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Analyzer Solutions Guide  
for the Energy and Chemical Industry

**GENERATE ACCURATE, RELIABLE DATA  
TO ENSURE QUALITY AND PRODUCTIVITY**



# IMPLEMENT NEW GC TECHNOLOGIES WHEN YOUR COMPANY IS READY FOR THEM

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*\*This guide reports typical quantitation limits for each system configuration. These values may differ from the absolute reporting limit required by the method.*

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# ANALYZER BY REFERENCE

## Refinery Gas

| Analyzer Model  | Description  | Configured per Published Method(s) |
|-----------------|--|------------------------------------|
| G3445 #521      | 3-Channel fast refinery gas analyzer   | ASTM D1945, ASTM D1946, UOP 539    |
| G3445 #522      | 3-Channel fast refinery gas analyzer—H <sub>2</sub> S and COS  | ASTM D1945, ASTM D1946, UOP 539    |
| G3445 #523      | Extended refinery gas analyzer   |                                    |
| G3445 #524      | Refinery gas analyzer with nickel columns  | ASTM D1945, ASTM D1946, UOP 539    |
| G3445 #526      | Refinery gas analyzer  | ASTM D1945, ASTM D1946, UOP 539    |
| G3445 #529      | 3-Channel fast refinery gas including H <sub>2</sub> S and O <sub>c</sub>  | ASTM D1945, ASTM D1946             |
| G3445 #530      | Refinery gas analyzer with H <sub>2</sub> S and oxygen using hydrogen as a carrier gas                                 | ASTM D1945, ASTM D1946, UOP 539    |
| G3445 #531      | High capacity refinery gas analyzer (RGA) with large valve oven and helium carrier gas for hydrogen sulfide and oxygen | ASTM D1945, ASTM D1946, UOP 539    |
| G3445 #532      | Fast refinery gas analyzer with large valve oven (LVO) and micropacked columns   | UOP 539                            |
| G3445 #533      | Refinery gas analyzer with large valve oven (LVO) and hydrogen carrier gas for oxygen and H <sub>2</sub> S             | UOP 539                            |
| Contact Agilent | Refinery gas analyzer: 4-channel Micro GC  | ASTM D2163, DIN-51666, UOP 59      |

## Natural Gas

| Analyzer Model | Description   | Configured per Published Method(s)  |
|----------------|---|---|
| G3445 #541     | Extended natural gas analyzer to C-12                                     | GPA 2286 (calculation without bridge compounds iC <sub>5</sub> and nC <sub>5</sub> )                    |
| G3445 #542     | Natural gas analyzer  | ASTM D1945, GPA 2261 (H <sub>2</sub> and He not included)   |
| G3445 #543     | Natural gas analyzer  | ASTM D1945, GPA 2261  |
| G3445 #544     | Natural gas analyzer  | ASTM D1945, GPA 2261  |
| G3445 #545     | Natural gas analyzer  | GPA 2261 (H <sub>2</sub> and He not included, without separation of O <sub>2</sub> and N <sub>2</sub> ) |
| G3445 #547     | 3-Channel natural gas analyzer with extended HC analysis                  | ASTM D1945, GPA 2261  |
| G3445 #548     | Extended natural gas analyzer   | GPA 2286 (calculation with bridge compounds iC <sub>5</sub> and nC <sub>5</sub> )                       |
| G3582A #120    | Natural gas analyzer A: 2-channel Micro GC                                | ASTM D3588-98, GPA 2172, GPA 2177, ISO 6974-6   |
| G3582A #121    | Natural gas analyzer A extended: 3-channel Micro GC                       | ASTM D3588-98, GPA 2172, GPA 2177, ISO 6974-6   |
| G3582A #122    | Natural gas analyzer B with H <sub>2</sub> S: 2-channel Micro GC          | ASTM D3588-98, GPA 2172, GPA 2177, ISO 6974-6   |
| G3582A #123    | Natural gas analyzer B extended with H <sub>2</sub> S: 3-channel Micro GC | ASTM D1945, ASTM D3588-98, GPA 2172, GPA 2177, ISO 6974-6   |
| 7890-0110      | Liquefied natural gas analyzer  | GPA 2177  |
| 7890-0610      | Natural gas analyzer: permanent gases and hydrocarbons                    |   |
| 7890-0611      | Natural gas analyzer: permanent gas and extended hydrocarbons             |   |

## Reformulated Fuel

| Analyzer Model | Description   | Configured per Published Method(s) |
|----------------|---|------------------------------------|
| G3445 #611     | Single channel oxygenates and aromatics in fuel analyzer                | ASTM D4815, ASTM D5580             |
| G3445 #612     | Dual parallel channel oxygenates and aromatics in fuel analyzer         | ASTM D4815, ASTM D5580             |
| G3445 #615     | Benzene in gasoline analyzer  | ASTM D3606                         |
| G3445 #616     | Aromatics in fuel analyzer  | ASTM D5580                         |
| G3445 #617     | Oxygenates and aromatics in gasoline by Deans Switch analyzer           | EN 12177, EN 13132                 |
| G3445 #618     | Low level oxygenates in light hydrocarbons by capillary flow technology | ASTM D7423                         |
| G3445 #621     | 3-in-1 reformulated fuel analyzer with large valve oven                 | ASTM D3606, ASTM D4815, ASTM D5580 |
| 7890-0340      | Trace oxygenates in gasoline analyzer                                   | ASTM D7754                         |

## Biodiesel/Renewable Fuel

| Analyzer Model | Description   | Configured per Published Method(s) |
|----------------|---|------------------------------------|
| G3445 #631     | Glycerin in biodiesel analyzer                                  | ASTM D6584                         |
| G3445 #633     | FAME content in biodiesel analyzer                              | EN 14103:2011                      |
| G3445 #634     | Biodiesel analyzer  | EN 14105:2011                      |
| G3582A #110    | Biogas analyzer: 2-channel Micro GC                             |                                    |
| G3582A #111    | Biogas analyzer: 3-channel Micro GC                             |                                    |
| 7890-0295      | Biodiesel analyzer for EN 14110:2003 methanol content by HSS-GC | EN 14100:2003                      |
| M7482A         | FAMES in Jet Fuel Analyzer                                      | IP 585                             |

## Liquefied Petroleum Gas (LPG)

| Analyzer Model  | Description                                   | Configured per Published Method(s)             |
|-----------------|---|--|
| 7890-0138       | LPG composition analyzer with alumina column  | ASTM D2163, ASTM D2593, ASTM D2712, ASTM D4424 |
| 7890-0188       | Commercial propane and butane LPG analyzer    | ISO 7941, EN 27941, and IP 405                 |
| 7890-0397       | Hydrocarbons in liquefied petroleum gases     | ASTM D2163                                     |
| Contact Agilent | Ethane composition and impurities by Micro GC |  |
| Contact Agilent | Propane and butane streams by Micro GC        |  |

## Trace Impurities

| Analyzer Model     | Description  | Configured per Published Method(s) |
|--------------------|--|------------------------------------|
| G3445 #646         | Low CO and CO <sub>2</sub> in process gases containing high CH <sub>4</sub> analyzer |                                    |
| G3445 #647         | Low CO and CO <sub>2</sub> in process gas analyzer                                   |                                    |
| 7890-0191          | 2-channel inert impurities in pure chlorine analyzer                                 |                                    |
| 7890-0237          | Impurities in monomers analyzer by PDHID   |                                    |
| 7890-0355          | Low CO and CO <sub>2</sub> in process gases with nickel catalyst (methanizer) bypass |                                    |
| 7890-0366          | Trace CO and CO <sub>2</sub> in hydrogen and light gaseous hydrocarbon analyzer      | UOP 603                            |
| 7890-0409          | Impurities in ethylene/propylene analyzer by PDHID                                   |                                    |
| M7484AA or M7474AA | Impurities in ethylene/propylene by GC/MS  |                                    |



## Simulated Distillation

| Analyzer Model | Description  | Configured per Published Method(s) |
|----------------|--|------------------------------------|
| G3440 #653     | Simulated distillation analyzer, boiling range from 55 °C to 538 °C  | ASTM D2887                         |
| G3445 #654     | Simulated distillation analyzer, boiling range from 100 °C to 615 °C | ASTM D7213 (D2887 extended)        |
| G3445 #655     | Simulated distillation analyzer, boiling range from 174 °C to 700 °C | ASTM D6352                         |

## Sulfur and Nitrosamine

| Analyzer Model | Description  | Configured per Published Method(s) |
|----------------|--|------------------------------------|
| G3445 #661     | Sulfur in natural gas/fuel gas analyzer by sulfur chemiluminescence detector   | ASTM D5504                         |
| G3445 #662     | Sulfur in fuel/petroleum liquids analyzer by sulfur chemiluminescence detector | ASTM D5623, UOP 791                |
| 7890-0167      | Volatile sulfur analysis   | ASTM D6228                         |
| 7890-0460      | Nitrosamine in liquids analyzer by nitrogen chemiluminescence detector         |                                    |

## Transformer Oil Gas

| Analyzer Model | Description  | Configured per Published Method(s)      |
|----------------|--|---|
| G3445 #571     | Transformer oil gas analyzer (TOGA)  | ASTM D3612 Method C, headspace sampling |
| 7890-0552      | Transformer oil gas analyzer (TOGA) with C <sub>4</sub> + backflush and NiCat bypass | ASTM D3612 Method C, headspace sampling |

## Greenhouse Gas

| Analyzer Model | Description  | Configured per Published Method(s) |
|----------------|--|------------------------------------|
| G3445 #561     | Greenhouse gas analyzer, headspace sampler optional, CO 0.4 ppm—0.2% |                                    |
| G3445 #562     | Greenhouse gas analyzer, CO <sub>2</sub> 0.4 ppm—20%                 |                                    |
| G3445 #563     | Greenhouse gas analyzer with headspace sampler, CO 0.4 ppm—0.2%      |                                    |

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# ANALYZER BY COMPLIANCE METHOD

## ASTM Method Configurations

| ASTM D1945   | Analyzer Number |
|--|-----------------|
| 3-Channel fast refinery gas analyzer   | G3445 #521      |
| 3-Channel fast refinery gas analyzer—H <sub>2</sub> S and COS                                | G3445 #522      |
| Refinery gas analyzer with nickel columns  | G3445 #524      |
| Refinery gas analyzer  | G3445 #526      |
| 3-Channel fast refinery gas including H <sub>2</sub> S and O <sub>2</sub> with external oven | G3445 #529      |
| Refinery gas analyzer with H <sub>2</sub> S and O <sub>2</sub> using hydrogen carrier gas    | G3445 #530      |
| High capacity refinery gas analyzer  | G3445 #531      |
| Natural gas analyzer   | G3445 #542      |
| Natural gas analyzer   | G3445 #543      |
| Natural gas analyzer   | G3445 #544      |
| 3-Channel natural gas analyzer with extended HC analysis                                     | G3445 #547      |
| Natural gas analyzer B with H <sub>2</sub> S: 3-channel Micro GC                             | G3582A #123     |
| ASTM D1946   | Analyzer Number |
| 3-Channel fast refinery gas analyzer   | G3445 #521      |
| 3-Channel fast refinery gas analyzer—H <sub>2</sub> S and COS                                | G3445 #522      |
| Refinery gas analyzer with nickel columns  | G3445 #524      |
| Refinery gas analyzer  | G3445 #526      |
| 3-Channel fast refinery gas including H <sub>2</sub> S and O <sub>2</sub> with external oven | G3445 #529      |
| Refinery gas analyzer with H <sub>2</sub> S and O <sub>2</sub> using hydrogen carrier gas    | G3445 #530      |
| High capacity refinery gas analyzer  | G3445 #531      |
| ASTM D2163   | Analyzer Number |
| LPG composition analyzer   | 7890-0138       |
| Commercial propane and butane LPG analyzer   | 7890-0188       |
| Hydrocarbons in LPG analyzer   | 7890-0397       |
| Refinery gas analyzer: 4-channel Micro GC  | Contact Agilent |
| ASTM D2287   | Analyzer Number |
| Simulated distillation analyzer  | G3445 #653      |

| ASTM D3588-98   | Analyzer Number |
|---|-----------------|
| Natural gas analyzer A: 2-channel Micro GC                                | G3582A #120     |
| Natural gas analyzer A extended: 3-channel Micro GC                       | G3582A #121     |
| Natural gas analyzer B with H <sub>2</sub> S: 2-channel Micro GC          | G3582A #122     |
| Natural gas analyzer B extended with H <sub>2</sub> S: 3-channel Micro GC | G3582A #123     |
| ASTM D3606  | Analyzer Number |
| Benzene in gasoline analyzer  | G3445 #615      |
| 3-in-1 reformulated fuel analyzer   | G3445 #621      |
| ASTM D3612-C  | Analyzer Number |
| Transformer oil gas analyzer  | G3445 #571      |
| ASTM D4815  | Analyzer Number |
| Single channel oxygenates and aromatics in fuel analyzer                  | G3445 #611      |
| Dual parallel channel oxygenates and aromatics in fuel analyzer           | G3445 #612      |
| 3-in-1 reformulated fuel analyzer   | G3445 #621      |
| ASTM D5504  | Analyzer Number |
| Sulfur analyzer by SCD  | G3445 #661      |
| ASTM D5580  | Analyzer Number |
| Single channel oxygenates and aromatics in fuel analyzer                  | G3445 #611      |
| Dual parallel channel oxygenates and aromatics in fuel analyzer           | G3445 #612      |
| Aromatics in fuel analyzer  | G3445 #616      |
| 3-in-1 reformulated fuel analyzer   | G3445 #621      |
| ASTM D5623  | Analyzer Number |
| Sulfur analyzer by SCD  | G3445 #662      |
| ASTM D6228  | Analyzer Number |
| Volatile sulfur analyzer  | 7890-0167       |
| ASTM D6352  | Analyzer Number |
| Simulated distillation analyzer   | G3445 #655      |



