Waarom moeilijk doen als het makkelijk(er) kan

Fast analysis of Gas Properties

ORBITAL GAS PT 2

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Recognise this ?

Knowing (L)NG-properties

- Gas composition
  - C1 –> Cx including CO2 H2 Air
- LHV/HHV
  - Lower /Higher heating value (with or without water condensing energy loss)
- Wobbe Index
  - W(i)= relation between heating value and relative density of a gas

Why measuring wobbe

- Custody transfer
  - Selling Heating value against a measured delivered amount
- Boiler control
  - Optimisation of burning gas (less or more O2/fuel)
- Turbine control
  - Operation of turbine (knocking)

Existing Techniques

- Oxygen Demand Analysers (Wobbe Index)
  - Pro — Fast , Commonly known
  - Con — Large footprint , Maintenance , Utility gasses

- Proces Gas Chromatograph
  - Pro — Complete composition , accuracy
  - Con — Speed (cyclic)
    Carrier , calibration gasses needed
    Outside installation (maintenance)

The Alternative

Orbital GAS PT 2

- Fast
- Accurate
- No utility gasses
- Small footprint
- Hardly no maintenance

Prefer this ?

GAS-PT Pipe Mounted

Background to GasPT

- Developed by GL (formerly Advantica/British Gas R&D) in UK
- Licensed worldwide and exclusively to CUI Global inc./Orbital

- Inferential Gas Properties Transmitter

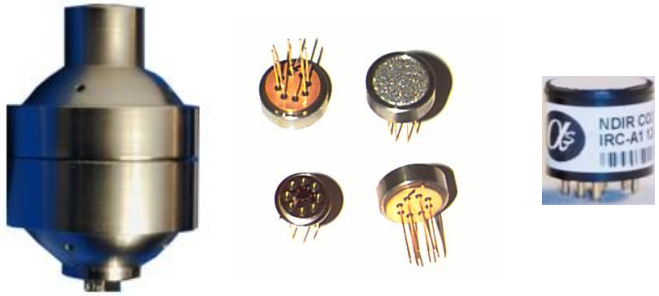
- GasPT1 measured speed of sound & thermal conductivity
- GasPT1 inferred 4-gas mixture of CH_4, C_3H_8, N_2 and CO_2
- Calculated RD, CV, Wobbe, Compressibility Factor to ISO6976

- GasPT2 has GasPT1 measurements with added CO_2 sensor unit
- GasPT2 infers a 5-gas mixture of CH_4, C_2H_6, C_3H_8, N_2 and CO_2
- More accurate calculation of gas properties
- Wider application across the complete range of natural gases

Method of Operation

GasPT2 Directly Measures

- Speed of Sound – Acoustic Resonator
- Thermal Conductivity – TCD Sensor
- Carbon Dioxide – NDIR Principle



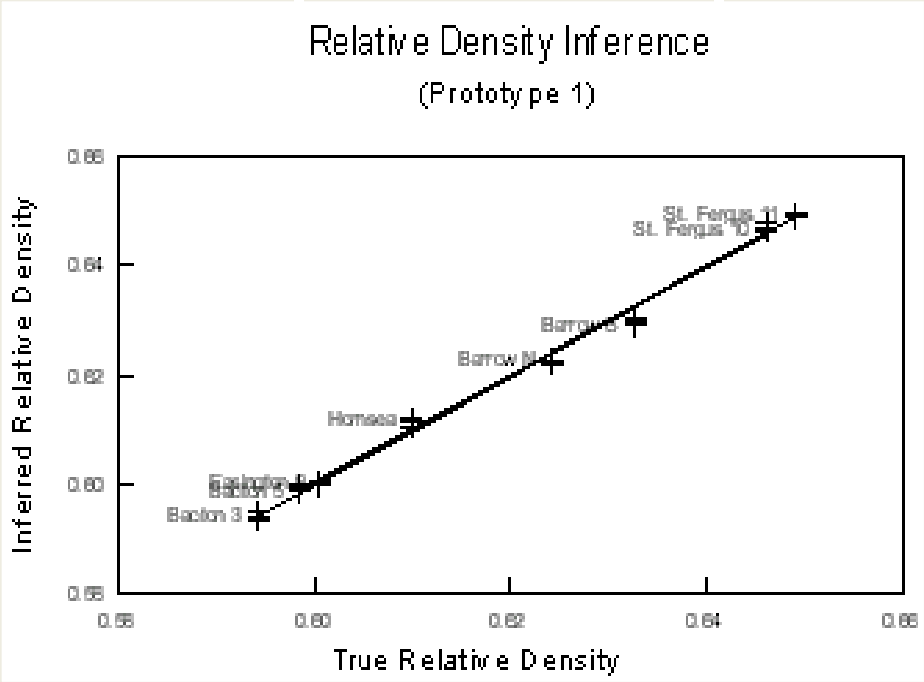
- Calibration gases are used to derive the response of each device
- Algorithms solved and flashed to the GasPT2

