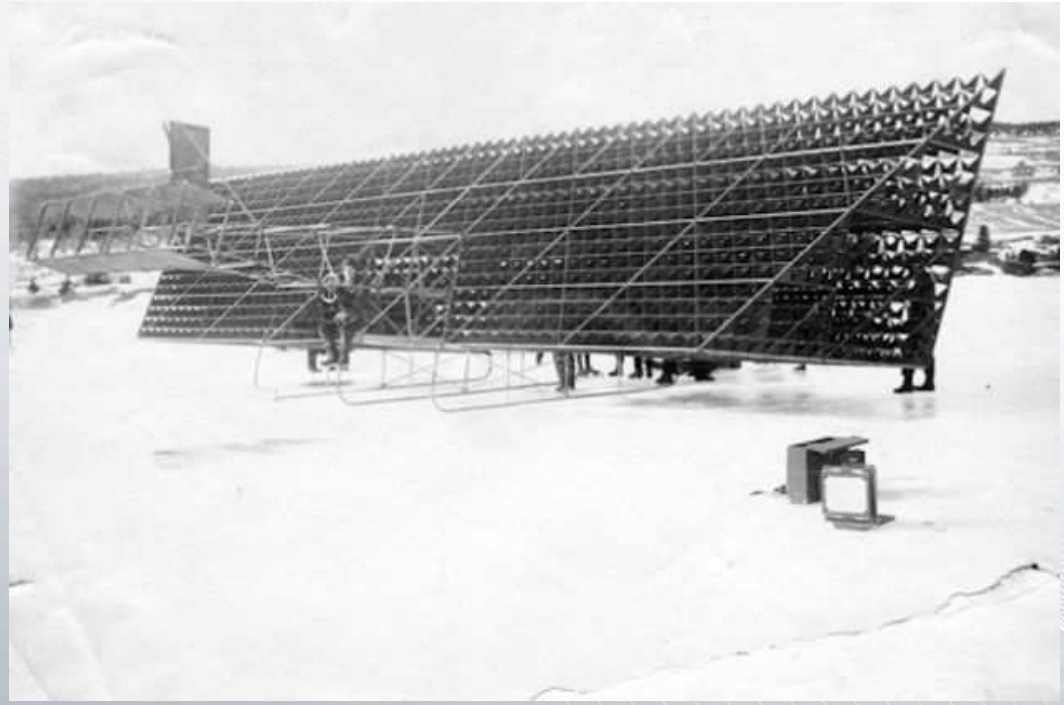
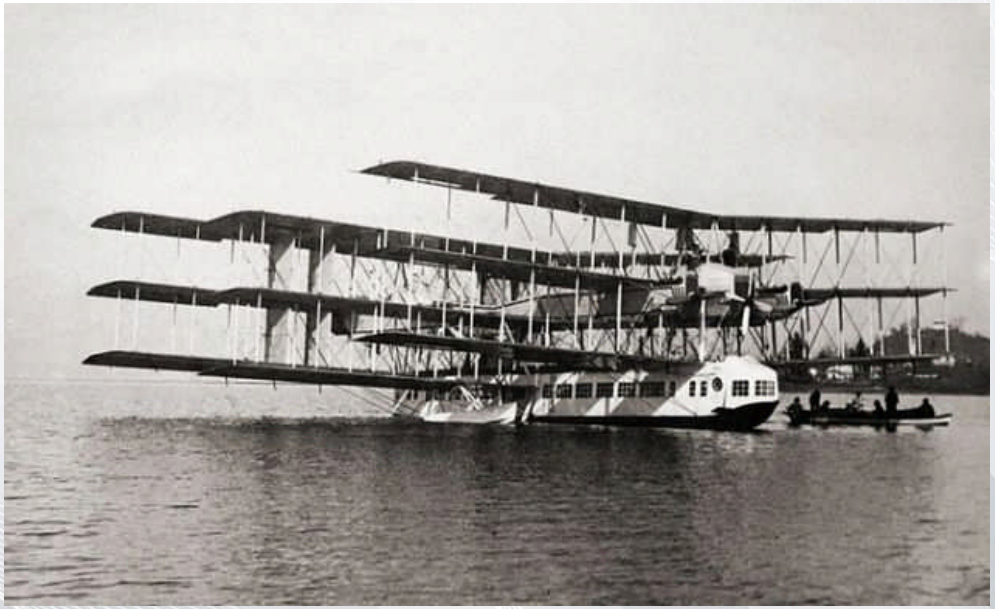
Truly Accurate Sampling Starts in the Pipe

Get it right from the start

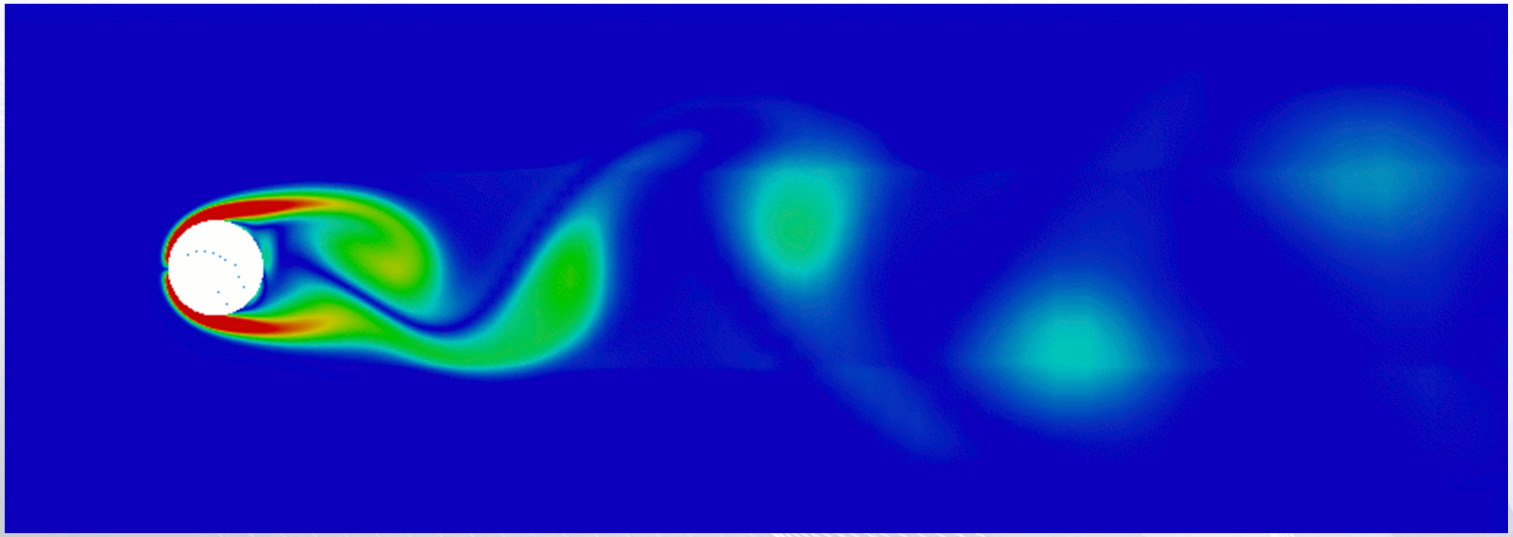
Aerodynamics matter



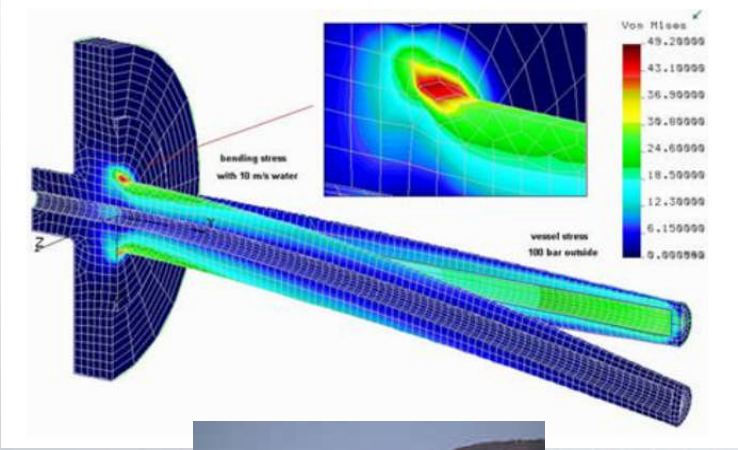


Sampling problems – The Observer effect ?