## ASTM Method Configurations

| ASTM D6584   | Analyzer Number |
|--|-----------------|
| Glycerin in biodiesel analyzer   | G3445 #631      |
| ASTM D7423   | Analyzer Number |
| Simulated distillation analyzer  | G3445 #654      |
| ASTM D7213   | Analyzer Number |
| Low level oxygenates in light hydrocarbons analyzer with capillary flow technology (CFT) | G3445 #618      |
| ASTM D7754   | Analyzer Number |
| Trace oxygenates in gasoline analyzer  | 7890-0340       |

## DIN Method Configurations

| DIN 51666                                 | Analyzer Number |
|---|-----------------|
| Refinery gas analyzer: 4-channel Micro GC | Contact Agilent |

## EN Method Configurations

| EN 12177                                      | Analyzer Number |
|---|-----------------|
| Oxygenates and aromatics in gasoline analyzer | G3445 #617      |
| EN 13132                                      | Analyzer Number |
| Oxygenates and aromatics in gasoline analyzer | G3445 #617      |
| EN 14103:2011                                 | Analyzer Number |
| FAME content in biodiesel analyzer            | G3445 #633      |
| EN 14105:2011                                 | Analyzer Number |
| Biodiesel analyzer                            | G3445 #634      |
| EN 14110:2003                                 | Analyzer Number |
| Methanol in biodiesel analyzer                | 7890-0295       |
| EN 27941                                      | Analyzer Number |
| Commercial propane and butane analyzer        | 7890-0188       |

## GPA Method Configurations

| GPA 2172                                   | Analyzer Number |
|--|-----------------|
| Natural gas analyzer A: 2-channel Micro GC | G3582A #120     |
| Natural gas analyzer A: 3-channel Micro GC | G3582A #121     |
| Natural gas analyzer B: 2-channel Micro GC | G3582A #122     |
| Natural gas analyzer B: 3-channel Micro GC | G3582A #123     |
| GPA 2177                                   | Analyzer Number |
| Liquefied natural gas analyzer             | 7890-0110       |
| Natural gas analyzer A: 2-channel Micro GC | G3582A #120     |
| Natural gas analyzer A: 3-channel Micro GC | G3582A #121     |
| Natural gas analyzer B: 2-channel Micro GC | G3582A #122     |
| Natural gas analyzer B: 3-channel Micro GC | G3582A #123     |
| GPA 2261                                   | Analyzer Number |
| Natural gas analyzer                       | G3445 #542      |
| Natural gas analyzer                       | G3445 #543      |
| Natural gas analyzer                       | G3445 #544      |
| Natural gas analyzer                       | G3445 #545      |
| Natural gas analyzer B: 3-channel Micro GC | G3582A #123     |
| GPA 2286                                   | Analyzer Number |
| Extended natural gas analyzer              | G3445 #541      |
| Extended natural gas analyzer              | G3445 #548      |

## IP Method Configurations

| IP 405                                 | Analyzer Number |
|--|-----------------|
| Commercial propane and butane analyzer | 7890-0188       |
| IP 585                                 | Analyzer Number |
| Jet Fuel Analyzer                      | M7482A          |

## ISO Method Configurations

| ISO 6974-6                                 | Analyzer Number |
|--|-----------------|
| Natural gas analyzer A: 2-channel Micro GC | G3582A #120     |
| Natural gas analyzer A: 3-channel Micro GC | G3582A #121     |
| Natural gas analyzer B: 2-channel Micro GC | G3582A #122     |
| Natural gas analyzer B: 3-channel Micro GC | G3582A #123     |
| ISO 7941                                   | Analyzer Number |
| Commercial propane and butane analyzer     | 7890-0188       |

## UOP Method Configurations

| UOP 539   | Analyzer Number |
|---|-----------------|
| 3-Channel fast refinery gas analyzer  | G3445 #521      |
| 3-Channel fast refinery gas analyzer—H <sub>2</sub> S and COS   | G3445 #522      |
| Refinery gas analyzer with nickel columns   | G3445 #524      |
| Refinery gas analyzer   | G3445 #526      |
| 3-Channel fast refinery gas analyzer including H <sub>2</sub> S and O <sub>2</sub> with external oven | G3445 #529      |
| Refinery gas analyzer with H <sub>2</sub> S and O <sub>2</sub> using hydrogen carrier gas             | G3445 #530      |
| High capacity refinery gas analyzer with H <sub>2</sub> S and O <sub>2</sub> using helium carrier gas | G3445 #531      |
| Fast refinery gas analyzer with micropacked columns   | G3445 #532      |
| Refinery gas analyzer with H <sub>2</sub> S and O <sub>2</sub> using hydrogen carrier gas             | G3445 #533      |
| UOP 603   | Analyzer Number |
| Trace CO and CO <sub>2</sub> in hydrogen and light hydrocarbons analyzer                              | 7890-0366       |
| UOP 59  | Analyzer Number |
| Refinery gas analyzer: 4-channel Micro GC   | Contact Agilent |

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# SOLUTIONS FOR REFINERY GAS



## Apply the latest GC technologies without disrupting your application workflow

Refineries use distillation and chemical reactions to convert crude oil into fuel, lubricants, and feedstock for downstream processes. In recent years, supply-related performance requirements, together with environmental regulations for emissions and fuel composition, have rapidly driven new plant designs, as well as upgrades to existing refineries.

The composition of refinery gases, which arise from cracking and subsequent distillation, depends on their generating source. Typically, refinery gases contain saturated and unsaturated hydrocarbons ( $C_1$ - $C_5$ ),  $H_2$ ,  $O_2$ ,  $N_2$ ,  $CO$ , and  $CO_2$ . In some instances,  $C_6$  or higher hydrocarbons and sulfur contaminants such as  $H_2S$  may also be present.

Confidently and precisely analyzing refinery gases is challenging, because the source and composition of each gas varies considerably. To succeed, refinery gas analyzers must be able to quickly separate complex mixtures from a broad range of samples found in refinery and petrochemical streams.

**Agilent Refinery Gas Analyzers** are *complete workflow solutions* that put the latest advances in reproducibility, speed, resolution, and retention into your hands without the hassles of setup, method development, and validation. Each arrives fully pre-configured and tested for applications such as fast and extended refinery gas analysis (RGA) of permanent gases, hydrocarbon content determination ( $C_1$ - $C_5$  with  $C_{6+}$  as backflush), and the extended analysis of hydrocarbons in natural gas to  $C_{14}$ .

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## Solutions for Refinery Gas

| Analyzer Number                           | Extended Hydrocarbon Analysis to C <sub>12</sub> / C <sub>14</sub> | Full-range Capacity for H <sub>2</sub> | Separates Air (O <sub>2</sub> and N <sub>2</sub> ) | High Level of H <sub>2</sub> S | Handles Liquefied Samples |
|---|--|--|--|--------------------------------|---------------------------|
| G3445 #521                                | Yes  | No                                     | Yes  | No                             | No                        |
| G3445 #522                                | Yes  | No                                     | Yes  | Yes                            | No                        |
| G3445 #523                                | No   | Yes                                    | Yes  | No                             | No                        |
| G3445 #524                                | No   | No                                     | Yes  | Yes                            | No                        |
| G3445 #526                                | No   | No                                     | Yes  | No                             | No                        |
| G3445 #529                                | Yes  | No                                     | Yes  | No                             | No                        |
| G3445 #530                                | No   | Yes                                    | Yes  | No                             | No                        |
| G3445 #531                                | No   | Yes                                    | Yes  | Yes                            | No                        |
| G3445 #532                                | No   | Yes                                    | Yes  | No                             | No                        |
| G3445 #533                                | No   | Yes                                    | Yes  | No                             | No                        |
| Contact Agilent for configuration details | Yes  | No                                     | Yes  | Yes                            | Yes                       |

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## Reference Methods for Refinery Gas: Quantitation Ranges for Compounds of Interest

| Compound                         | ASTM D1945<br>mol % | ASTM D1946<br>mol % | ASTM D2163<br>mol % | UOP 539<br>mol % | GPA 2186     | GPA 2286     | ISO 6974-6    |
|----------------------------------|---------------------|---------------------|---------------------|------------------|--------------|--------------|---------------|
| H <sub>2</sub> S                 | 0.3 to 30           |                     | –                   | 0.1 to 25        | –            | 0.1 to 100   | –             |
| O <sub>2</sub>                   | 0.01 to 20          |                     | –                   | 0.1 to 99.9      | –            | 0.005 to 20  | 0.007 to 5    |
| N <sub>2</sub>                   | 0.01 to 100         | –                   | –                   |                  | 0.005 to 5   | 0.005 to 100 | 0.007 to 40   |
| CH <sub>4</sub>                  | 0.01 to 100         | –                   | –                   |                  | 0.001 to 5   | 0.001 to 100 | 40 to 100     |
| CO                               |                     | –                   | –                   |                  | –            | –            | 0.001 to 1    |
| CO <sub>2</sub>                  | 0.01 to 20          | –                   | –                   |                  | 0.005 to 5   | 0.005 to 100 | 0.001 to 10   |
| He                               | 0.01 to 10          | –                   | –                   |                  | –            | –            | 0.002 to 0.5  |
| H <sub>2</sub>                   | 0.01 to 10          | –                   | –                   |                  | –            | –            | 0.001 to 0.5  |
| Ethane                           | 0.01 to 100         | –                   | 0.1 and above       | 0.1 to 99.9      | 0.001 to 95  | 0.001 to 100 | 0.002 to 15   |
| Propane                          | 0.01 to 100         | –                   | 0.1 and above       |                  | 0.001 to 100 | 0.001 to 100 | 0.001 to 5    |
| C <sub>4</sub> isomers           | 0.01 to 10          | –                   | 0.1 and above       |                  | 0.001 to 100 | 0.001 to 10  | 0.0001 to 1   |
| C <sub>5</sub> isomers           | 0.01 to 2           | –                   | 0.1 and above       |                  | 0.001 to 50  | 0.001 to 5   | 0.0001 to 0.5 |
| C <sub>6</sub> isomers           | 0.01 to 2           | –                   | –                   | –                | 0.001 to 30  | 0.001 to 5   | 0.0001 to 0.5 |
| C <sub>6+</sub>                  | –                   | –                   | –                   | 0.1 to 99.9      | –            | –            | –             |
| C <sub>7+</sub>                  | 0.01 to 1           | –                   | –                   | –                | 0.001 to 30  | –            | –             |
| C <sub>7</sub> -C <sub>8</sub>   | –                   | –                   | –                   | –                | –            | 0.001 to 2   | 0.0001 to 0.5 |
| C <sub>9</sub>                   | –                   | –                   | –                   | –                | –            | 0.001 to 2   | –             |
| C <sub>10</sub> -C <sub>14</sub> | –                   | –                   | –                   | –                | –            | 0.001 to 1   | –             |

\* This guide reports typical quantitation limits for each system configuration. These values may differ from the absolute reporting limit required by the method.

Note: In the table above the symbol “-” indicates that this parameter was not specified.