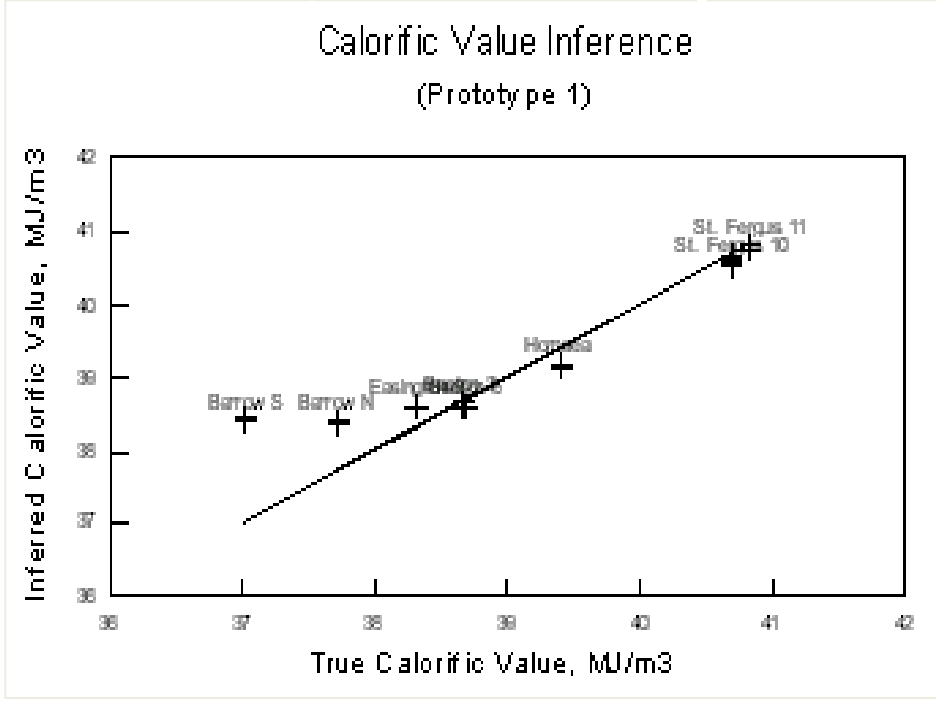
- 3 measurements are mathematically solved to derive a 4 component pseudo composition consisting of