Low Pressure Zones, Vortices, & Resonant Vibration



Monju & Attempts to Solve The Resonance Issue



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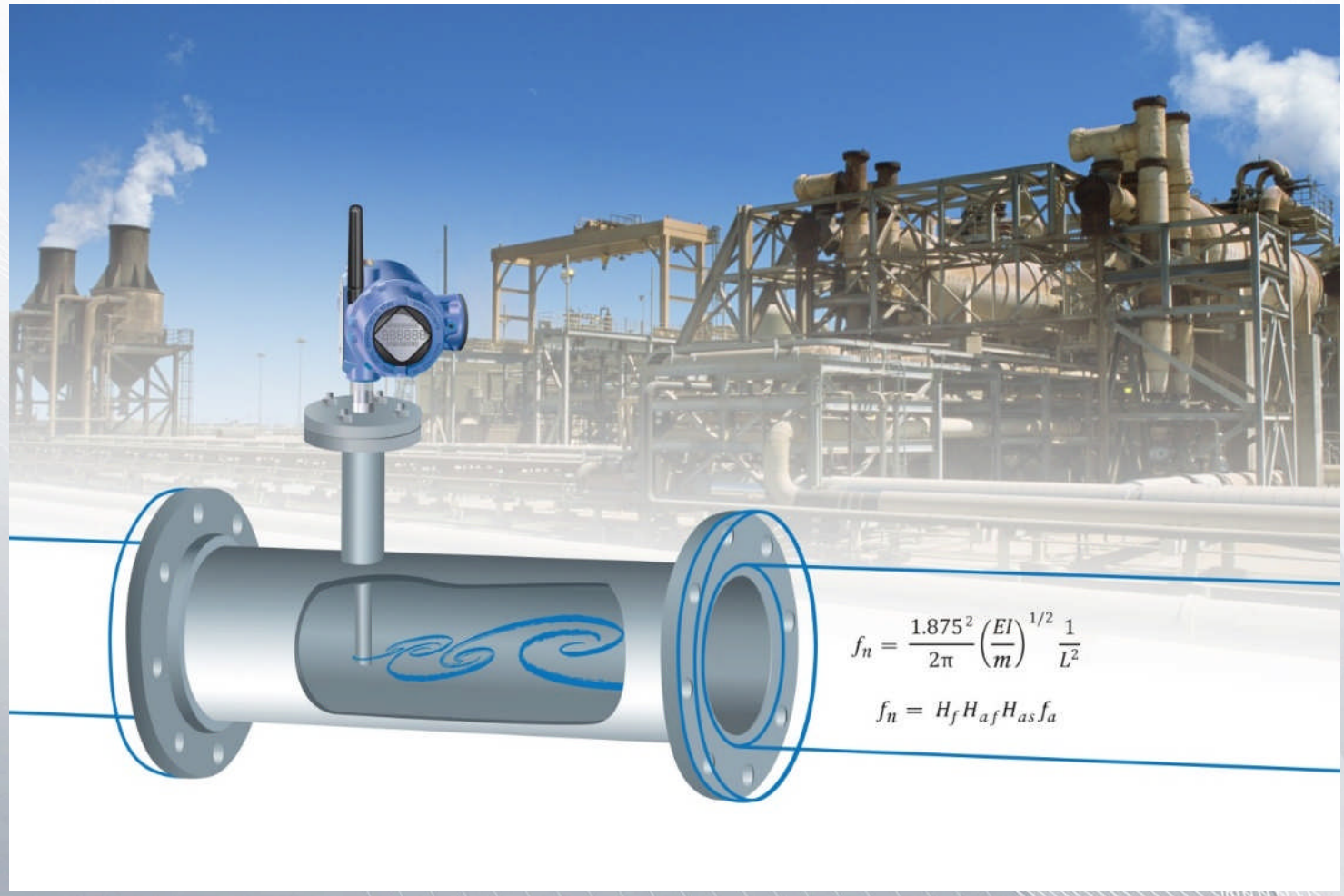
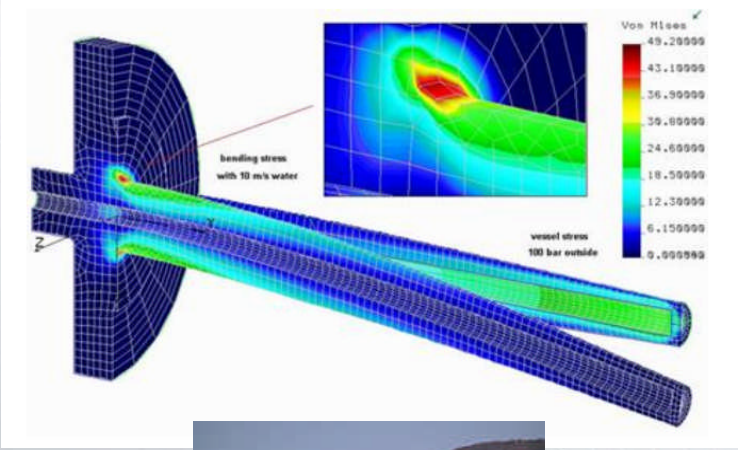
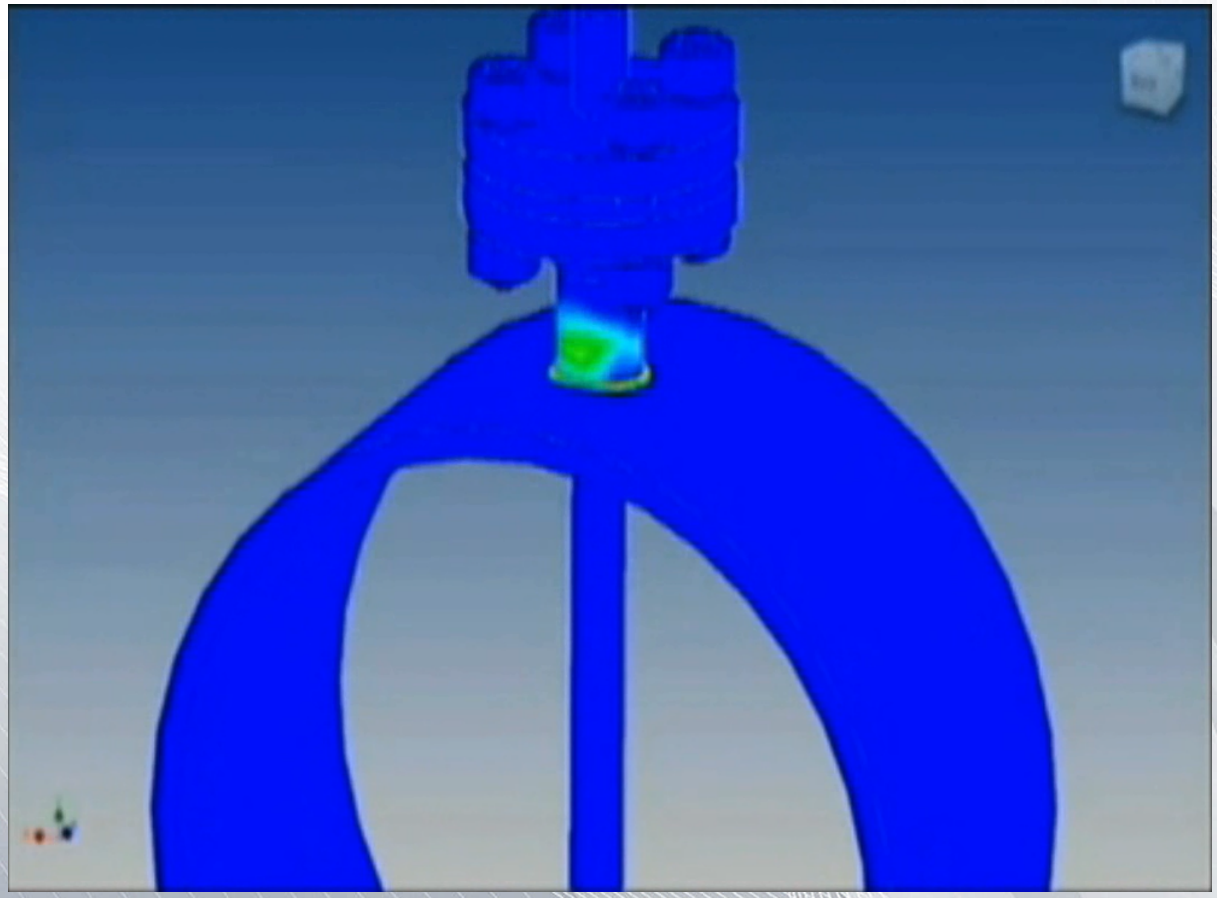

$f_n = \frac{1.875^2}{2\pi}\left(\frac{EI}{m}\right)^{1/2}\frac{1}{L^2}$
$f_n = H_f H_{af} H_{as} f_a$

Monju & Attempts to Solve The Resonance Issue





What if I told you…. A downward spiral could take Thermowell design to new heights?

Vortex Eliminating Thermowells

- Exempt from ASME 19.3
- Proven to 300 ft\sec (gas & liquid)
- Low thermal mass
- Any length\size possible without creating a heat sink

The Sampling Catch 22 ….

Contamination:

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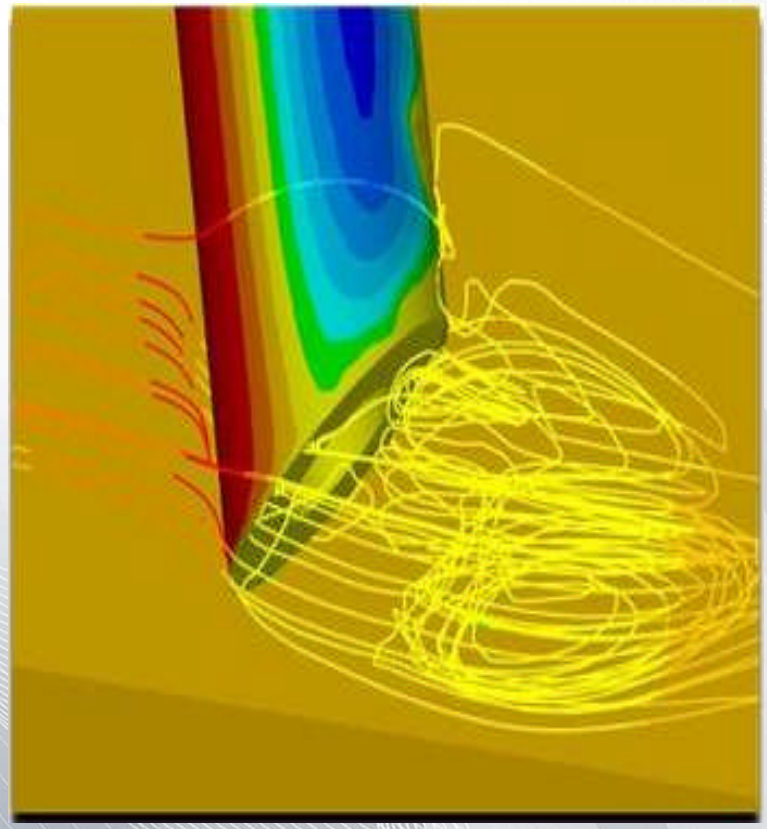
What if I told you that by taking a sample you are actually changing it

- Low pressure turbulence creates -
- Areas of reduced pressure which attract contamination like a vacuum
- Vortices which cause resonant oscillation preventing measurement in the center third
- More contamination, means larger filters, necessitates multi-stage regulation