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## 3-Channel Fast Refinery Gas Analyzer (G3445 #521)

### Analyzer Description

#### Configuration:

- 5-valve/7-column (capillary and packed), 2-TCD/FID

#### Sample type:

- Refinery gas such as atmospheric overhead, FCC overhead, fuel gas, recycle gas

#### Compounds analyzed:

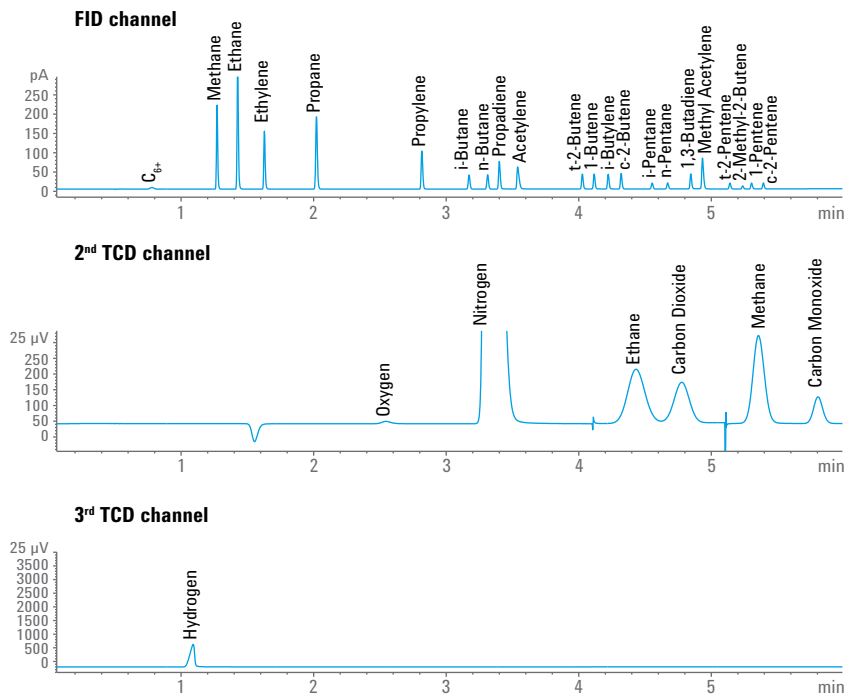
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush, H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO

#### Typical quantification range:

- 0.01 mol% for all above mentioned components

#### Configured per method:

- ASTM D1945, ASTM D1946, UOP 539



### ► KEY BENEFITS AND FEATURES

- Three parallel channels with simultaneous detection for complete refinery gas analysis within 6 minutes
- Optimized columns to allow for faster hydrocarbon and permanent gas analysis using the same oven temperature program
- Full-range capability for H<sub>2</sub> by third TCD using N<sub>2</sub> or Argon carrier gas
- For H<sub>2</sub>S and COS analysis, order G3445A #522

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## 3-Channel Fast Refinery Gas Analyzer— H<sub>2</sub>S and COS (G3445 #522)

### Analyzer Description

#### Configuration:

- 5-valve/7-column (capillary and packed), 2-TCD/FID/nickel tubing, Hastelloy valve

#### Sample type:

- Refinery gas, such as atmospheric overhead, desulfurizer off gas, FCC overhead, fuel gas, recycle gas

#### Compounds analyzed:

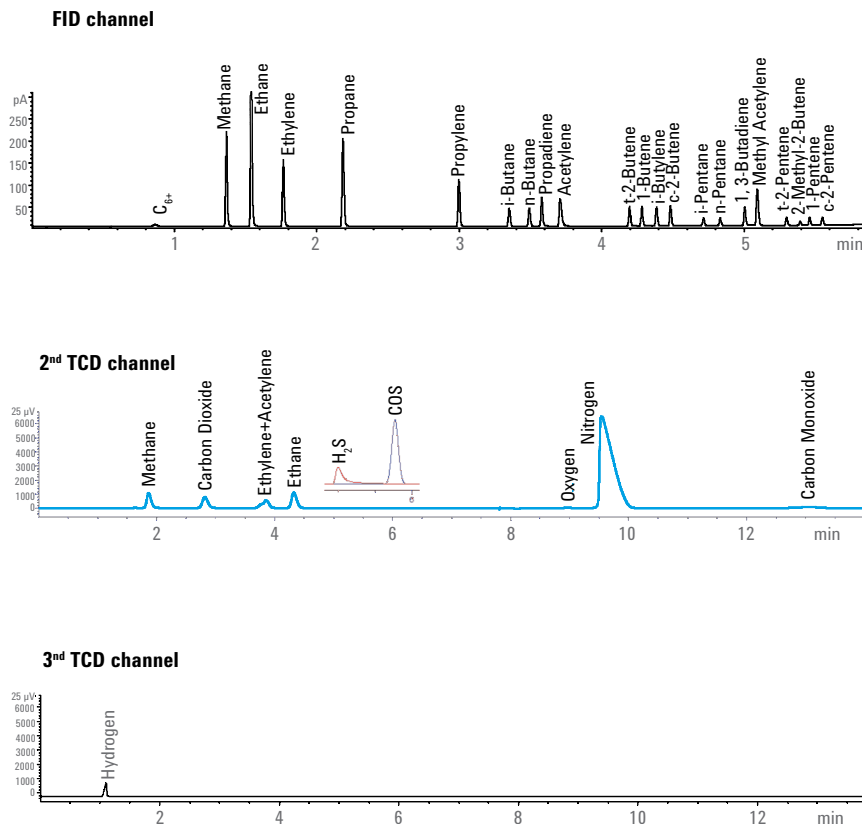
- C<sub>1</sub>-C<sub>5</sub> and C<sub>6+</sub> as backflush, H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO, H<sub>2</sub>S, COS

#### Typical quantification range:

- 0.01 mol% for all above mentioned components except H<sub>2</sub>S and COS
- 500 ppm for H<sub>2</sub>S
- 300 ppm for COS

#### Configured per method:

- ASTM D1945, ASTM D1946, UOP 539



### ► KEY BENEFITS AND FEATURES

- Three parallel channels with simultaneous detection for complete refinery gas analysis within 10 minutes
- Optimized columns to allow faster hydrocarbon and permanent gas analysis using the same oven temperature program
- Full-range capability for H<sub>2</sub> by third TCD using N<sub>2</sub> or Argon carrier gas
- Nickel tubing and Hastelloy valve for high H<sub>2</sub>S and COS analysis
- O<sub>2</sub> may be present but not for quantitation

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## Extended Refinery Gas Analyzer (G3445 #523)

### Analyzer Description

#### Configuration:

- 4-valve/5-column (capillary and packed), TCD/FID

#### Sample type:

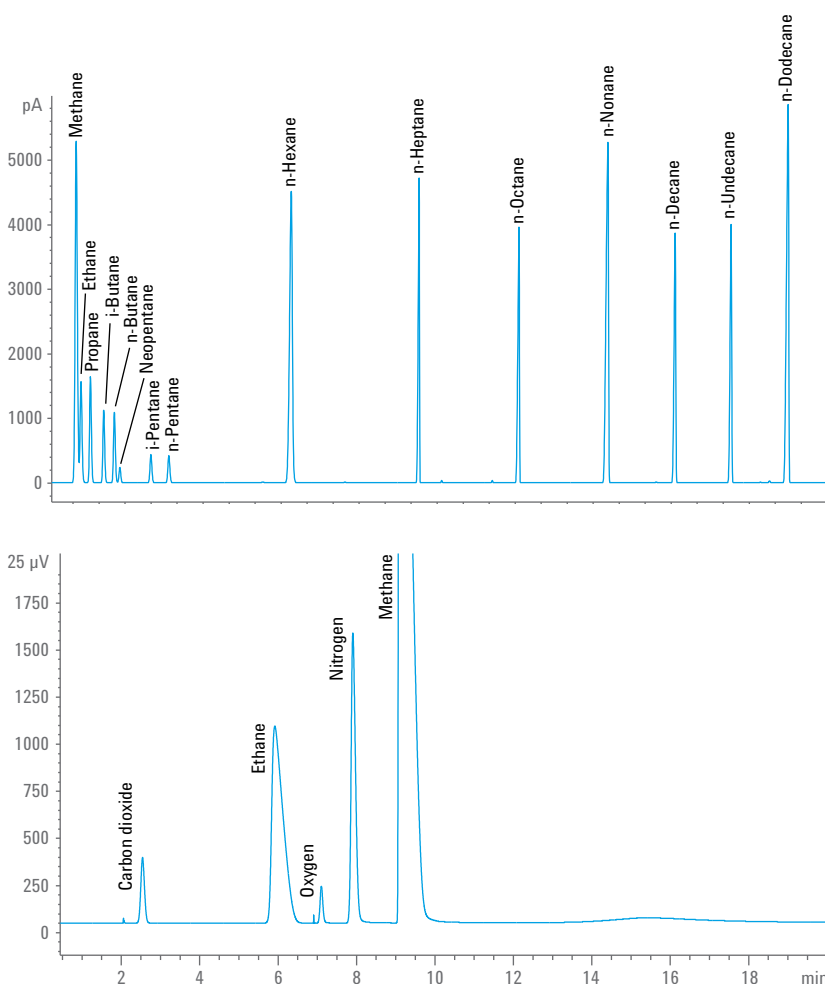
- Refinery gas such as atmospheric overhead, FCC overhead, fuel gas, recycle gas

#### Compounds analyzed:

- C<sub>1</sub>-C<sub>12</sub>, H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, and CO

#### Typical quantification range:

- 0.01 mol% for all components



### ► KEY BENEFITS AND FEATURES

- PONA column provides extended RGA separation to C<sub>14</sub>
- Achieve analysis of H<sub>2</sub> and He by switching carrier gases
- Argon or N<sub>2</sub> carrier used for H<sub>2</sub> analysis, use He carrier for remaining compounds
- For hydrocarbons up to C<sub>12</sub>, approximately 25 minutes analysis time, depends on hydrocarbon range

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# Refinery Gas Analyzer with Nickel Columns (G3445 #524)

## Analyzer Description

### Configuration:

- 4-valve (Hastelloy)/5-column (packed), 2-TCD, plumbed with sulfur-resistant material

### Sample type:

- Refinery gas, such as atmospheric overhead, FCC overhead, fuel gas, recycle gas, sour gas

### Compounds analyzed:

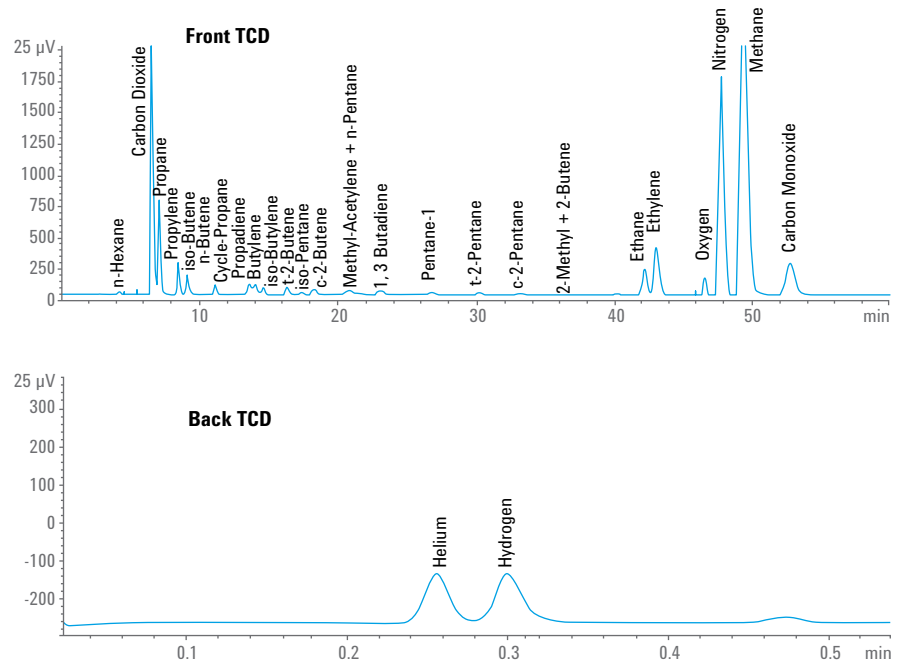
- C<sub>1</sub>-C<sub>5</sub> and C<sub>6+</sub> as backflush, H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO, H<sub>2</sub>S, COS

### Typical quantification range:

- 0.01 mol% for all above mentioned components except H<sub>2</sub>S
- 500 ppm for H<sub>2</sub>S

### Configured per method:

- ASTM D1945, ASTM D1946, GPA 2231



## ► KEY BENEFITS AND FEATURES

- Dual TCD channels
- Plumbed with sulfur-resistant material including nickel columns and plumbing and Hastelloy valves for sour gas analysis
- Rugged packed columns
- Dedicated channel for He and H<sub>2</sub>
- Approximate 20 minute analysis time
- Hardware configuration same as G3445 #526

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# Refinery Gas Analyzer (G3445 #526)

## Analyzer Description

### Configuration:

- 4-valve/5-column (packed), 2-TCD

### Sample type:

- Refinery gas such as atmospheric overhead, FCC overhead, fuel gas, recycle gas

### Compounds analyzed:

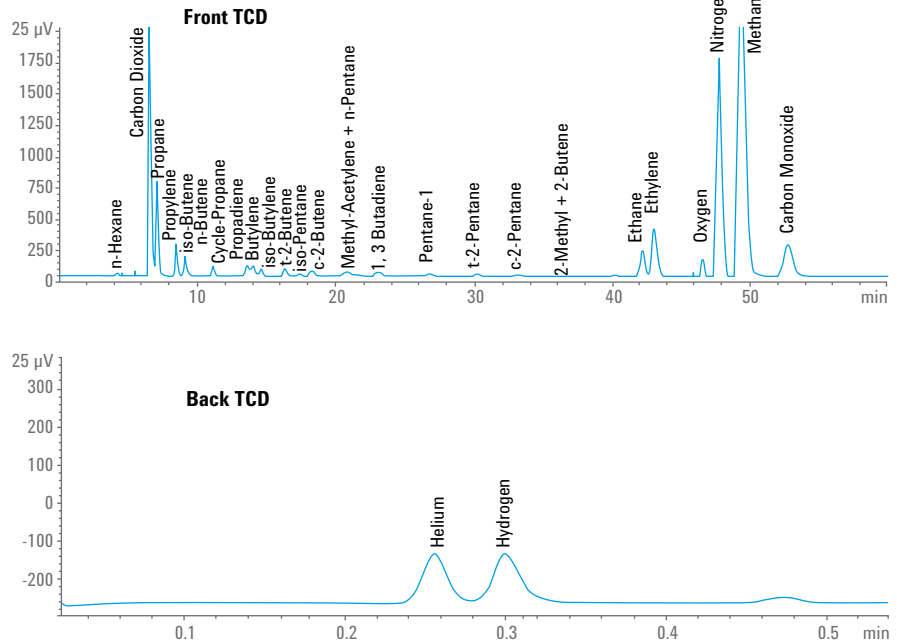
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush, H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO

