Take Gas Analysis Mobile — Without Sacrificing Results

Key Learning Objectives:

- Learn how to determine composition and calorific value of natural gas
- Learn how to take typical laboratory analysis mobile and get reproducible results
- Learn how to configure analysis in accordance with ASTM, GPA, and ISO methods

Who Should Attend:

- (lab) technicians in (petro)chem and natural gas performing gas chromatographic analysis and in particular gas analysis
- (lab) managers in (petro)chem and natural gas in charge of (contract) labs performing gas chromatographic analysis and in particular gas analysis
- R&D personnel developing solutions where they have a need to analyze gases
- Academics developing solutions in alternative fuels, fuel cells etc having the need to analyze gases

LIVE WEBCAST: Tuesday, July 23, 2013 at 9:00 am EDT
Register free at www.chromatographyonline.com/gasanalysis

Event Overview:

The natural gas (NG) market is broken into four discrete segments: exploration, liquefaction, transportation, and regasification. All four of these segments require diligent and accurate characterization of the NG to ensure maximum efficiency in investment and operational expenditures.

Come learn about and discuss the most critical characterizations of NG characterization utilizing a gas chromatograph (GC). Since the two key aspects of characterization are diligence and accuracy, the benefits taking the analysis onsite with micro GC analysis can offer unprecedented performance in both of the two critical aspects mentioned.

The following applications will be discussed in detail and supported by real-world data:

- Exploration: mud logging characterization; up to C12 qualification and quantification
- Liquefaction: calorific value determination
- Transportation: gas composition during loading
- Regasification: calorific value validation and odorant addition monitoring

Presenters:
Coen Duvekot
Product Manager, Micro GC
Thomas Szakas
Mobile Measurement Business Development & Commercialization Manager

Moderator:
Laura Bush
Editorial Director, LCGC

For questions contact Kristen Farrell at kfarrell@advanstar.com

Presented by
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Agilent Technologies
LCGC
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- Digital marketing toolkits to support content creation and campaigns
- Metrics on all campaigns to capture best practices and drive effectiveness
- Web Content Editorial Calendar to keep content fresh, accurate and up-to-date
- New Centers of Excellence for Content Development, Localization and Publishing
- Building and nurturing customer relationships through social media
Agilent Lab Quality… When and Where You Need It

What if you could take your laboratory equipment to the sample?
The Agilent 490 Micro GC Family

490 Micro GC Family
Basic cabinets, 19” rack and Field Case

The field case provides “on-the-go” measurements
### Natural Gas

- Permanent gases
- Hydrocarbons
- Odorants

<table>
<thead>
<tr>
<th>Compound</th>
<th>Typical Concentration (%)&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>70 - 90</td>
</tr>
<tr>
<td>Ethane</td>
<td></td>
</tr>
<tr>
<td>Propane</td>
<td>0 - 20</td>
</tr>
<tr>
<td>Butane</td>
<td></td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>0 – 8</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0 – 0.2</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0 – 5</td>
</tr>
<tr>
<td>Hydrogen sulphide</td>
<td>0 – 5</td>
</tr>
<tr>
<td>Other: Helium, Argon,</td>
<td></td>
</tr>
<tr>
<td>Neon, Xeon, Hydrogen</td>
<td>Traces</td>
</tr>
</tbody>
</table>

Reference [1]: http://naturalgas.org

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**Micro-Gasifier for Liquefied Natural Gas (LNG)**

Sample introduction
Measure 2 Mitigate

What are we measuring?
What are we trying to mitigate?
Measure 2 Mitigate

Explore
Pipeline
Transport
Distribute

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Pricing/Profitability Determination

1. Quantity of gas
2. Amount of processing to make it ‘pipe’ ready
3. Amount of transportation

For example:
- lowest will be ‘well head’ customers
- Highest will be ‘residential’ customers
Phase 1 – Exploration