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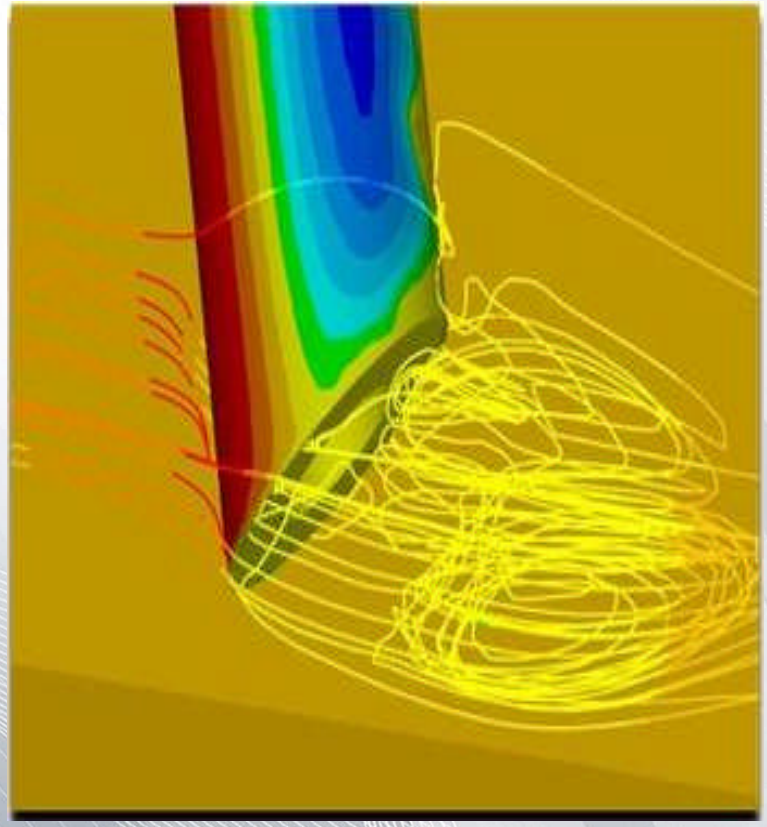
Facing the problem...



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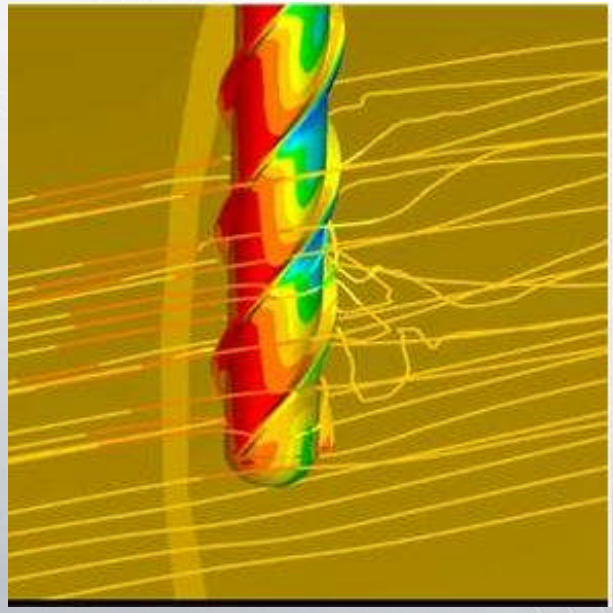
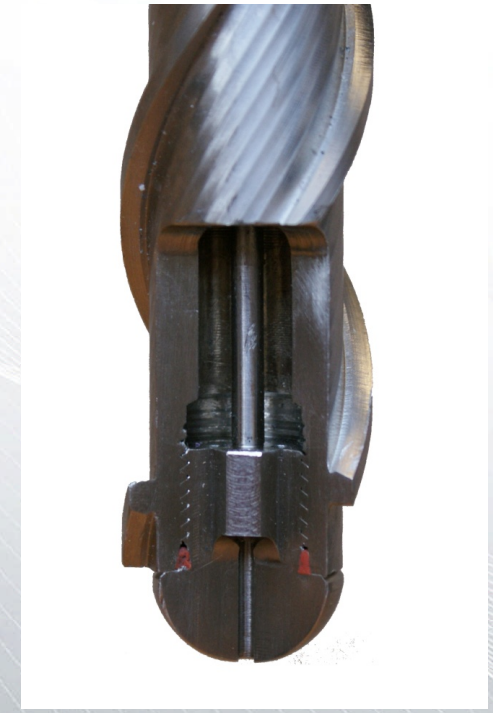
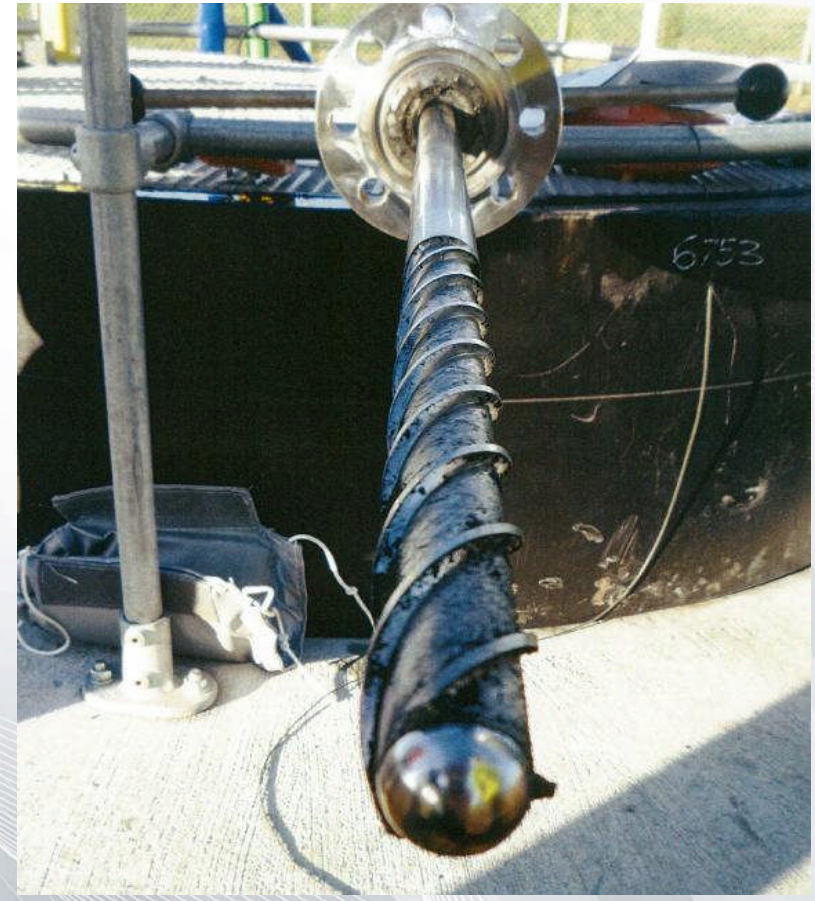
The Solution







Aerodynamic Tip = Self cleaning sample

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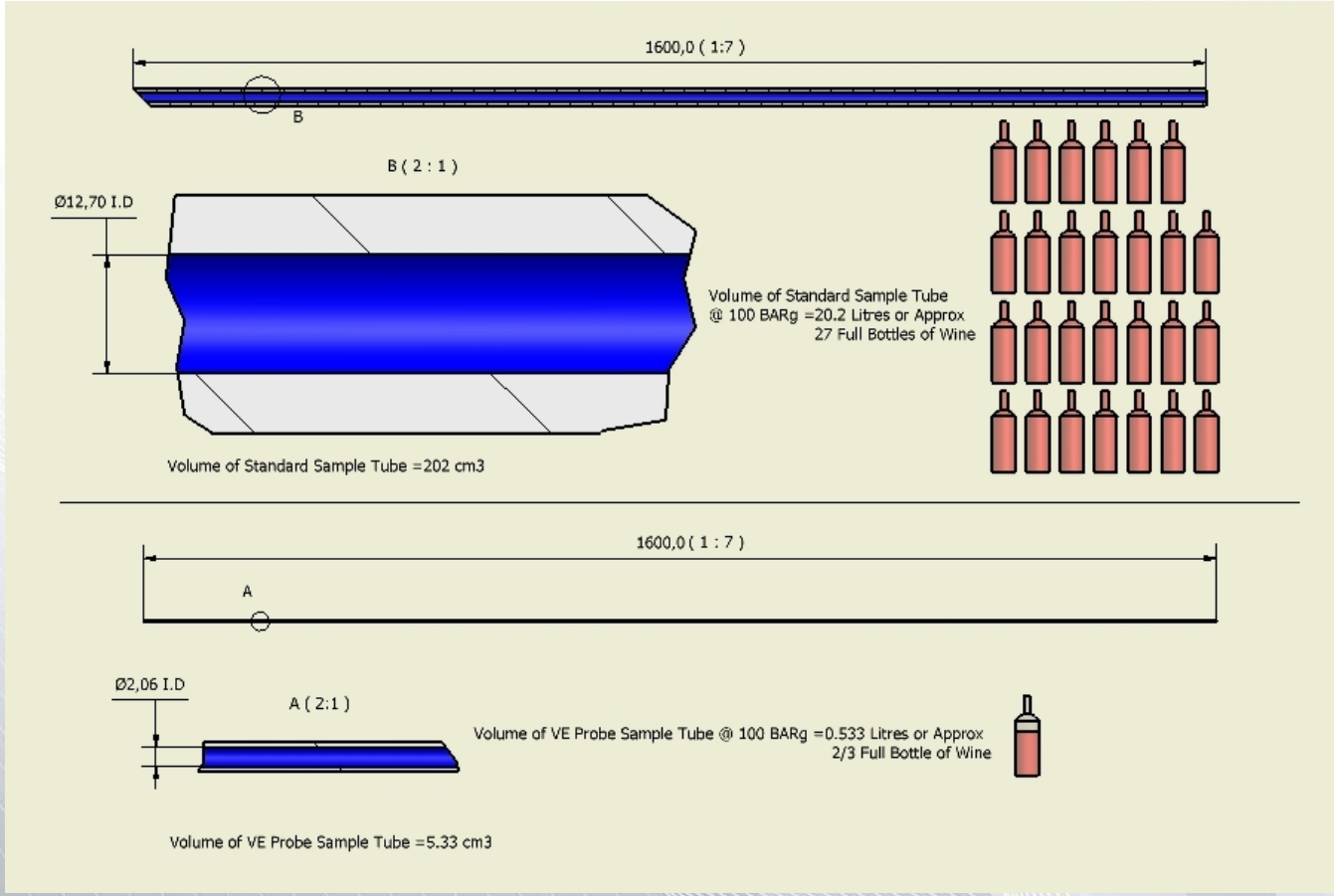
Volume Reduction