### Typical quantification range:

- 0.01 mol% for all components

### Configured per method:

- ASTM D1945, ASTM D1946, UOP 539



## ► KEY BENEFITS AND FEATURES

- Dual TCD channels
- Rugged packed columns
- Full-range capability for He and H<sub>2</sub>
- 55 minute analysis time
- To analyze samples containing high levels of H<sub>2</sub>S, please order G3445 #526

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## 3-Channel Fast Refinery Gas Analyzer including H<sub>2</sub>S and O<sub>2</sub> with External Oven (G3445 #529)

### Analyzer Description

#### Configuration:

- 5-valve/1-sample shut-off valve (optional)/external oven/7-column (PLOT, packed, micro-packed), 2-TCD/FID

#### Sample type:

- Refinery gas such as atmospheric overhead, FCC overhead, fuel gas, recycle gas

#### Compounds analyzed:

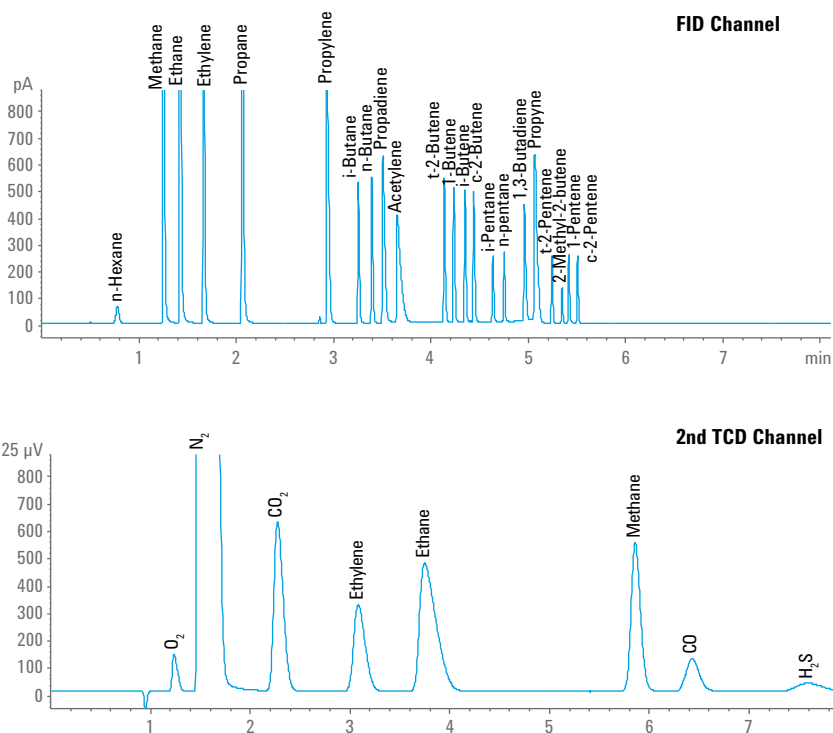
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub>, H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO, H<sub>2</sub>S

#### Typical quantification range:

- 0.01 mol% for all above mentioned components except H<sub>2</sub>S
- 500 ppm for H<sub>2</sub>S

#### Configured per method:

- ASTM D1945, ASTM D1946, UOP 539



### ► KEY BENEFITS AND FEATURES

- Three parallel channels with simultaneous detection provides a comprehensive, fast analysis of refinery gas with one injection in 8 minutes
- External oven is used for permanent gas analysis including H<sub>2</sub>S and O<sub>2</sub> at isothermal temperature
- Sample shut-off valve (optional)

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## 3-Channel Fast Refinery Gas Analyzer with H<sub>2</sub>S and O<sub>2</sub> using Hydrogen and Nitrogen Carrier Gas (G3445 #530)

### Analyzer Description

#### Configuration:

- 5-valve/external oven/7-column (capillary, packed, micro-packed), 2-TCD/FID, nickel tubing, Hastelloy valve

#### Sample type:

- Refinery gas such as atmospheric overhead, desulfurizer off gas, FCC overhead, fuel gas, recycle gas

#### Compounds analyzed:

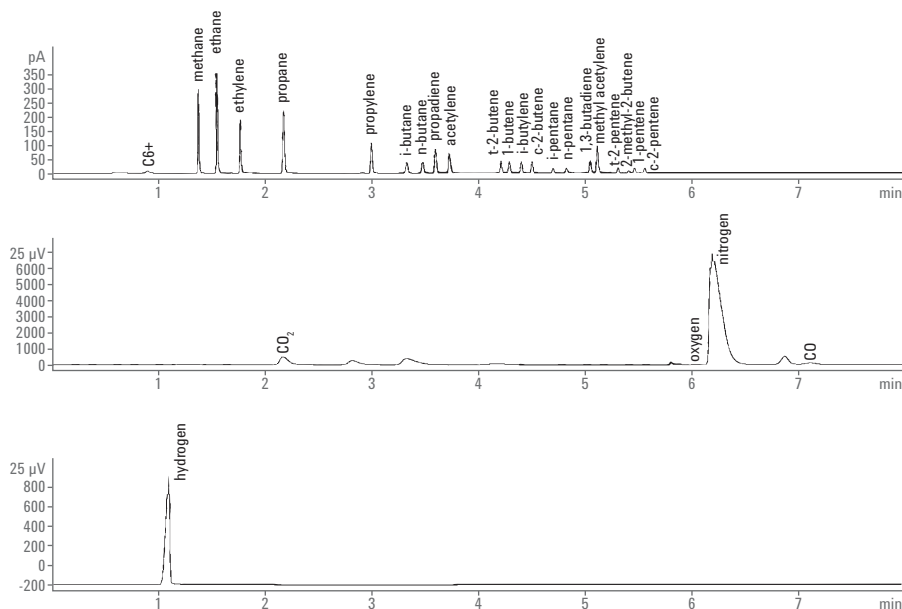
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush, H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO, H<sub>2</sub>S

#### Typical quantification range:

- 0.01 mol% for all above mentioned components except H<sub>2</sub>S
- 500 ppm for H<sub>2</sub>S

#### Configured per method:

- ASTM D1945, ASTM D1946, UOP 539



### ► KEY BENEFITS AND FEATURES

- Three parallel channels with simultaneous detection for complete refinery gas analysis within 13 minutes
- External oven for Micropacked columns allows independent hydrocarbon and permanent gas analysis
- Full-range capability for H<sub>2</sub> by third TCD using N<sub>2</sub> carrier gas
- Nickel tubing and Hastelloy valve for resistance to sulfur corrosion

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# 3-Channel High Capacity Refinery Gas Analyzer with Large Valve Oven and Helium Carrier for H<sub>2</sub>S and O<sub>2</sub> (G3445 #531)

## Analyzer Description

### Configuration:

- 3-valve/large valve oven/5-column (PLOT, packed), 2-TCD/FID, nickel tubing, Hastelloy valve

### Sample type:

- Refinery gas such as atmospheric overhead, desulfurizer off gas, FCC overhead, fuel gas, recycle gas

### Compounds analyzed:

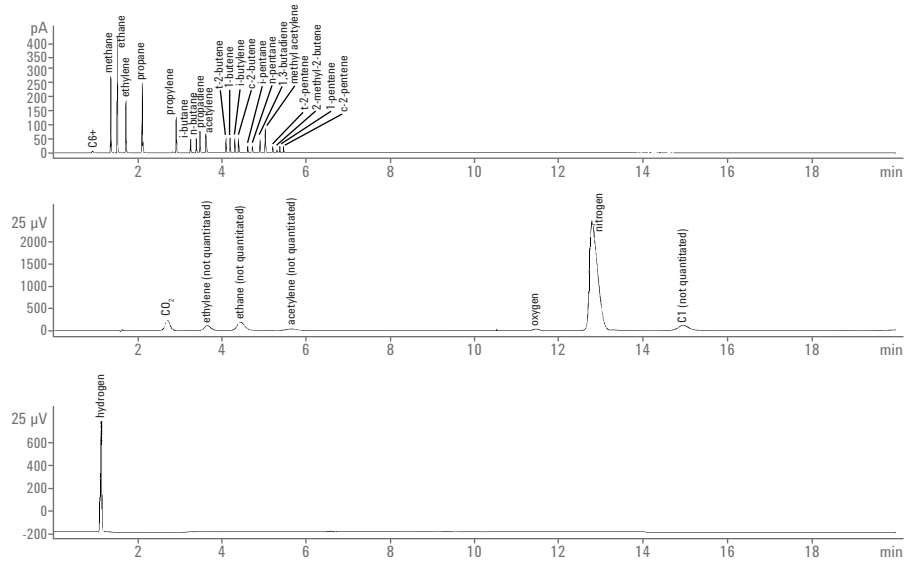
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush, H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO, H<sub>2</sub>S, COS

### Typical quantification range:

- 0.01 mol% for all above mentioned components except H<sub>2</sub>S
- 500 ppm for H<sub>2</sub>S
- 300 ppm for COS

### Configured per method:

- ASTM D1945, ASTM D1946, UOP 539



## ► KEY BENEFITS AND FEATURES

- Three parallel channels with simultaneous detection for complete refinery gas analysis within 17 minutes
- Large valve oven (LVO) for packed columns allows independent hydrogen, hydrocarbon, and permanent gas analysis
- Full-range capability for H<sub>2</sub> by third TCD using N<sub>2</sub> carrier gas
- Nickel tubing and Hastelloy valve for resistance to sulfur corrosion

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## 3-Channel Fast Refinery Gas Analyzer with Large Valve Oven and Micropacked Columns for H<sub>2</sub>S and O<sub>2</sub> (G3445 #532)

### Analyzer Description

#### Configuration:

- 3-valve/large valve oven/  
4-column (PLOT, micro-packed),  
2-TCD/FID, nickel tubing,  
Hastelloy valve

#### Sample type:

- Refinery gas such as atmospheric overhead, desulfurizer off gas, FCC overhead, fuel gas, recycle gas

#### Compounds analyzed:

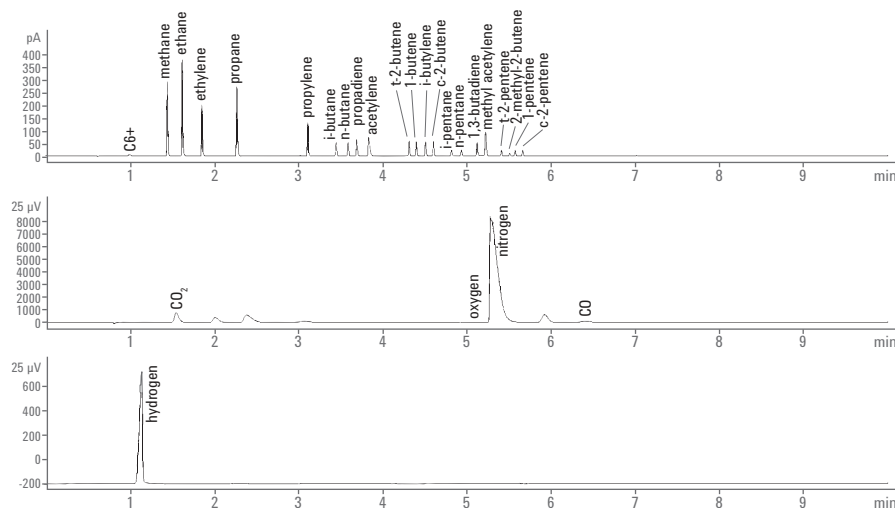
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush, H<sub>2</sub>, He, O<sub>2</sub>,  
N<sub>2</sub>, CO<sub>2</sub>, CO, H<sub>2</sub>S, COS

#### Typical quantification range:

- 0.01 mol% for all above mentioned components except H<sub>2</sub>S
- 500 ppm for H<sub>2</sub>S
- 300 ppm for COS

#### Configured per method:

- UOP 539



### ► KEY BENEFITS AND FEATURES

- Three parallel channels with simultaneous detection for complete refinery gas analysis within 9 minutes
- Large valve oven (LVO) for Micropacked columns allows independent hydrogen, hydrocarbon, and permanent gas analysis
- Full-range capability for H<sub>2</sub> by third TCD using N<sub>2</sub> carrier gas
- Nickel tubing and Hastelloy valve for resistance to sulfur corrosion

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## 3-Channel Fast Refinery Gas Analyzer with Large Valve Oven and Hydrogen Carrier Gas for H<sub>2</sub>S and O<sub>2</sub> (G3445 #533)