    - Methane, Ethane, Propane, Nitrogen (Effective)
    - Plus Carbon Dioxide

Principle of Operation

Speed of Sound Correlation

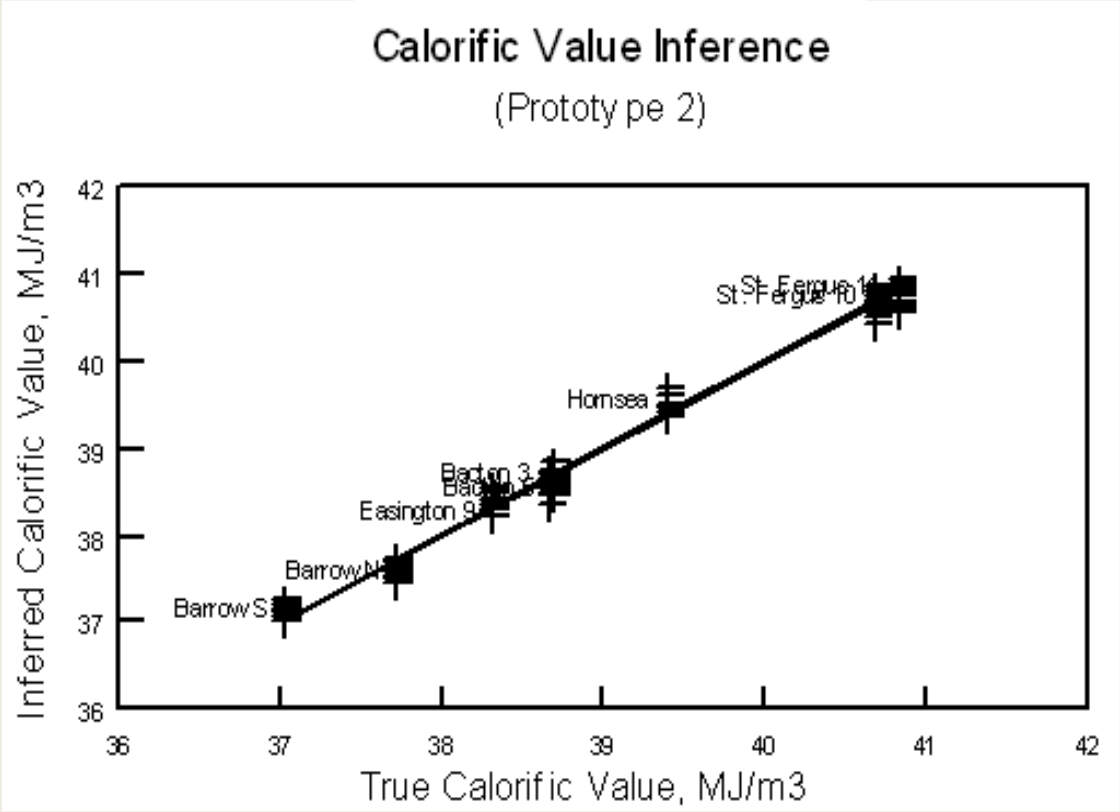


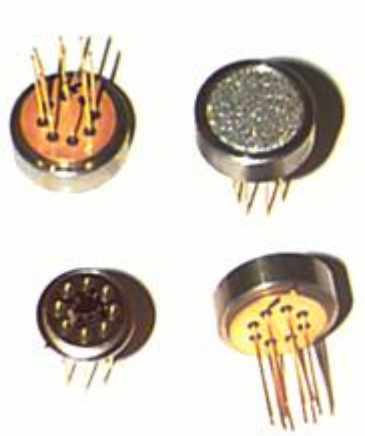


Speed of Sound correlates strongly to molecular weight of gas

Principle of Operation

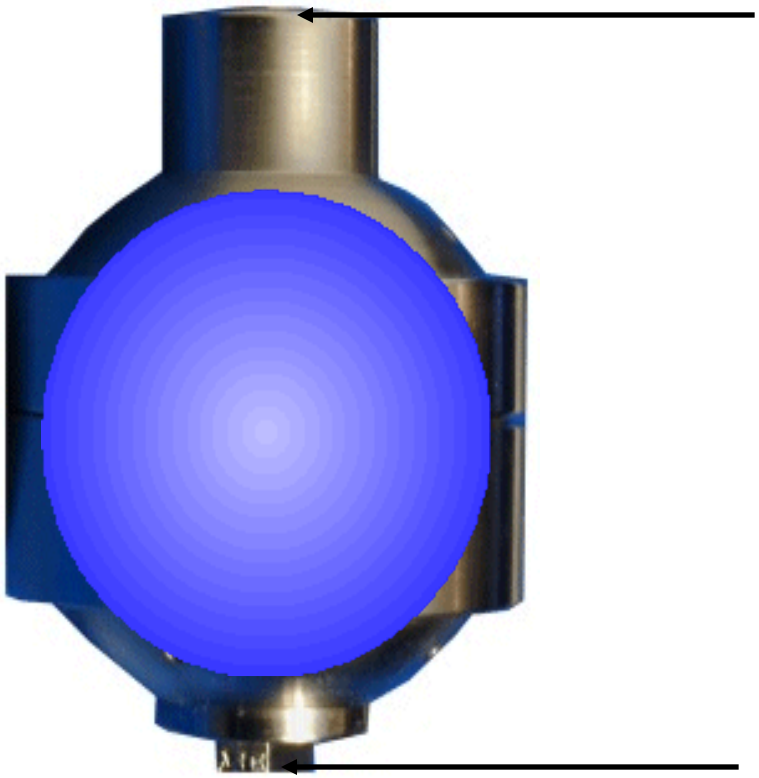
Correlation using Thermal Conductivity



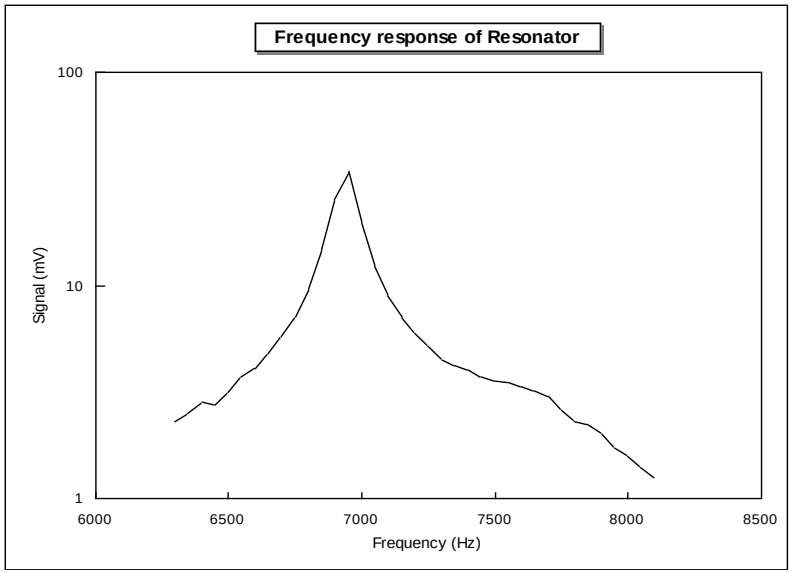