Critical in gas phase

SUPER critical in liquid phase with >400:1 expansion ratio



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Maths exercise – Volume of a sampling probe in MOL sieve based drying system

5cm (2” NB) tubing, 200 cm (6ft) long

= 3927cc or 3.927 ltrs capacity x LNG expansion >400:1

= 15708 ltrs min Vent line needed for vapourized sample waste

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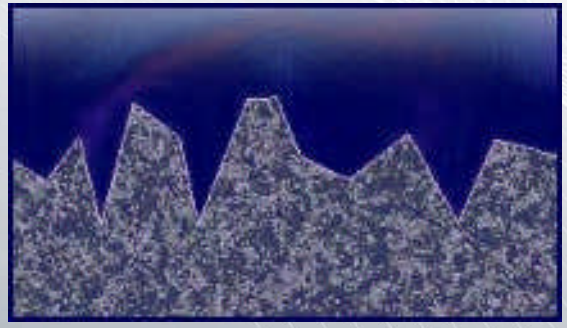
Area Changes and Surface Preparation

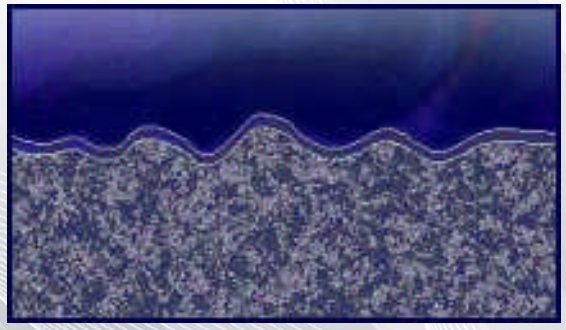
Maintaining identity & improving accuracy

Surface Finish

- 90% reduction in surface area
- Reduction in ad/desorption and physical entrapment
- Improved corrosion resistance
- Easier to clean
- Improved flow (reduced recirculation)



Picture from Anopol



Before EP

After EP

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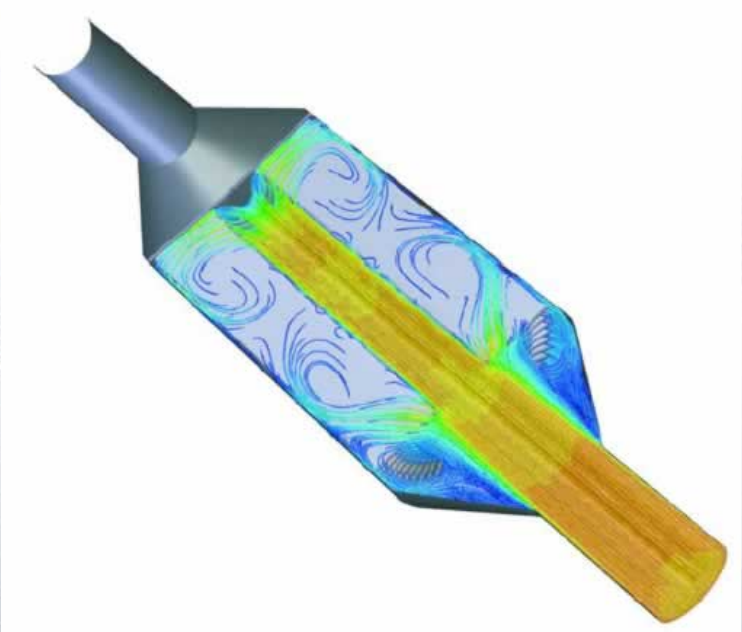

Why Constant Pathway?

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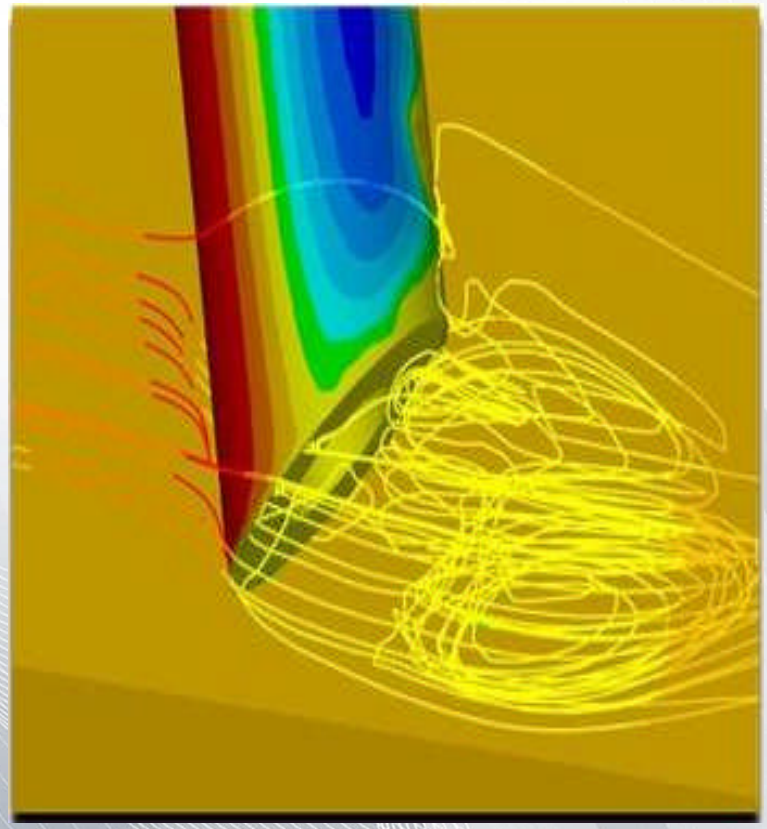
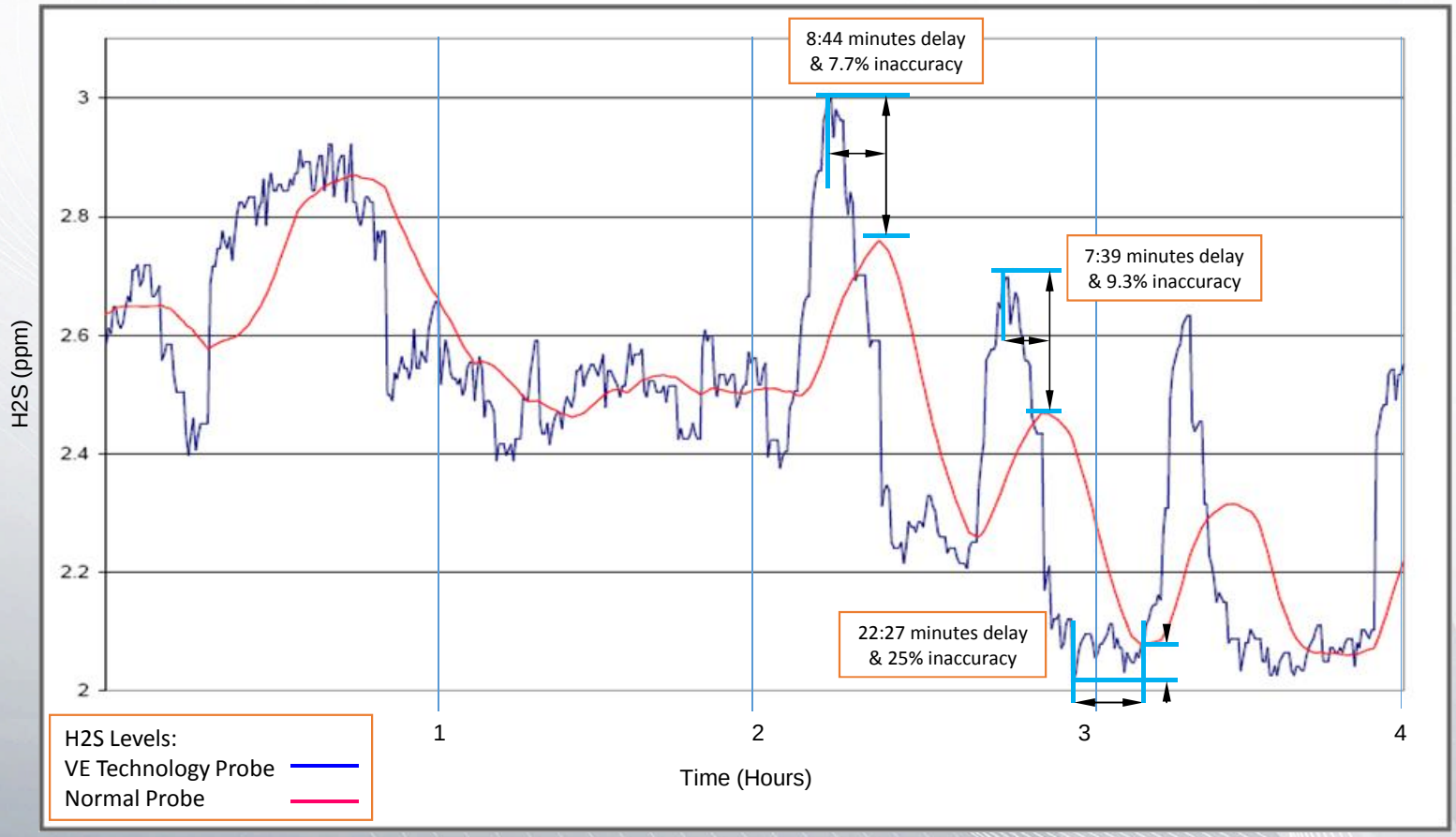
4 difficult measurements made easy

- Moisture
- Hydrocarbon Dewpoint
- H2S
- Mercury

The rule: Reduce your sample size, reduce internal surface area, & make your sample pathway constant