### Analyzer Description

#### Configuration:

- 3-valve/large valve oven/  
4-column (PLOT, micro-packed),  
2-TCD/FID, nickel tubing,  
Hastelloy valve

#### Sample type:

- Refinery gas such as atmospheric overhead, desulfurizer off gas, FCC overhead, fuel gas, recycle gas

#### Compounds analyzed:

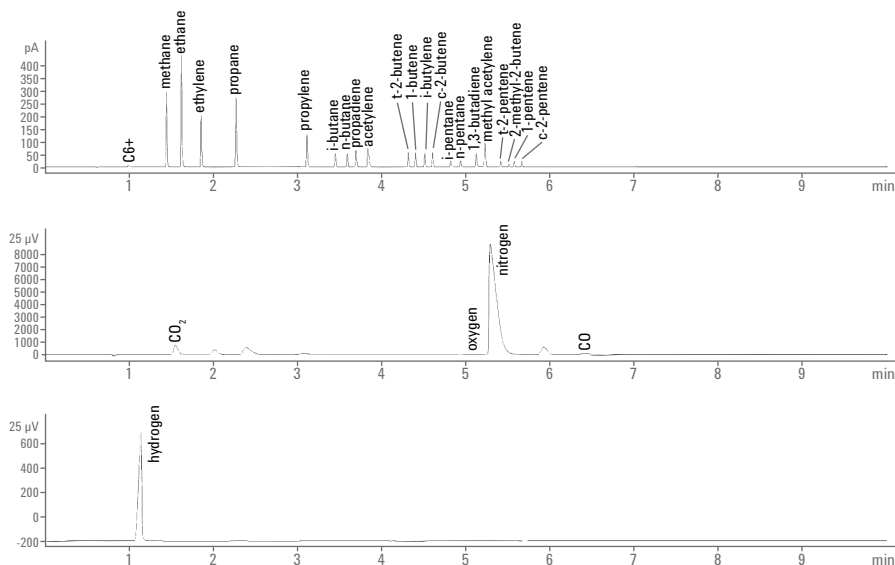
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush, H<sub>2</sub>, He, O<sub>2</sub>,  
N<sub>2</sub>, CO<sub>2</sub>, CO, H<sub>2</sub>S, COS

#### Typical quantification range:

- 0.01 mol% for all above mentioned components except H<sub>2</sub>S
- 500 ppm for H<sub>2</sub>S
- 300 ppm for COS

#### Configured per method:

- UOP 539



### ► KEY BENEFITS AND FEATURES

- Three parallel channels with simultaneous detection for complete refinery gas analysis within 9 minutes
- Large valve oven (LVO) for Micropacked columns allows independent hydrogen, hydrocarbon, and permanent gas analysis
- Hydrogen carrier gas for hydrocarbon and permanent gas analysis
- Full-range capability for H<sub>2</sub> by third TCD using N<sub>2</sub> carrier gas
- Nickel tubing and Hastelloy valve for resistance to sulfur corrosion

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# Refinery Gas Analyzer: 4-Channel Micro GC (Contact Agilent)

## Analyzer Description

### Configuration:

- Four channel Micro GC
  - Channel 1: CP-molsieve 5Å with backflush
  - Channel 2: CP-PoraPLOT U with backflush
  - Channel 3: Alumina oxide with backflush
  - Channel 4: CP-Sil 5 CB

### Sample type:

- Refinery, high-pressure refinery, and liquefied refinery gases
  - Fluid coking overheads
  - Ethylene/propylene
  - Fuel gases
  - Stack gases
  - Off gases

### Compounds analyzed:

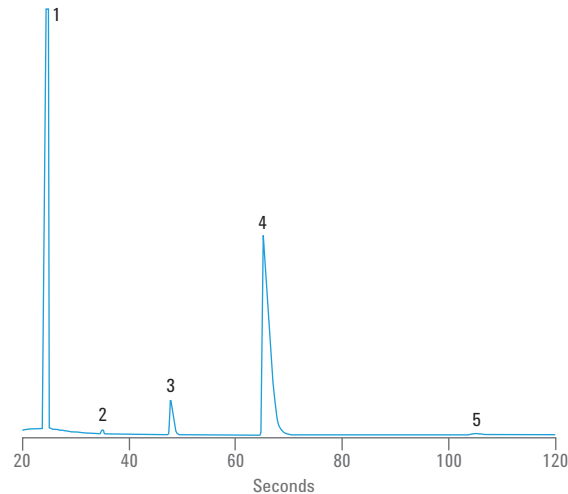
- C<sub>1</sub>-C<sub>5+</sub>
- H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO

### Typical quantification range:

- 1-10 ppm

### Configured per method:

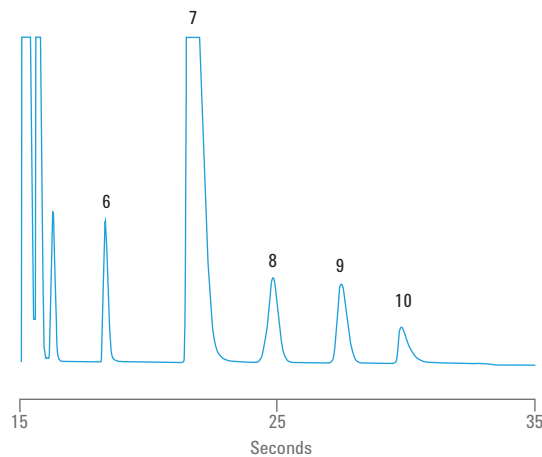
- UOP 59, DIN-51666, ASTM D2163



#### Peak Identification

1. hydrogen
2. oxygen
3. nitrogen
4. methane
5. carbon monoxide

10 meter molsieve 5Å column with BF



#### Peak Identification

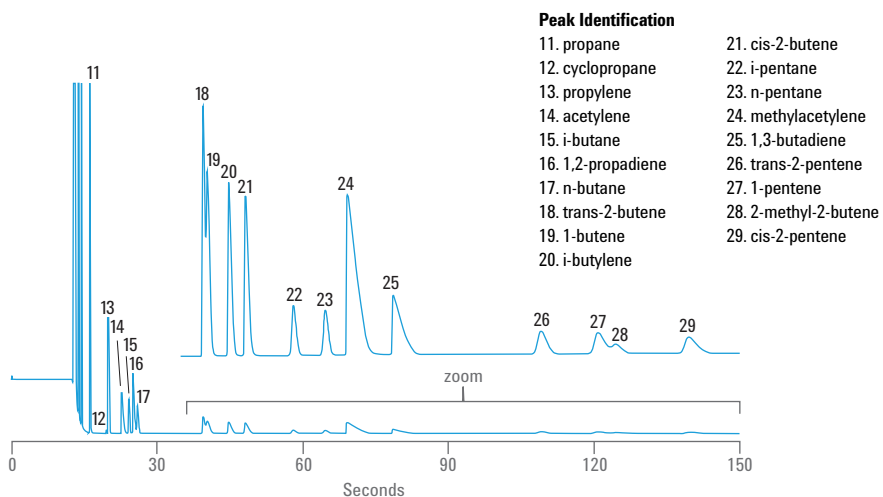
6. carbon dioxide
7. ethylene
8. ethane
9. acetylene
10. hydrogen sulfide

10 meter PLOT U column with BF

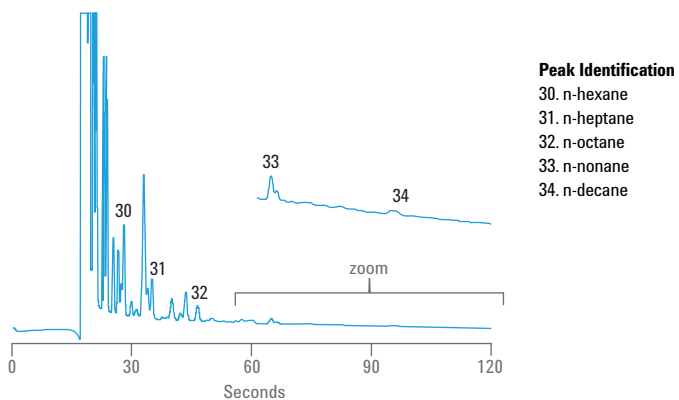
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10 meter Al<sub>2</sub>O<sub>3</sub>/KCl column (special with short pre-column)



6 meter CP-Sil 5 CB



Our team is ready to work with you to produce a solution for your unique analytical challenges. For more information, visit

[www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## ► KEY BENEFITS AND FEATURES

- Optimized for the rapid analysis of natural gas composition in 150 seconds
  - Characterizes hydrocarbons C<sub>1</sub>-C<sub>10</sub>, carbon dioxide and air concentrations
- Preconfigured with analytical method
  - Injection parameters
  - Analytical parameters
- Excellent repeatability: RSD 0.5%

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## SOLUTIONS FOR NATURAL GAS



### Quickly and reliably determine composition and calorific value

Natural gas is widely used for heating buildings, generating electricity, and providing needed power for industrial processes.

This naturally occurring mixture of gaseous hydrocarbons consists primarily of methane, but can also include other hydrocarbons ( $C_1$ - $C_4$  chain length), as well as small amounts of impurities, such as  $O_2$ ,  $N_2$ ,  $CO_2$ ,  $H_2$ , He, and sulfur-containing hydrocarbons.

Before it can be sold, natural gas must meet specifications for calorific value and purity; accordingly, collection, processing, transmitting, and distribution demands an array of analytical capabilities. Production by-products—such as ethane, propane, butanes, pentanes and hydrogen sulfide—must also be characterized prior to use in downstream processes.

**Agilent Natural Gas Analyzers** measure permanent gases and hydrocarbon content ( $C_1$ - $C_5$  with  $C_{6+}$  as backflush), and perform extended analysis of hydrocarbons in natural gas to  $C_{14}$ . These factory-configured, chemically tested GC analyzers help you evaluate the chemical composition of natural gas, natural gas liquids, and by-products that result from processing.

Learn more about Analyzer Solutions for the energy and chemical industry at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)



## Solutions for Natural Gas

| Analyzer Number | Extended Hydrocarbon Analysis to C <sub>12</sub> /C <sub>14</sub> | Full-range Capacity for H <sub>2</sub> | Separates Air (O <sub>2</sub> and N <sub>2</sub> ) | High Level of H <sub>2</sub> S | Handles Liquefied Samples |
|-----------------|---|--|--|--------------------------------|---------------------------|
| G3445 #541      | Yes   | No                                     | Yes  | No                             | No                        |
| G3445 #542      | No  | No                                     | Yes  | No                             | No                        |
| G3445 #543      | No  | Yes                                    | Yes  | No                             | No                        |
| G3445 #544      | No  | No                                     | Yes  | Yes                            | No                        |
| G3445 #545      | No  | No                                     | No   | No                             | No                        |
| G3445 #547      | No  | Yes                                    | Yes  | No                             | No                        |
| G3445 #548      | Yes   | No                                     | Yes  | No                             | No                        |
| G3582A #120     | Yes   | No                                     | No   | No                             | Optional                  |
| G3582A #121     | Yes   | No                                     | No   | No                             | Optional                  |
| G3582A #122     | No  | No                                     | No   | Yes                            | Optional                  |
| G3582A #123     | No  | No                                     | Yes  | Yes                            | Optional                  |
| 7890-0110       | No  | No                                     | No   | No                             | Yes                       |
| 7890-0610       | No  | No                                     | Yes  | No                             | Yes                       |
| 7890-0611       | Yes   | No                                     | Yes  | No                             | Yes (with optional LSV)   |

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## Reference Methods for Natural Gas: Quantitation Ranges for Compounds of Interest

| Compound                         | ASTM D1945<br>mol % | ASTM D1946<br>mol % | ASTM D2163<br>mol % | UOP 539<br>mol % | GPA 2186     | GPA 2286     | ISO 6974-6    |
|----------------------------------|---------------------|---------------------|---------------------|------------------|--------------|--------------|---------------|
| H <sub>2</sub> S                 | 0.3 to 30           |                     | –                   | 0.1 to 25        | –            | 0.1 to 100   | –             |
| O <sub>2</sub>                   | 0.01 to 20          |                     | –                   | 0.1 to 99.9      | –            | 0.005 to 20  | 0.007 to 5    |
| N <sub>2</sub>                   | 0.01 to 100         | –                   | –                   |                  | 0.005 to 5   | 0.005 to 100 | 0.007 to 40   |
| CH <sub>4</sub>                  | 0.01 to 100         | –                   | –                   |                  | 0.001 to 5   | 0.001 to 100 | 40 to 100     |
| CO                               |                     | –                   | –                   |                  | –            | –            | 0.001 to 1    |
| CO <sub>2</sub>                  | 0.01 to 20          | –                   | –                   |                  | 0.005 to 5   | 0.005 to 100 | 0.001 to 10   |
| He                               | 0.01 to 10          | –                   | –                   |                  | –            | –            | 0.002 to 0.5  |
| H <sub>2</sub>                   | 0.01 to 10          | –                   | –                   |                  | –            | –            | 0.001 to 0.5  |
| Ethane                           | 0.01 to 100         | –                   | 0.1 and above       | 0.1 to 99.9      | 0.001 to 95  | 0.001 to 100 | 0.002 to 15   |
| Propane                          | 0.01 to 100         | –                   | 0.1 and above       |                  | 0.001 to 100 | 0.001 to 100 | 0.001 to 5    |
| C <sub>4</sub> isomers           | 0.01 to 10          | –                   | 0.1 and above       |                  | 0.001 to 100 | 0.001 to 10  | 0.0001 to 1   |
| C <sub>5</sub> isomers           | 0.01 to 2           | –                   | 0.1 and above       |                  | 0.001 to 50  | 0.001 to 5   | 0.0001 to 0.5 |
| C <sub>6</sub> isomers           | 0.01 to 2           | –                   | –                   | –                | 0.001 to 30  | 0.001 to 5   | 0.0001 to 0.5 |
| C <sub>6+</sub>                  | –                   | –                   | –                   | 0.1 to 99.9      | –            | –            | –             |
| C <sub>7+</sub>                  | 0.01 to 1           | –                   | –                   | –                | 0.001 to 30  | –            | –             |
| C <sub>7</sub> -C <sub>8</sub>   | –                   | –                   | –                   | –                | –            | 0.001 to 2   | 0.0001 to 0.5 |
| C <sub>9</sub>                   | –                   | –                   | –                   | –                | –            | 0.001 to 2   | –             |
| C <sub>10</sub> -C <sub>14</sub> | –                   | –                   | –                   | –                | –            | 0.001 to 1   | –             |

\* This guide reports typical quantitation limits for each system configuration. These values may differ from the absolute reporting limit required by the method.