Explore
- Mud Logging
- Composition
- Clean-up

Pipeline
- Clean-up Verification
- Calorific Value

Transport
- Vessel Testing
- Liquefaction
- Regasification

Distribute
- Blending
- Odorant Addition
- Calorific Value

Measure 2 Mitigate
Where is the Starting point?
Mud Logging

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Mud Losses</th>
<th>Lithology Description</th>
<th>Total Gas</th>
<th>Methane</th>
<th>Ethane</th>
<th>Propane</th>
<th>Butanes</th>
<th>Pentanes</th>
<th>Hexanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-60</td>
<td>0</td>
<td>Sandstone</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>61-120</td>
<td>10</td>
<td>Limestone</td>
<td>100</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>121-180</td>
<td>50</td>
<td>Dolomite</td>
<td>1000</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Fast, Accurate, Robust, Simple
What can you do in 30 Seconds?

- Composite air
- Methane
- Carbon dioxide
- Ethane
- Propane
- i-Pentane
- n-Pentane
- Neo-pentane
- i-Butane
- n-Butane

100 x zoom
490-PRO Micro GC

A Fast, Small Form Factor, High Performance Gas Measurement Platform Designed for Unattended Operation and supports Industrial networks

Same hardware as the 490 Micro GC
490 Micro GC versus 490-PRO

Set up / Operation

- **PC Data System**
- **Control**
- **Signal**
- **Report**

**Standard 490 Micro GC**
- **490 Micro GC**

**Set up**

- **PC PROstation**
- **Method**
- **Maintenance**

**490-PRO Micro GC**
- **490-PRO**

**Operation**

- **PC PROstation**
- **Communication Result**
- **Industrial networks**

**490-PRO**
490-PRO Micro GC

- OBDH
- Automation
- Application
- Modbus
- FTP client
- PROstation
- External I/O devices
- Local display (optional)
On Board Data Handling

Built into the 490-PRO Micro GC:

- Peak integration
- Peak identification
- Peak calibration
- Peak grouping

This means that for routine measurements:

- Full autonomous operation (no operator required)
- No external data handling software required
- No PC needed to generate results
Sequential measurement runs that include:

- sample type
- valve/sample position
- flush time
- calibration level

Calibration and/or verification analysis

- after a desired # of samples
- based on a specific time
- on demand via remote command
- automatic (re)calibration if verification values “fail”
Stream selection and control:

- Electrically actuated multi-position valves
- Solenoids based stream selectors

Remote Communication:

- MODBUS
- Digital input
- 4-20 mA
- ftp server
Phase 2 – Pipeline

Explore
- Mud Logging
- Composition
- Clean-up

Pipeline
- Clean-up Verification
- Calorific Value

Transport
- Vessel Testing
- Liquefaction
- Regasification

Distribute
- Blending
- Odorant Addition
- Calorific Value

Measure Mitigate
Pipeline

Transportation

Treatment

- Condensate removal
- CO₂ removal
- Dehydration
- Mercury & H₂S removal

Refrigeration

Liquefaction

Storage & Loading

Transportation & Marketing
Calorific Value = $MJ/m^3$

- The CV of natural gas is measured continually using process gas chromatographs.
- Process gas chromatographs separate natural gas into its constituent compounds (i.e. methane, ethane, carbon dioxide, etc.) and measure the amount of each in the gas. The physical characteristics of each component, as defined by ISO 6976, are programmed into the chromatograph and an overall CV is derived from the measured composition.
- The determination of the CV of gas is carried out in accordance with international standards.
- The calorific value of natural gas is measured at reception terminals.
- All domestic customers and most industrial customers are billed on the basis of the daily CV averages.
EZReporter for calorific value calculations

- Option number G3582A#105
- External software compatible with Agilent CDS
- Key parameters available:
  - In printed format
  - As an export
  - For monitoring incl min/max values
  - For trend analysis