H2S Actual Readings from a transmission network



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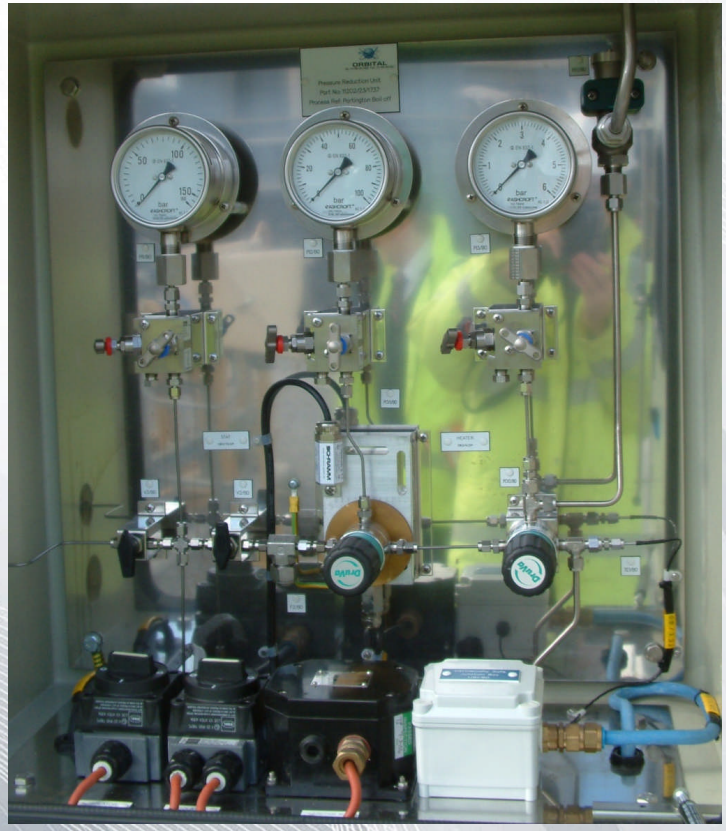
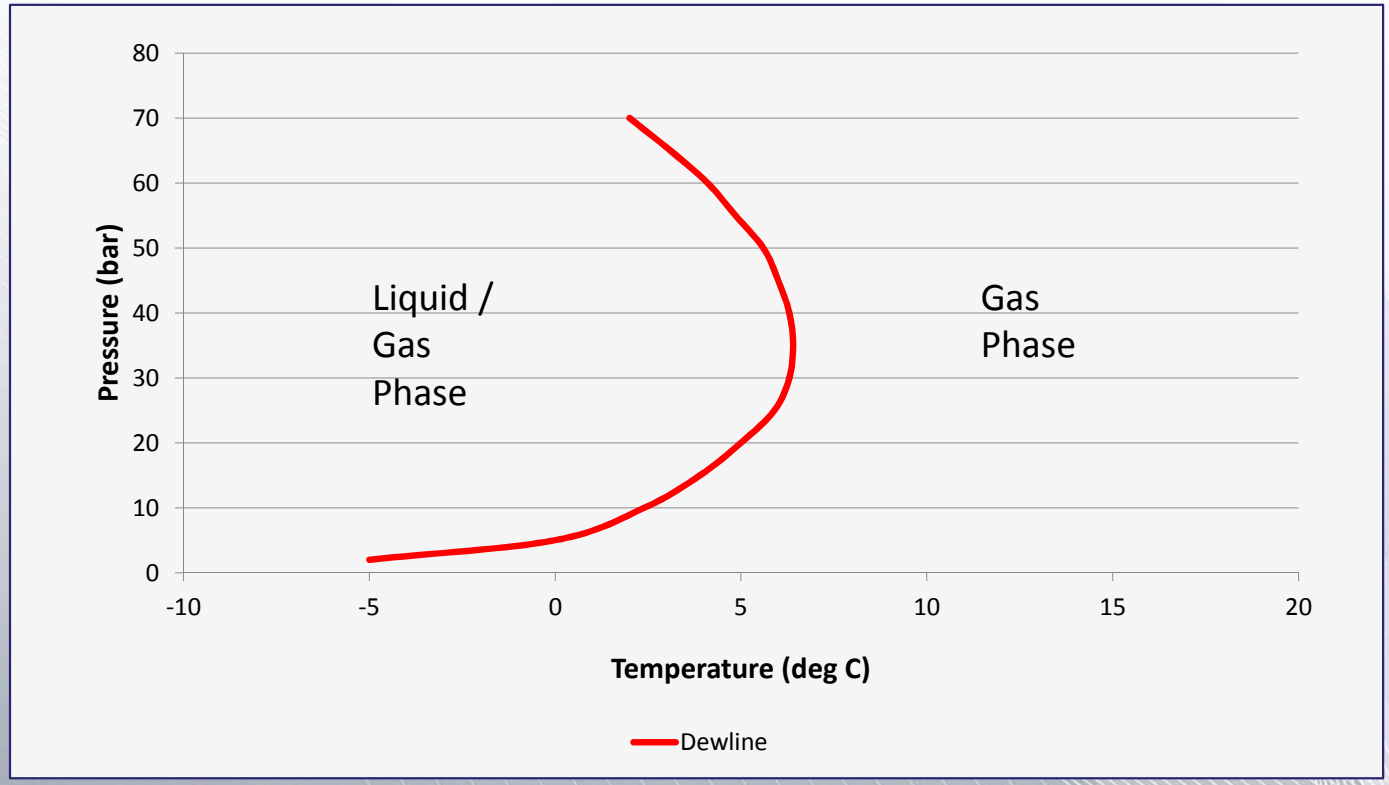
The Issues With Multistage Regulation

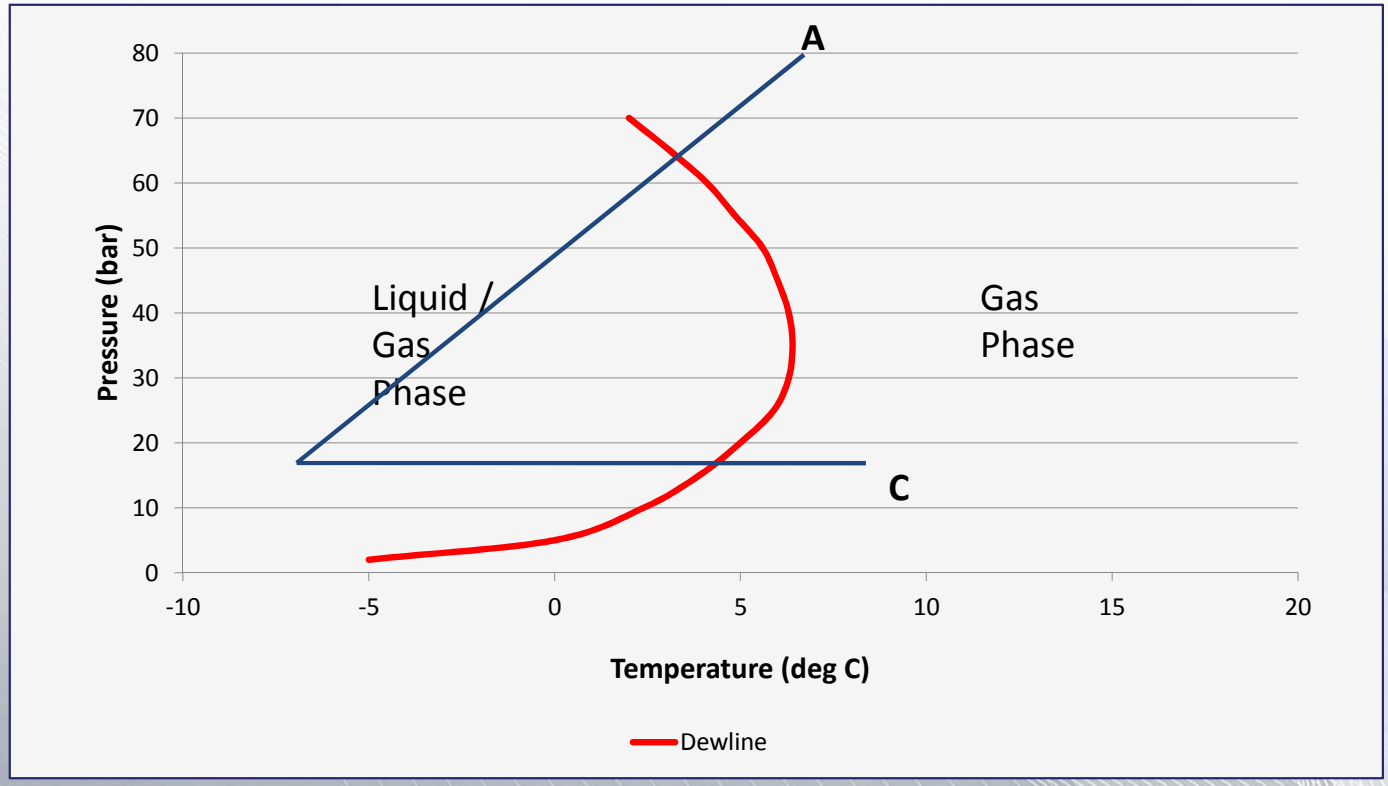
- Few analysers can operate at process\pipeline pressure
- Pressure cuts from 1500psi to 3psi are typical
- Traditional solution is multi stage regulation and heaters
- We still see “sweaty” regulators
- Phase change does still occur
- Solution: *Turn the sampling equation on its head*