Note: In the table above the symbol "–" indicates that this parameter was not specified.

### Can't find your application?

Agilent Technologies can configure custom solutions to meet your analytical requirements!

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## Extended Natural Gas Analyzer to C-12 (G3445 #541)

### Analyzer Description

#### Configuration:

- 3-valve/4-column (capillary and packed), TCD/FID

#### Sample type:

- Natural gas and similar gaseous mixtures

#### Compounds analyzed:

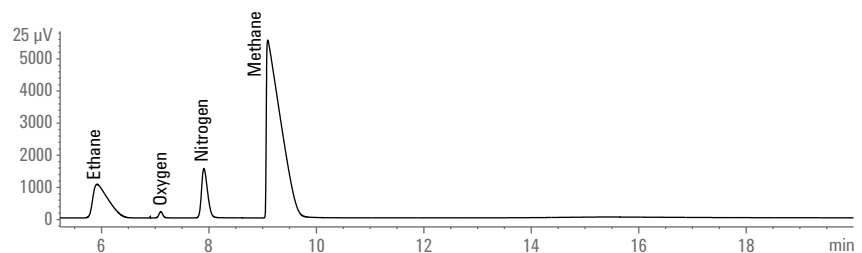
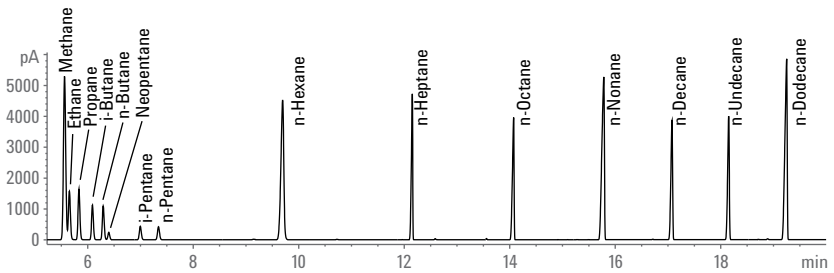
- C<sub>1</sub>-C<sub>12</sub>, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO

#### Typical quantification range:

- 50 ppm for permanent gases and C<sub>1</sub>-C<sub>2</sub> hydrocarbons on TCD
- 10 ppm for C<sub>3</sub>-C<sub>12</sub> on FID

#### Configured per method:

- Results per GPA 2286, but calculation without bridge components iC<sub>5</sub> and nC<sub>5</sub>



### ► KEY BENEFITS AND FEATURES

- Dual channels with TCD and FID detectors
- TCD channel with packed column for C<sub>1</sub>-C<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub> analysis
- C<sub>3</sub>-C<sub>12</sub> hydrocarbons separated on PONA column and measured on FID
- Adapt to liquefied natural gas by adding additional liquid sampling valve

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## Natural Gas Analyzer (G3445 #542)

### Analyzer Description

#### Configuration:

- 3-valve/4-column (packed), TCD

#### Sample type:

- Natural gas and similar gaseous mixtures

#### Compounds analyzed\*:

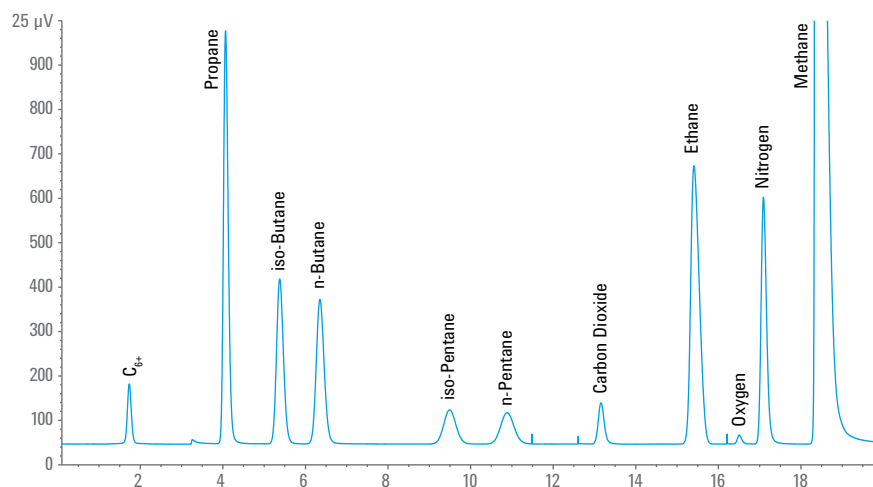
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush
- O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO

#### Typical quantification range:

- 0.01 mol% for all components

#### Configured per method:

- ASTM D1945, GPA 2261 (H<sub>2</sub> and He are not included)



### ► KEY BENEFITS AND FEATURES

- Single TCD channel
- Rugged packed columns
- 20 minute analysis time
- Software provided for natural gas calculations per GPA 2261

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# Natural Gas Analyzer (G3445 #543)

## Analyzer Description

### Configuration:

- 4-valve/6-column (packed), 2-TCD

### Sample type:

- Natural gas and similar gaseous mixtures

### Compounds analyzed:

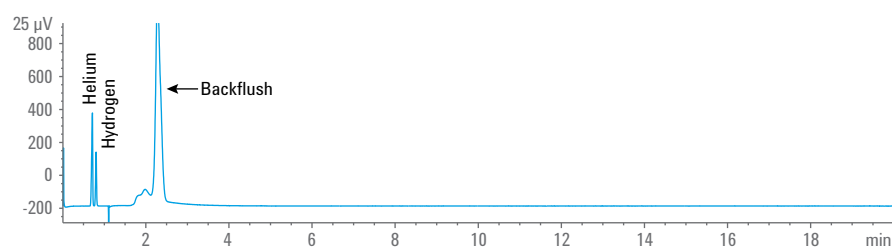
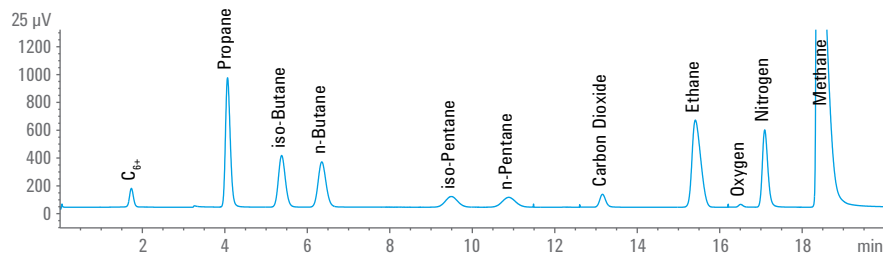
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush
- H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO

### Typical quantification range:

- 0.01 mol% for all components

### Configured per method:

- ASTM D1945, GPA 2261



## ► KEY BENEFITS AND FEATURES

- Dual TCD channels
- Rugged packed columns
- 20 minute analysis time
- Dedicated channel for H<sub>2</sub> and He analysis

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# Natural Gas Analyzer (G3445 #544)

## Analyzer Description

### Configuration:

- 3-valve/4-column (packed), TCD

### Sample type:

- Natural gas and similar gaseous mixtures

### Compounds analyzed:

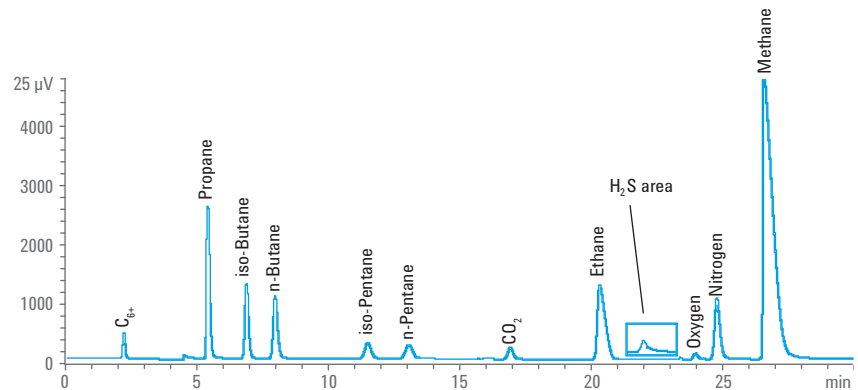
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush
- O<sub>2</sub>, N<sub>2</sub>, H<sub>2</sub>S, CO<sub>2</sub>, CO

### Typical quantification range:

- 0.01 mol% for all components except H<sub>2</sub>S
- 500 ppm for H<sub>2</sub>S

### Configured per method:

- ASTM D1945, GPA 2261



## ► KEY BENEFITS AND FEATURES

- Single TCD channel
- Rugged packed columns
- 30 minute analysis time
- Software provided for natural gas calculations per GPA 2261
- Similar to G3445 #542 but with hardware to allow H<sub>2</sub>S analysis
- Dedicated channel for H<sub>2</sub> and He analysis

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# Natural Gas Analyzer (G3445 #545)

## Analyzer Description

### Configuration:

- 1-valve/2-column (packed), TCD

### Sample type:

- Natural gas and similar gaseous mixtures

### Compounds analyzed:

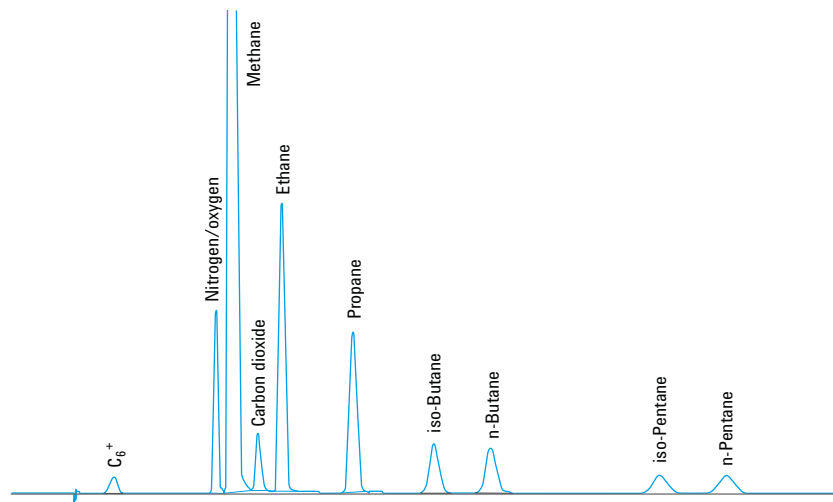
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub> as backflush
- Air composite
- CO<sub>2</sub>

### Typical quantification range:

- 0.01 mol% for all components

### Configured per method:

- GPA 2261 (H<sub>2</sub> and He is not included, without separation of O<sub>2</sub> and N<sub>2</sub>)



## ► KEY BENEFITS AND FEATURES

- Single TCD channel
- Rugged packed columns
- 13 minute analysis time
- Simple and low cost solution for light hydrocarbon analysis

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## 3-Channel Enhanced Hydrocarbon Natural Gas Analyzer (G3445 #547)