Thermal conductivity distinguishes between hydrocarbons and Inerts

GasPT: Speed of Sound

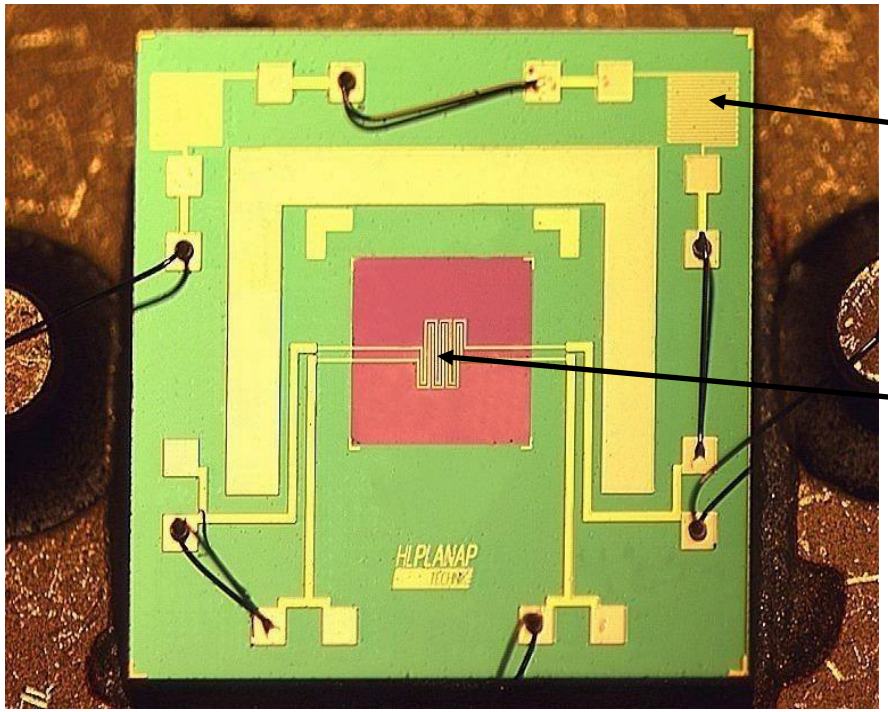


Microphone: Detects amplitude of oscillation



Miniature Speaker drives the resonance

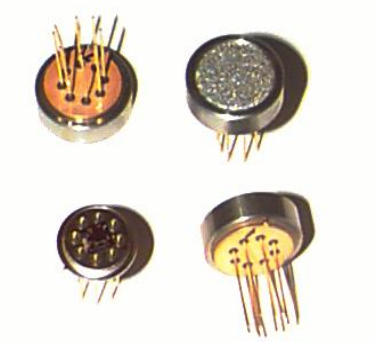
GasPT : Thermal conductivity (TCD)



Ambient temperature sensor

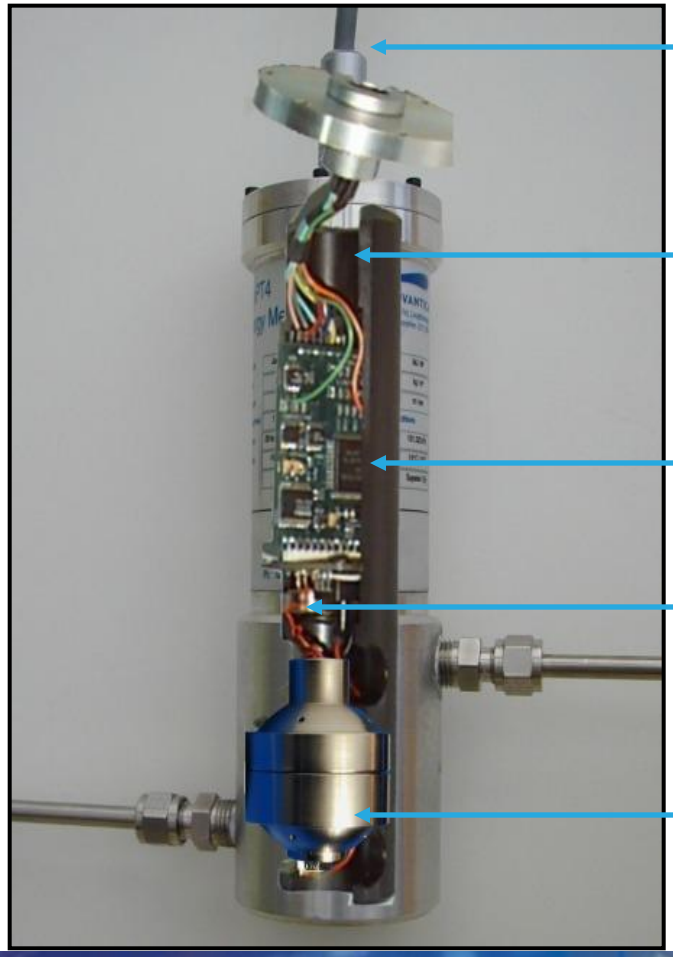
Thermal conductivity sensing resistor.

Heated above ambient



GasPT Sensor Units and Safety Interfaces

GasPT Auxiliary (AU) Sensor Unit Components



- Electrical Connections
- Insulating Sleeve
- Processor Board
- Thermal Conductivity Sensor
- Spherical Resonator

Theoretical Analysis
Gas Interchangeability

All hydrocarbons typically found in a natural gas can be represented by a mix of effective methane (CH4'), effective ethane (C2H6') and effective propane (C3H8') that yield the same number of carbon and hydrogen atoms.