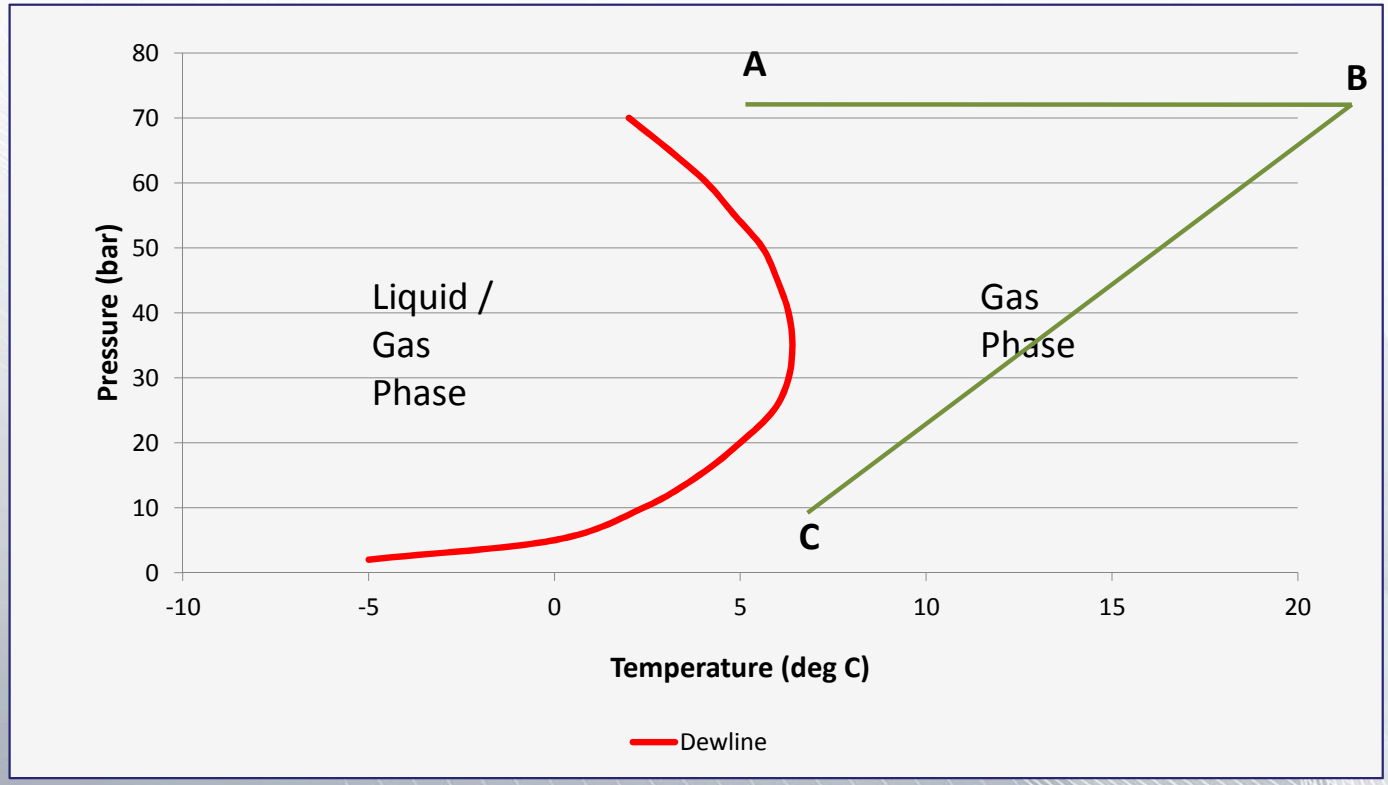
Hydrocarbon Phase Envelope



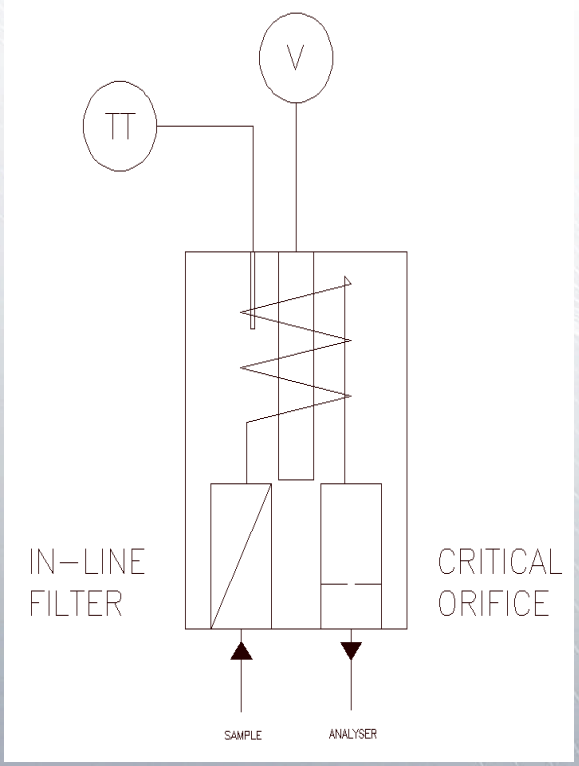
Hydrocarbon Phase Envelope

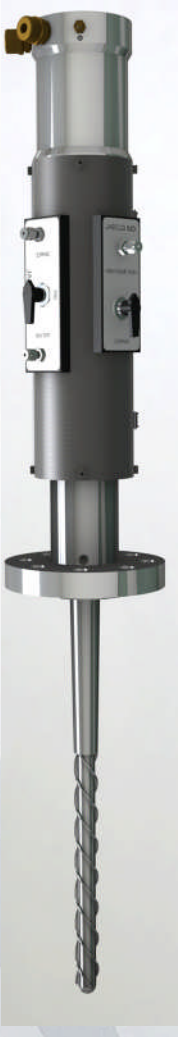


Hydrocarbon Phase Envelope



Integration of Conditioning Units





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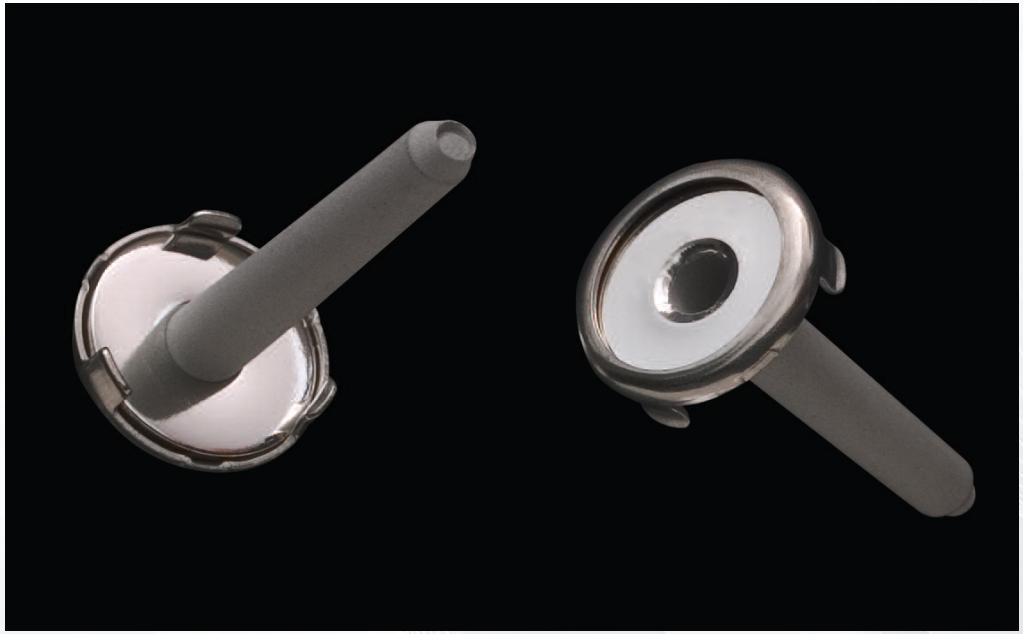
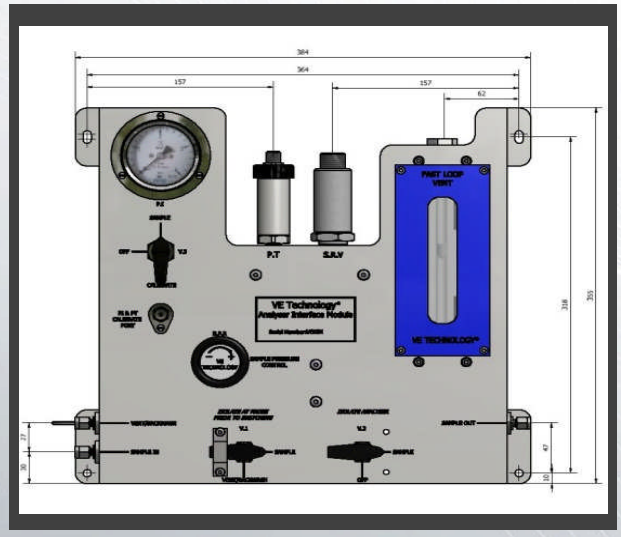
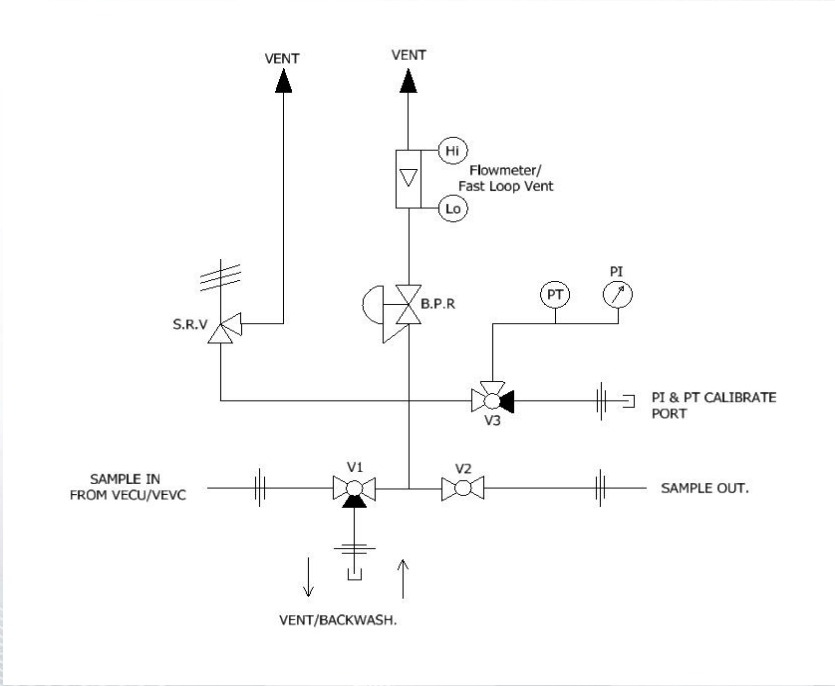