### Analyzer Description

#### Configuration:

- 4-valve/6-column (packed), 2-TCD/FID

#### Sample type:

- Natural gas and similar gaseous mixtures

#### Compounds analyzed:

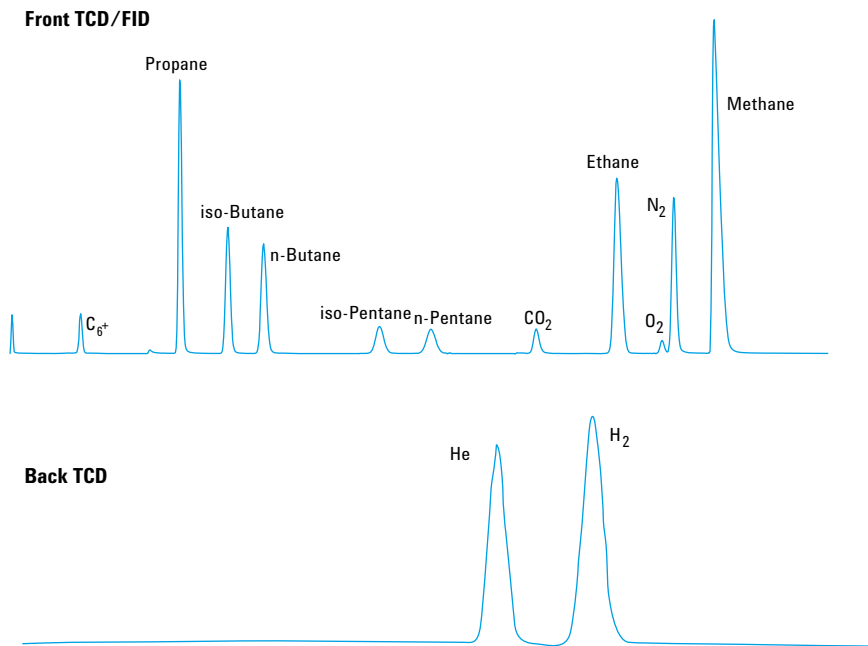
- C<sub>1</sub>-C<sub>5</sub>, C<sub>6+</sub>
- H<sub>2</sub>, He, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO

#### Typical quantification range:

- 10 ppm for hydrocarbons (FID)
- 0.01 mol% for all permanent gases

#### Configured per method:

- ASTM D1945, GPA 2261



### ► KEY BENEFITS AND FEATURES

- Dual TCD and FID for enhanced hydrocarbon sensitivity
- Rugged packed columns
- Dedicated channel for H<sub>2</sub> and He analysis
- 20 minute analysis time

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## Extended Natural Gas Analyzer (G3445 #548)

### Analyzer Description

#### Configuration:

- 4-valve/3-column (packed, capillary), TCD/FID

#### Sample type:

- Natural gas and similar gaseous mixtures

#### Compounds analyzed:

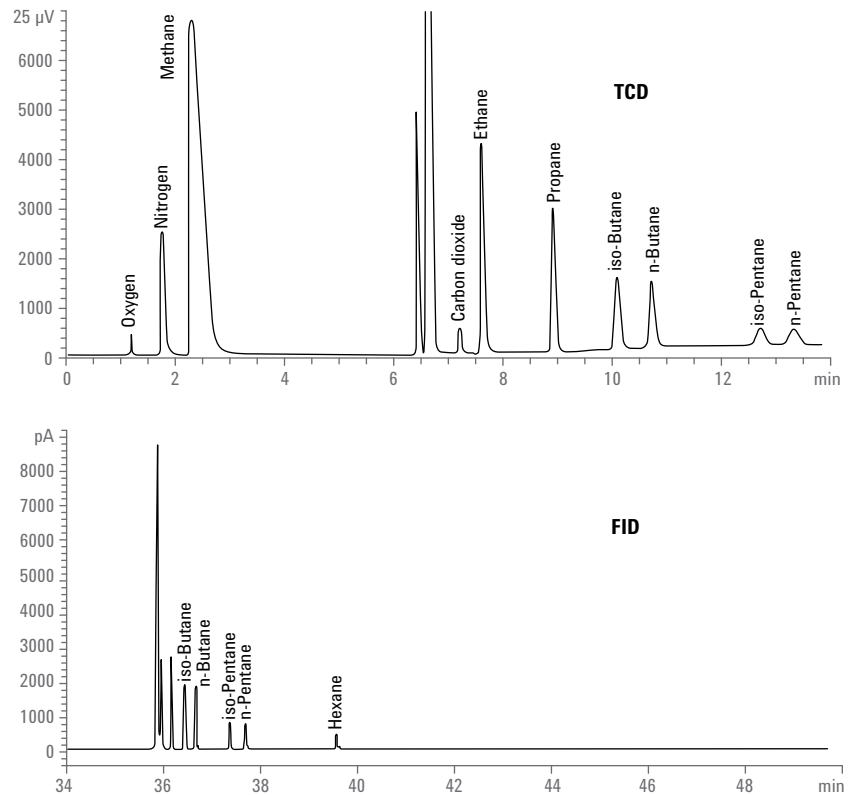
- C<sub>1</sub>-C<sub>5</sub>
- N<sub>2</sub>, O<sub>2</sub>, CO<sub>2</sub>

#### Typical quantification range:

- 50 ppm for permanent gases and C<sub>1</sub>-C<sub>5</sub> (TCD)
- 10 ppm for C<sub>5</sub>-C<sub>6</sub> (FID)

#### Configured per method:

- GPA 2286



### ► KEY BENEFITS AND FEATURES

- 2-channel with TCD and FID detectors
- Fixed gases and hydrocarbons up to C<sub>5</sub> on packed columns and thermal conductivity detector
- Hydrocarbons from C<sub>5</sub> to C<sub>14</sub> are analyzed on a capillary column and a flame ionization detector
- The pentanes are used as 'bridging' compounds for calculations per GPA 2286
- Software supplied to generate a data report per GPA 2286

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# Natural Gas Analyzer A: 2-Channel Micro GC (G3582A #120)

## Analyzer Description

### Configuration:

- 2-channel Micro GC
  - Channel 1: HayeSep A
  - Channel 2: CP-Sil 5 CB

### Sample type:

- Natural gas and liquefied\* natural gas

### Compounds analyzed:

- Hydrocarbons C<sub>1</sub>-C<sub>9</sub>
- Carbon dioxide and Air

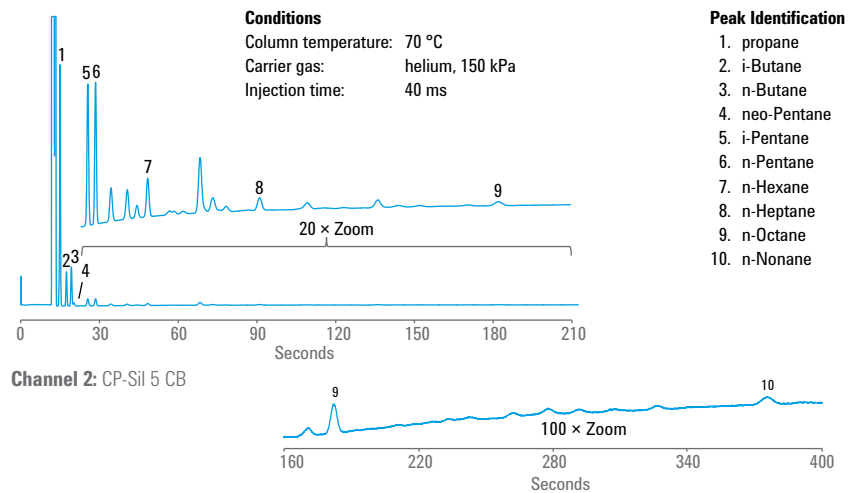
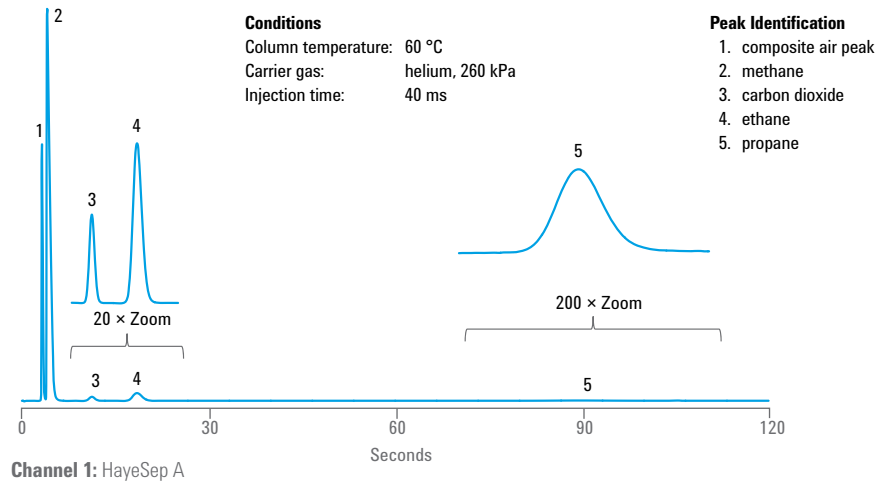
### Typical quantification range:

- 1-10 ppm

### Configured per method:

- ASTM D3588-98, GPA 2177, GPA 2172, ISO 6974-6

\* Injection of liquefied samples, e.g., LPG and LNG, require use of a microgasifier



## ► KEY BENEFITS AND FEATURES

- Optimized for the rapid analysis of natural gas composition in 210 seconds
  - Characterizes hydrocarbons C<sub>1</sub>-C<sub>9</sub>, carbon dioxide and air concentrations
- Preconfigured with analytical method
  - Injection parameters
  - Analytical parameters
- Excellent repeatability: RSD 0.5%

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# Natural Gas Analyzer A Extended: 3-Channel Micro GC (G3582A #121)

## Analyzer Description

### Configuration:

- 3-channel Micro GC
  - Channel 1: HayeSep A with Backflush
  - Channel 2: CP-Sil 5 CB with Backflush
  - Channel 3: CP-Sil 5 CB

### Sample type:

- Natural gas and liquefied natural gas

### Compounds analyzed:

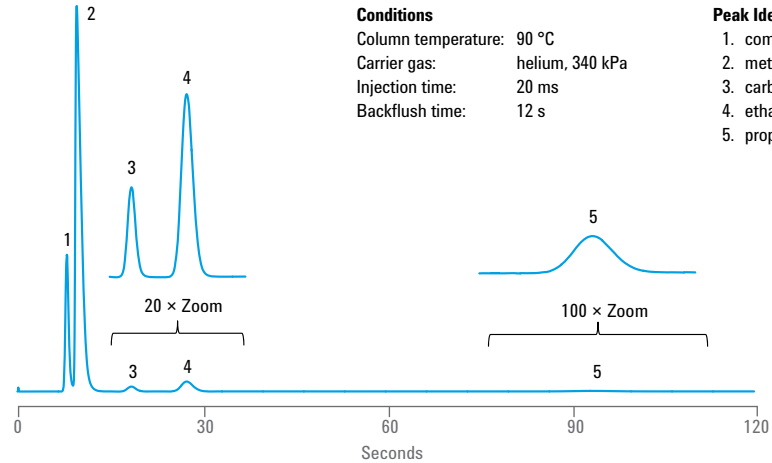
- Hydrocarbons C<sub>1</sub>-C<sub>12</sub>
- Carbon dioxide and air

### Typical quantification range:

- 1-10 ppm

### Configured per method:

- ASTM D3588-98, GPA 2177, GPA 2172, ISO 6974-6



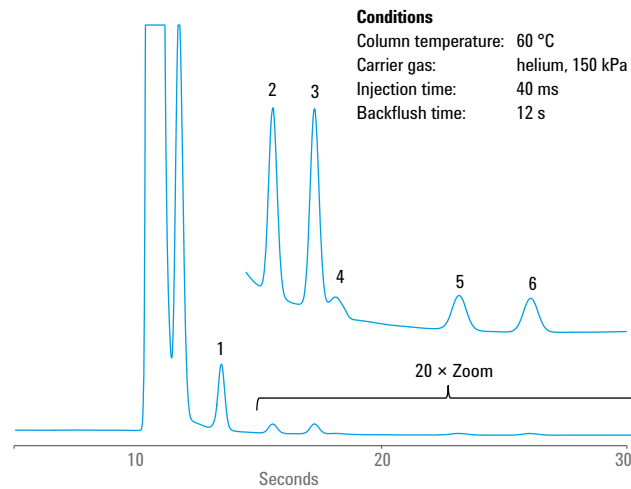
### Conditions

Column temperature: 90 °C  
 Carrier gas: helium, 340 kPa  
 Injection time: 20 ms  
 Backflush time: 12 s

### Peak Identification

1. composite airpeak
2. methane
3. carbon dioxide
4. ethane
5. propane

Channel 1: HayeSep A with Backflush



### Conditions

Column temperature: 60 °C  
 Carrier gas: helium, 150 kPa  
 Injection time: 40 ms  
 Backflush time: 12 s

### Peak Identification

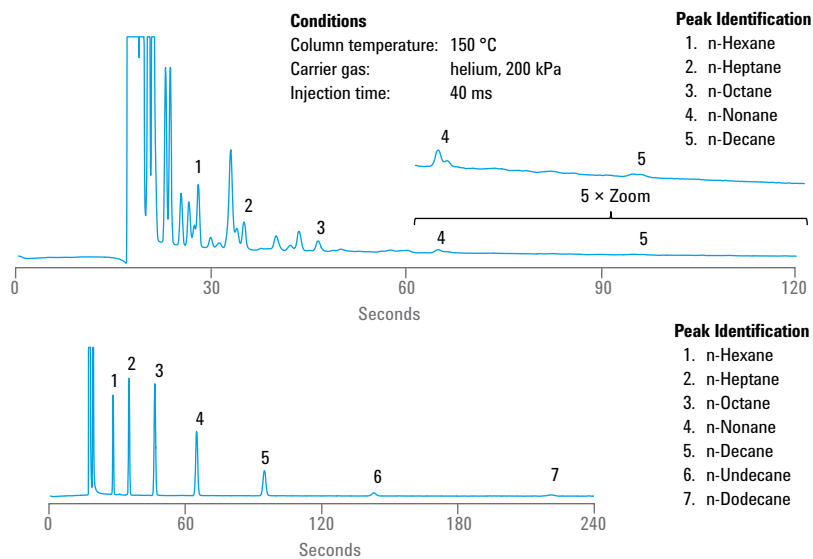
1. propane
2. i-Butane
3. n-Butane
4. neo-Pentane
5. i-Pentane
6. n-Pentane

Channel 2: CP-Sil 5 CB with Backflush

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Channel 3: CP-Sil 5 CB



**Robust and reliable:**

Agilent lets you choose from more than 100 factory-tested GC instrument configurations and analyzers—all application pre-tested to run according to industry standards such as ISO, ASTM, EPA, USP, CEN, UOP, and GPA.