Examples :

$$1C_4H_{10} = C_2H_6 + C_3H_8 - CH_4$$

(1 mol. Butane = 1 mol. Ethane + 1 mol. Propane - 1 mol. Methane)

$$2C_5H_{12} = 2C_2H_6 + 3C_3H_8 - 3CH_4$$

(2 mols. Pentane = 2 mols. Ethane + 3 mols. Propane – 3 mols. Methane)

$$C_6H_{14} = 3C_3H_8 - CH_4 - C_2H_6$$

(1 mol. Hexane = 3 mols. Propane – 1 mol. Methane – 1 mol. Ethane)

Calculation of an inferred gas composition

Ref Gas	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	CO_2	N_2		Total
	94.451	3.11	0.512	0.198	0.17	0	0.647	0.912		100

Ref gas CV=38.731 MJ/m³

	Effective Methane			Effective Ethane			Effective Propane		
Methane	1.0	94.451	94.451	0.0	94.451	0	0.0	94.451	0
Ethane	0.0	3.11	0	1.0	3.11	3.11	0.0	3.11	0
Propane	0.0	0.512	0	0.0	0.512	0	1.0	0.512	0.512
Butane	-1.0	0.198	-0.198	1.0	0.198	0.198	1.0	0.198	0.198
Pentane	-1.5	0.17	-0.255	1.0	0.17	0.17	1.5	0.17	0.255
Hexane	-1.0	0	0	-1.0	0	0	3.0	0	0
			93.998			**3.478**			**0.965**

Pseudo Gas	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	CO_2	N_2		Total
	93.998	3.478	0.965	0	0	0	0.647	0.912		100

Inferred Gas CV=38.725 MJ/m³

Principle of Operation – Property Calculations

Physical Property Calculations	11 Components	5 Components	Δ Difference
Compressibility @ 15 ^{O}C	0.9978	0.9978	0.0000
Density @ 0 ^{O}C	0.7646	0.7646	0.0000
Relative Density @ 15 ^{O}C	0.5912	0.5912	0.0000
Gross CV @ 15 ^{O}C	38.7309	38.7334	-0.0025
Net CV @ 15 ^{O}C	34.9209	34.9234	-0.0025
Sooting Index	0.5130	0.5131	-0.0001
ICF	-0.1434	-0.1414	-0.0020
Wobbe @ 15 ^{O}C	50.3722	50.3755	-0.0033

Operational Specification

Sensor Unit ambient or sample gas temperature Safety Interface ambient temperature	-20 to +55 DegC -20 to +50 DegC
Max. pressure	4.3 psig (~300mbar)
Humidity	Non-condensing
Sample gas flowrate	0.5 to 2.0 l/min
Analysis Time	Instrument Update < 2 sec
ATEX, IECEx and CSA approvals	Probes suitable for NG in Zone 1 and Zone 2 hazardous areas
Accuracy	Better than ± 0.3% error on CV and Wobbe measured value
Repeatability	CV and Wobbe ± 0.04MJ/m3 (1.07Btu/ft3) at Amb. Temperature
Power requirement	24 Vdc @ 250 mA (trimmed to 23Vdc)

Operational range and limits

Methane	50 - 100 %
Ethane	0 - 12.0 %
Propane	0 - 7.0 %
iso-Butane	0 - 1.0 %
n-Butane	0 - 1.0 %
iso-Pentane	0 - 0.5 %
n-Pentane	0 - 0.5%
C6+ Total	0 - 0.5 %
Carbon Dioxide	0 - 20 % (Adjustable zero)
Nitrogen	0 - 20.0 %
H2S	< 5ppm
He	< 0.5%
O2 and H2	Low levels only
H2O	Dry, non-condensing

GAS PT -2 outputs

- CV/BTU Value
- Relative Density
- Wobbe
- Compressibility
- Motor Octane Number
- Carbon Dioxide content

Conclusion

- A -2- second GAS PT measurement benefit in
  - Fast determination of gasproperties
  - Easy installation requirement
  - Less maintenance
  - Certified for Custody Transfer
- Resulting in
  - Optimal use of burning or selling (L)NG in a easy way

ORBITAL
GLOBAL SOLUTIONS

Vragen ?????

ASAP