Featured: .4 Micron in-line filter w/ 50 pence for scale (similar to a qtr in size)

Example Analyser Interface Module



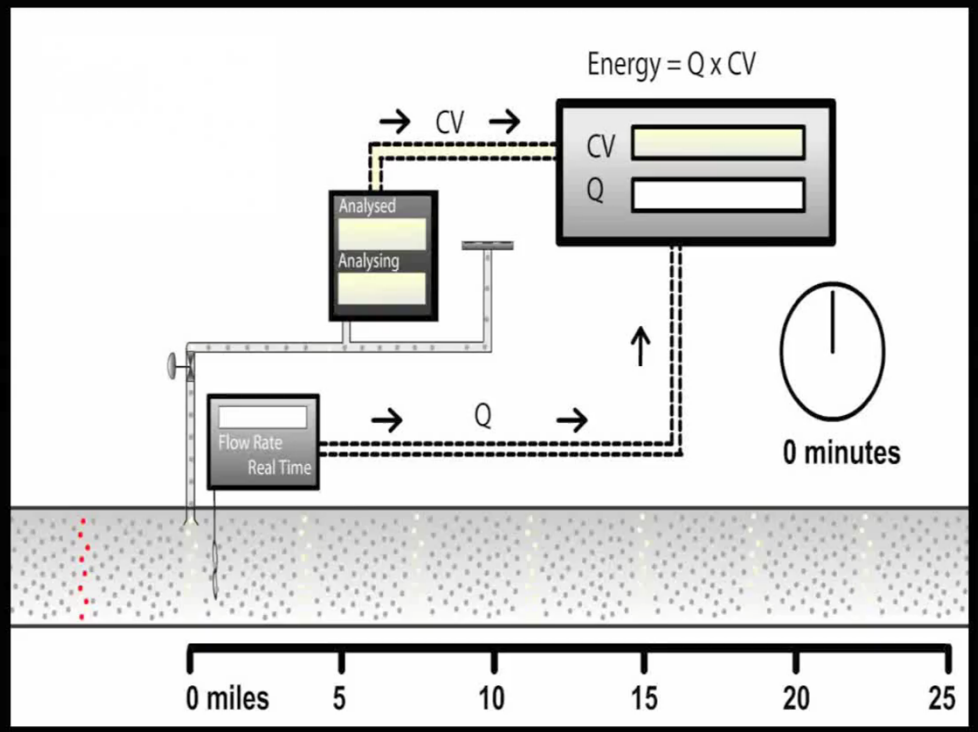


With hard to handle components, simplicity *is accuracy*

Summary Results

EXPERIMENT NUMBER	DESCRIPTION	RESULTS		
			SYSTEM TYPE	RESPONSE TIME
1	Initial response for 1st exposure to H2S (Unconditioned State)	1	Conventional	4 Days
		2	VE Tech	58 Minutes
			VE Tech SilcoNert	7.5 Minutes
		3	Control	5.2 Minutes
2	Subsequent response to 2nd exposure to H2S (Conditioned State)	1	Conventional	3 Hours
		2	VE Technology	9.5 Minutes
		3	Control	5.2 Minutes
3	Repeatable switching from 3ppm H2S to zero levels	1	Conventional	45 Minutes
				45 Minutes
		2	VE Technology	6.8 Minutes to Max
				5.8 Minutes to Zero
		3	Control	5.2 Minutes
				5.2 Minutes
4	National UK Transmission Testing	1	Conventional Delay Vs VE Technology	7.4 – 8.8 Minutes Response Delay
		2	Conventional Error Vs VE Technology	7.7% to Max & 25% to Min Error

The Ignored Uncertainty



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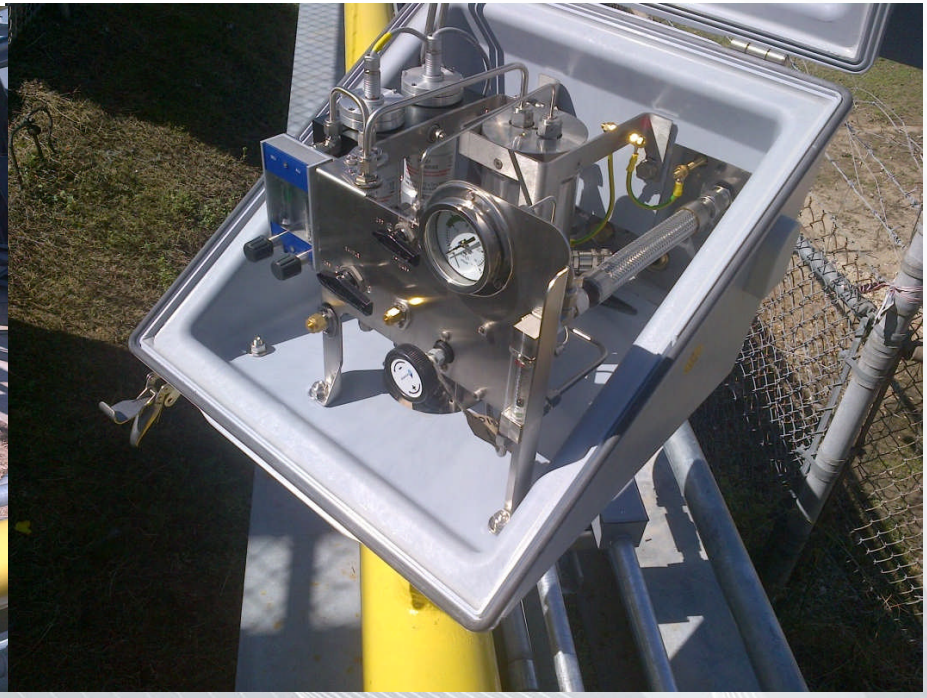
The Ignored Uncertainty

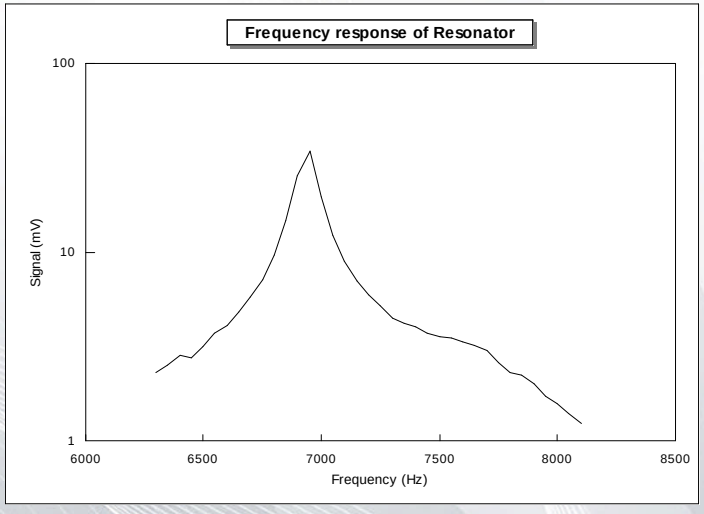
- Gas Chromatographs are accurate, but slow
- In the time it takes a GC to measure a single sample (15-25 minutes) – 12 to 15 miles of gas (or more) will typically have passed down the pipeline.
- Slow measurement, *costs you money*
- Poorly designed sample systems only make this worse

Small Footprint Integrated System



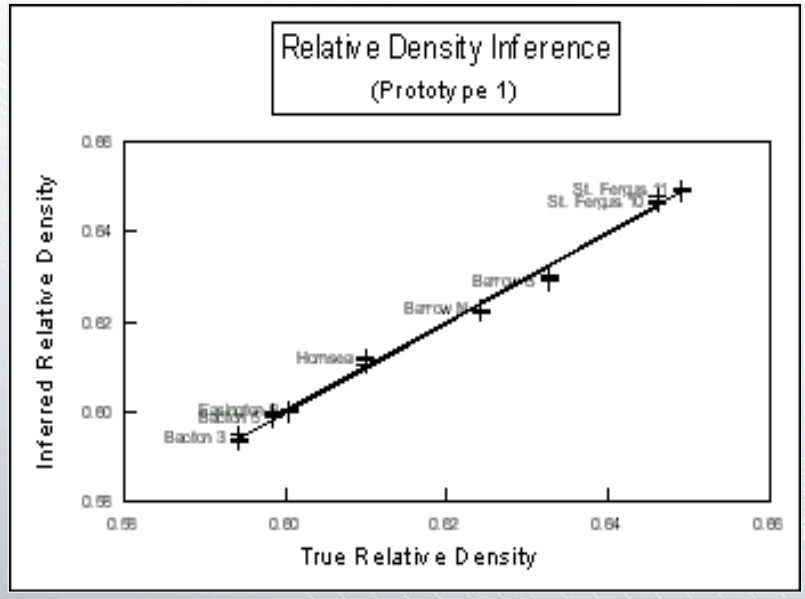
Speed of Sound/ Relative Density Ultrasonic Flowmeters 101

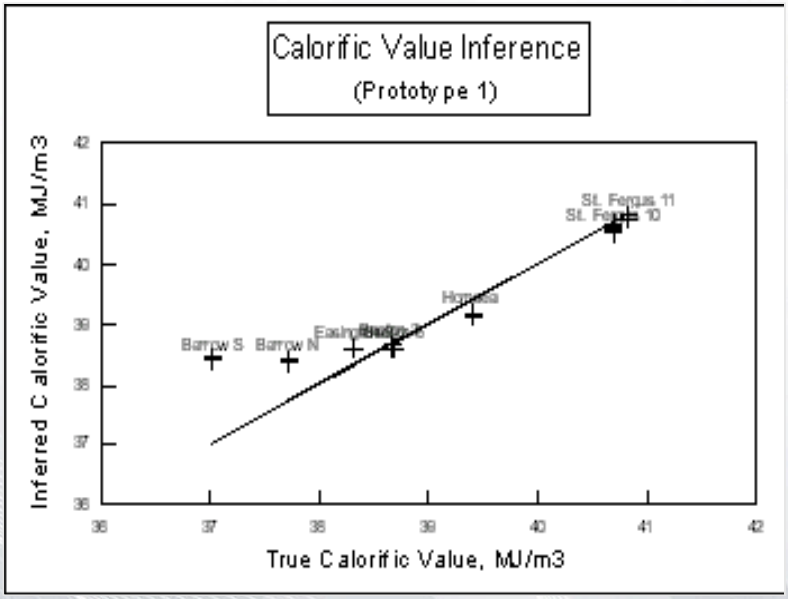
Microphone: Detects amplitude of oscillation