<table>
<thead>
<tr>
<th>Product description</th>
<th>Compatible with</th>
<th>Supported standards</th>
</tr>
</thead>
</table>
| EZReporter for calorific value / BTU calculations | Agilent EZChrom 3.3.2., Agilent OpenLAB CDS EZChrom Edition and Agilent OpenLAB CDS ChemStation Edition | GPA 2172-09  
ASTM D 3588-98 (2003)  
ISO 6976 (1995)  |
## Natural Gas Analyzer portfolio

<table>
<thead>
<tr>
<th>Analyzer characteristics</th>
<th>Natural Gas Analyzer A</th>
<th>Natural Gas Analyzer A Extended</th>
<th>Natural Gas Analyzer B</th>
<th>Natural Gas Analyzer B Extended</th>
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</thead>
<tbody>
<tr>
<td>Option number</td>
<td>G3882A#120</td>
<td>G3882A#121</td>
<td>G3882A#122</td>
<td>G3882A#123</td>
</tr>
<tr>
<td>Micro GC cabinet</td>
<td>Dual with 2 channels</td>
<td>Quad with 3 channels</td>
<td>Dual with 2 channels</td>
<td>Quad with 3 channels</td>
</tr>
<tr>
<td>Column channels installed</td>
<td>HayeSep A 40 cm, without back flush</td>
<td>HayeSep A 40 cm, with back flush</td>
<td>PoraPLOT U 10 m, with backflush</td>
<td>CP-MolSieve 5A 10 m, with backflush and retention time stability option</td>
</tr>
<tr>
<td></td>
<td>CP-Sil 5 CB 6 m, without back flush</td>
<td>CP-Sil 5 CB 4 m, with back flush</td>
<td>CP-Sil 5 CB 6 m, without back flush</td>
<td>PoraPLOT U 10 m, with backflush</td>
</tr>
<tr>
<td></td>
<td>CP-Sil 5 CB 8 m, without back flush</td>
<td>CP-Sil 5 CB 8 m, without back flush</td>
<td>CP-Sil 5 CB 6 m, without back flush</td>
<td>CP-Sil 5 CB 6 m, without back flush</td>
</tr>
<tr>
<td>Analysis</td>
<td>Hydrocarbons C1-C9</td>
<td>Hydrocarbons C1-C12</td>
<td>Hydrocarbons C1-C9</td>
<td>Hydrocarbons C1-C9</td>
</tr>
<tr>
<td></td>
<td>Carbon dioxide, Air</td>
<td>Carbon dioxide, Air</td>
<td>Carbon dioxide, Air</td>
<td>Carbon dioxide, Air</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrogen sulfide</td>
<td>Hydrogen sulfide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Permanent gases (N₂, O₂, He &amp; H₂)</td>
</tr>
<tr>
<td>Typical analysis time</td>
<td>100 s (until C7)</td>
<td>100 s (until C7)</td>
<td>75 s (until C7)</td>
<td>75 s (until C7)</td>
</tr>
<tr>
<td></td>
<td>400 s (until C9)</td>
<td>240 s (until C12)</td>
<td>400 s (until C9)</td>
<td>400 s (until C9)</td>
</tr>
</tbody>
</table>
Natural Gas Analyzer B

- **Natural gas**: composition primarily CH₄, Air, CO₂, C2 – C9 hydrocarbons
- Dual channel cabinet with 2 column channels
- Heated sample line and injectors

- PPU equipped with Backflush functionality
- UltiMetal treated sample lines: ready for H2S analysis
- Part number **G3582A + G3582A#122**
Natural Gas Analyzer B

6 m CP-Sil 5 CB

Conditions
Column temperature 70 °C
Carrier gas helium, 150 kPa
Injection time 40 ms

Peak identification
1. propane
2. i-butane
3. n-butane
4. neo-pentane
5. i-pentane
6. n-pentane
7. n-hexane
8. n-heptane
9. n-octane

Peak identification
9. n-octane
10. n-nonane
Natural Gas Analyzer B Extended

- Natural gas with detailed Permanent Gas Analysis
- Quad channel cabinet with 3 column channels
- Channel 1 & 2 identical to Natural Gas Analyzer B (#122)
- Separate carrier gas inlet to have the flexibility to change between helium and argon
- Part number G3582A + G3582A#123

Sample 1
Helium carrier gas

Conditions
- Column temperature: 80 °C
- Carrier gas: helium, 200 kPa
- Injection time: 40 ms
- Backflush time: 11 s

Sample 2
Argon carrier gas

Conditions
- Column temperature: 80 °C
- Carrier gas: argon, 200 kPa
- Injection time: 40 ms
- Backflush time: 11 s

Peak identification
1. helium
2. neon
3. hydrogen
4. oxygen
5. nitrogen
6. methane
Phase 3 - Transportation

Explore
- Mud Logging
- Composition
- Clean-up

Pipeline
- Clean-up Verification
- Calorific Value

Transport
- Vessel Testing
- Liquefaction
- Regasification

Distribute
- Blending
- Odorant Addition
- Calorific Value

Measure 2 Mitigate
Phase 3 - Transportation

- Explore
  - Mud Logging
  - Composition
  - Clean-up

- Pipeline
  - Clean-up Verification
  - Calorific Value

- Transport
  - Vessel Testing
  - Liquefaction
  - Regasification

- Distribute
  - Blending
  - Odorant Addition
  - Calorific Value
Vessel

Transportation

Treatment

Condensate removal
Dehydration
CO₂ removal
Mercury & H₂S removal

Refrigeration
Liquefaction
Storage & Loading
Transportation & Marketing
Where are the vessels coming from and going to?
Gas composition analysis during tank loading

- Tank flushed with nitrogen
- Gaseous compounds loaded (heavier than nitrogen, sinks to the bottom)
- Micro GC analysis to check tank is 100% filled
- Tank chilled and filled with liquefied compound

- Samples from three stages in the tank are taken with 10 ml gas tight
- Injection on the (optional) luer-lock front inlet
- Micro GC equipped with portable field case

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Gas composition analysis during tank loading

PoraPLOT U, 10m

1,3-butadiene

Calibration gas
Sample from top level of the tank

nitrogen
impurity

0 30 60 90 120
Seconds
Phase 4 - Delivery

Explore
- Mud Logging
- Composition
- Clean-up

Measure Mitigate

Pipeline
- Clean-up Verification
- Calorific Value

Transport
- Vessel Testing
- Liquefaction
- Regasification

Distribute
- Blending
- Odorant Addition
- Calorific Value
On its way out of the terminal, the gas undergoes any number of treatment processes needed to bring its specifications in line with regulatory and end user requirements.

Its heating value, for example, may be adjusted by altering nitrogen, butane or propane content or blending it with other gases.
Natural Gas: \textit{THT (odorant)}

![Graph showing THT (Tetrahydrothiophene) in natural gas. The x-axis represents time in seconds (Sec), ranging from 0 to 90. There are multiple peaks indicating the presence of THT.](image-url)
Natural Gas: **THT** (odorant)

- **Column:** CP-Sil 19 CB for THT
- **Temperature:** 90°C
- **Carrier gas:** Helium, 200 kPa

![Graph showing natural gas matrix with peaks labeled Tetrahydrothiophene (THT) and Nonane](image-url)
Natural Gas: MES

Column: MES in Nat Gas
Temperature: 90°C
Carrier gas: Helium, 70 kPa

Matrix
n-Decane
Methyl Ethyl Sulfide (MES)

Seconds

60  90  120

Agilent Technologies
Natural Gas: *Tert-Butyl Mercaptan (TBM)*

- Column: CP-Sil 13 CB for TBM
- Temperature: 40°C
- Carrier gas: Helium, 250 kPa
The 490-PRO Micro GC provides outstanding accuracy and longevity, requiring no maintenance over long periods of time. Two Micro GC’s, installed by QC LAB in 1994, are still functioning and providing over 450 analyses per day, without any repair or loss of service.