Miniature Speaker drives the resonance

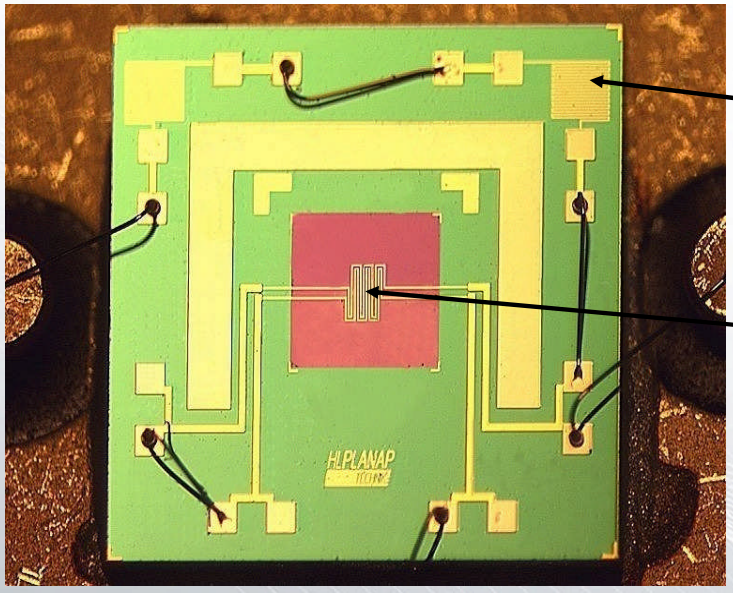
Speed of Sound Correlations





Speed of Sound correlates strongly to molecular weight of gas

Thermal conductivity, account for Inert Elements

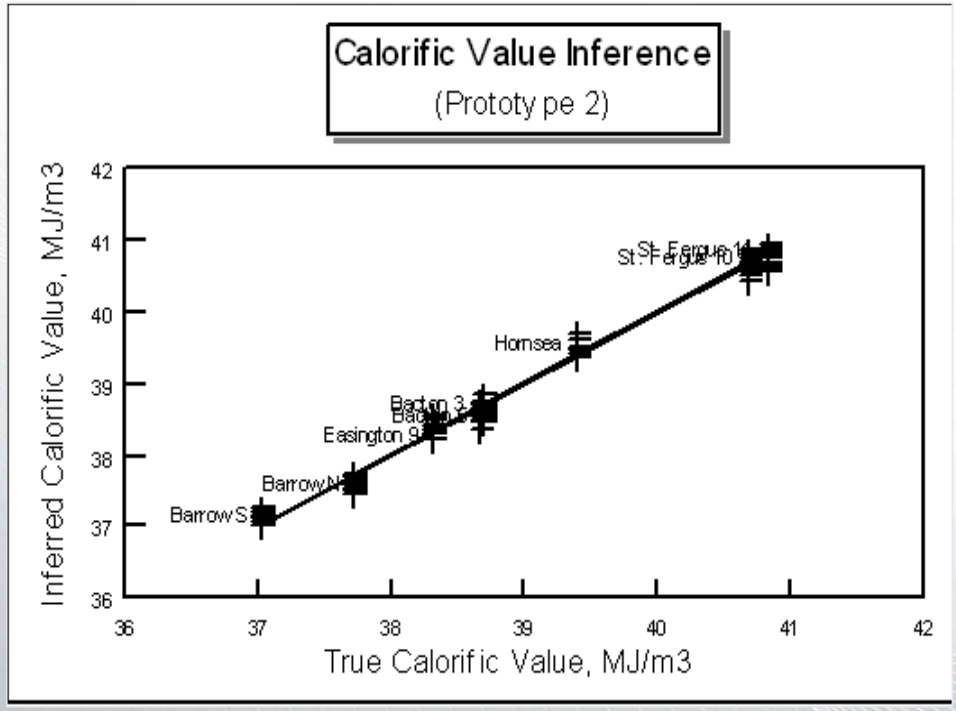


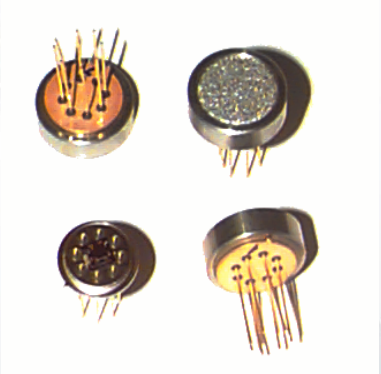
Ambient temperature sensor

Thermal conductivity sensing resistor.

Heated above ambient

Correlation using Thermal Conductivity





Thermal conductivity distinguishes between hydrocarbons and inerts

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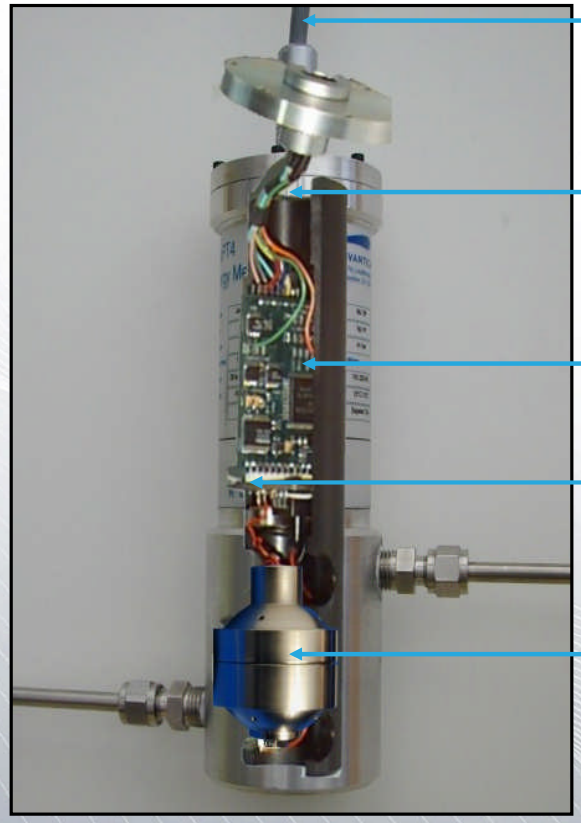

Electrical Connections

Insulating Sleeve

Processor Board

Thermal Conductivity Sensor

Spherical Resonator

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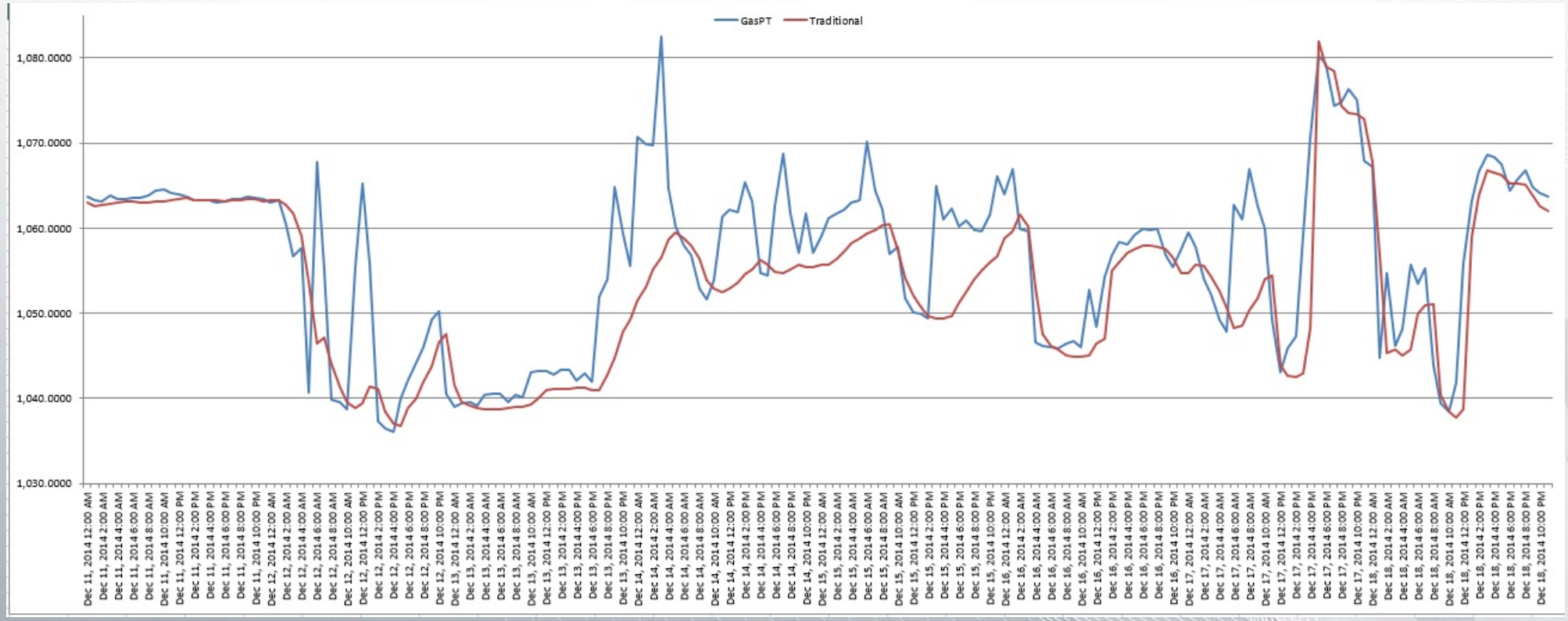
Double Checking a GC Installation – "A day late a $ short"