Serge Syz, QC LAB Inc, Calgary, Canada

Liquefied ethane stream

PoraPLOT Q Channel

Single analysis for:
- Composition analysis
- Trace levels of H2S for pipeline corrosion
- Trace levels methanol for catalyst protection
- Auto ranging micro TCD → high and low levels in single run

“The 490-PRO Micro GC provides outstanding accuracy and longevity, requiring no maintenance over long periods of time. Two Micro GC’s, installed by QC LAB in 1994, are still functioning and providing over 450 analyses per day, without any repair or loss of service.”

Serge Syz, QC LAB Inc, Calgary, Canada
Versatility of Multi-Channel Simultaneous Analysis

CP-PoraPLOT U

- Separate ethane, ethylene and acetylene
- Propane and propylene will co elute

CP-PoraPLOT Q

- Propane and propylene separated
- Co elution of ethylene and acetylene

Array of chemistry to fit unique application
Advantages of Using a Micro GC in the Nat Gas Market

• Micro GCs offer unprecedented speed
• Micro GCs can be deployed throughout the entire process
• Micro GCs are flexible and can be ‘fit for purpose’
• Data is used for both compliance and control
• The data is actionable AND defendable
Unique Features of a Micro GC

MICRO EGC → CHIP INJECTOR → GC COLUMN → MICRO TCD
Flexibility is Essential
<table>
<thead>
<tr>
<th>Column short name</th>
<th>Column type</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS5A</td>
<td>CP-MolSieve 5Å</td>
<td>Permanent gases (N₂ / O₂ separation), methane, CO, (20m required for O₂ / Ar baseline separation). Natural gas and Biogas analysis.</td>
</tr>
<tr>
<td>HSA</td>
<td>Hayesep A</td>
<td>Hydrocarbons C1-C3, N₂, CO₂, air, volatile solvents, Natural gas analysis.</td>
</tr>
<tr>
<td>5CB</td>
<td>CP-Sil 5 CB</td>
<td>Hydrocarbons C3-C10, aromatics, organic solvents, SO₂. Natural gas analysis.</td>
</tr>
<tr>
<td>19CB</td>
<td>CP-Sil 19 CB</td>
<td>Hydrocarbons C4-C10, volatile solvents, BTEX.</td>
</tr>
<tr>
<td>52CB</td>
<td>CP-Wax 52 CB</td>
<td>Polar volatile solvents, BTEX.</td>
</tr>
<tr>
<td>AlOx</td>
<td>CP-Al₂O₃</td>
<td>Light hydrocarbons C1-C5 saturated and un-saturated. Refinery gas analysis.</td>
</tr>
<tr>
<td>PPQ</td>
<td>PoraPLOT Q</td>
<td>Hydrocarbons C1-C6, halocarbons/freons, anesthesia gases, H₂S, CO₂, volatile solvents. Separation propylene and propane, coelution of ethylene and acetylene.</td>
</tr>
<tr>
<td>COX</td>
<td>CP-COX</td>
<td>CO, CO₂, H₂, Air (coelution of N₂ and O₂), CH₄.</td>
</tr>
<tr>
<td>19CB THT</td>
<td>CP-Sil 19 CB for THT</td>
<td>THT and C3-C₆⁺ in Natural gas.</td>
</tr>
<tr>
<td>13CB TBM</td>
<td>CP-Sil 13 CB TBM</td>
<td>TBM and C3-C₆⁻ in Natural gas.</td>
</tr>
<tr>
<td>MES NGA</td>
<td>MES for NGA</td>
<td>MES in Natural gas.</td>
</tr>
</tbody>
</table>
We stand ready!