► **KEY BENEFITS AND FEATURES**

- Optimized for the rapid analysis of natural gas composition in 240 seconds
  - Characterizes hydrocarbons C<sub>1</sub>-C<sub>12</sub>, carbon dioxide and air concentrations
- Preconfigured with analytical method
  - Injection parameters
  - Analytical parameters
- Excellent repeatability: RSD 0.5%

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# Natural Gas Analyzer B with H<sub>2</sub>S: 2-Channel Micro GC (G3582A #122)

## Analyzer Description

### Configuration:

- 2-channel Micro GC
  - Channel 1: PoraPLOT U Backflush
  - Channel 2: CP-Sil 5 CB

### Sample type:

- Natural gas and liquefied natural gas

### Compounds analyzed:

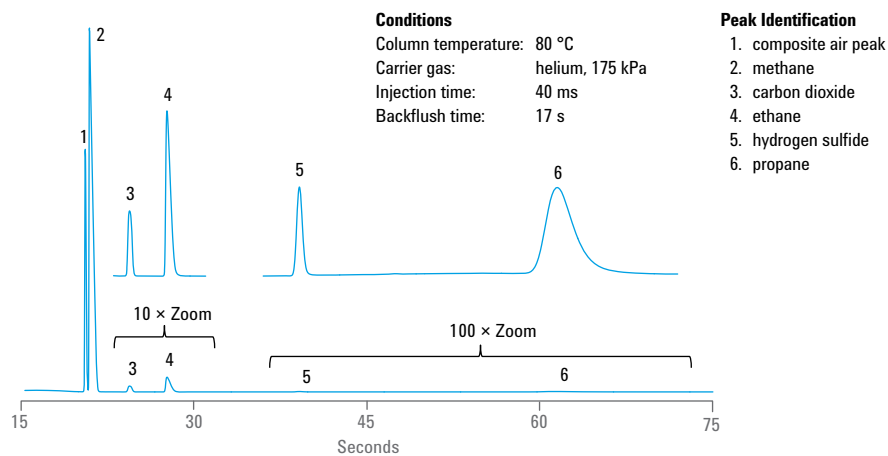
- Hydrocarbons C<sub>1</sub>-C<sub>9</sub>
- Carbon dioxide and Air
- H<sub>2</sub>S

### Typical quantification range:

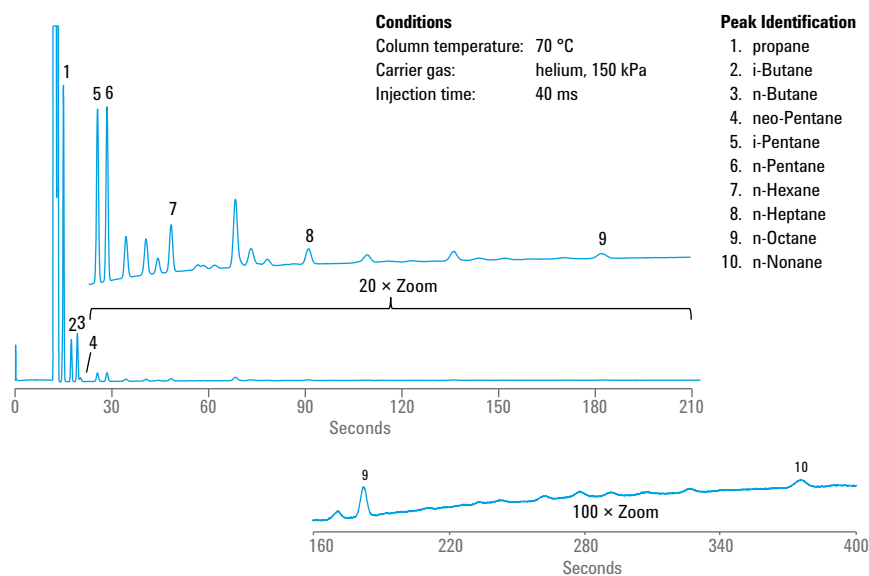
- 1-10 ppm

### Configured per method:

- ASTM D3588-98, GPA 2177, GPA 2172, ISO 6974-6



Channel 1: PoraPLOT U Backflush



Channel 2: CP-Sil 5 CB

## ► KEY BENEFITS AND FEATURES

- Optimized for the rapid analysis of natural gas composition in 210 seconds
  - Characterizes hydrocarbons C<sub>1</sub>-C<sub>9</sub>, carbon dioxide and air concentrations
- Preconfigured with analytical method
  - Injection parameters
  - Analytical parameters
- Excellent repeatability: RSD 0.5%

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# Natural Gas Analyzer B Extended with H<sub>2</sub>S: 3-Channel Micro GC (G3582A #123)

## Analyzer Description

### Configuration:

- 3-channel Micro GC
  - Channel 1: CP-molsieve 5Å Backflush
  - Channel 2: PoraPLOT U Backflush
  - Channel 3: CP-Sil 5 CB

### Sample type:

- Natural gas and liquefied natural gas

### Compounds analyzed:

- Hydrocarbons C<sub>1</sub>-C<sub>9</sub>
- Carbon dioxide and Air
- H<sub>2</sub>S
- N<sub>2</sub>, O<sub>2</sub>, He and H<sub>2</sub>

### Typical quantification range:

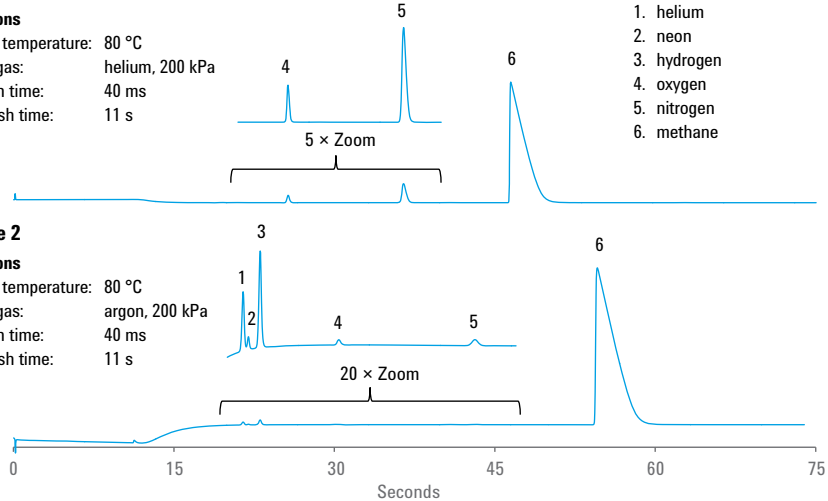
- 1-10 ppm

### Configured per method:

- ASTM D3588-98, GPA 2261, GPA 2177, GPA 2172, ISO 6974-6, ASTM D1945

### Sample 1

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



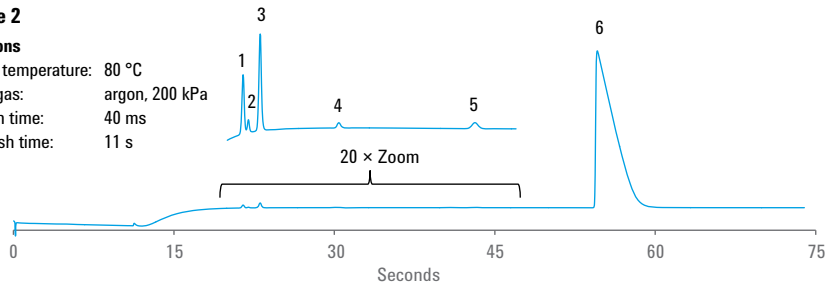
### Peak Identification

1. helium
2. neon
3. hydrogen
4. oxygen
5. nitrogen
6. methane

### Sample 2

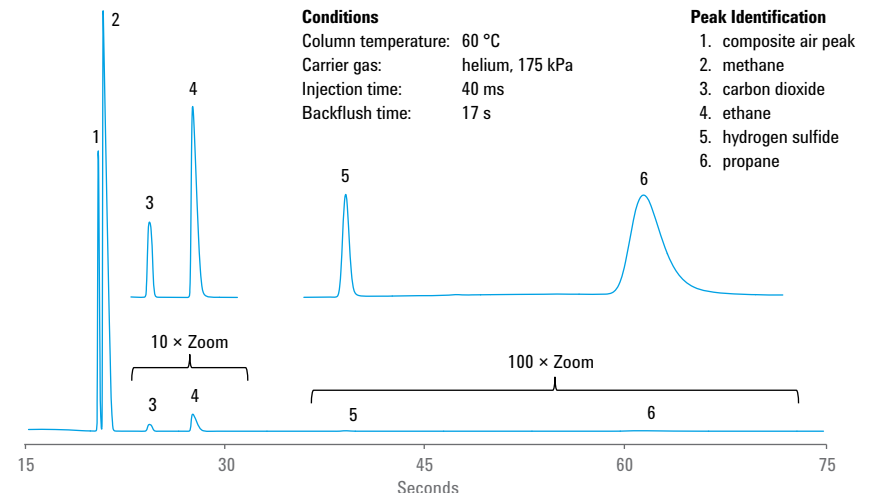
**Conditions**  
 Column temperature: 80 °C  
 Carrier gas: argon, 200 kPa  
 Injection time: 40 ms  
 Backflush time: 11 s

Channel 1: CP-molsieve 5Å Backflush



### Channel 2: PoraPLOT U Backflush

**Conditions**  
 Column temperature: 60 °C  
 Carrier gas: helium, 175 kPa  
 Injection time: 40 ms  
 Backflush time: 17 s



### Peak Identification

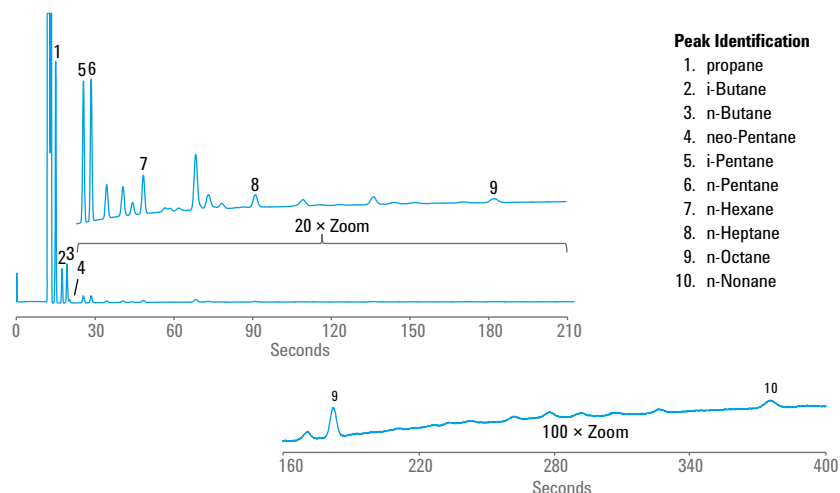
1. composite air peak
2. methane
3. carbon dioxide
4. ethane
5. hydrogen sulfide
6. propane

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Channel 3: CP-Sil 5 CB



**Agilent solutions significantly reduce your time from system arrival to final validation.** With pre-configured hardware and method-specific separation tools, your analysts can focus on calibration and validation per your laboratory's SOPs.

### ► KEY BENEFITS AND FEATURES

- Optimized for the rapid analysis of natural gas composition in 210 seconds
  - Characterizes hydrocarbons C<sub>1</sub>-C<sub>9</sub>, carbon dioxide and air concentrations
- Preconfigured with analytical method
  - Injection parameters
  - Analytical parameters
- Excellent repeatability: RSD 0.5%
- Optional report for calorific value
- Dual carrier gas for optimal detection

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# Liquefied Natural Gas Analyzer (7890-0110)

## Analyzer Description

### Configuration:

- 1-valve/1-liquid valve/2-column (packed)/TCD

### Sample type:

- Natural gas and similar gaseous mixtures; liquefied natural gas

### Compounds analyzed:

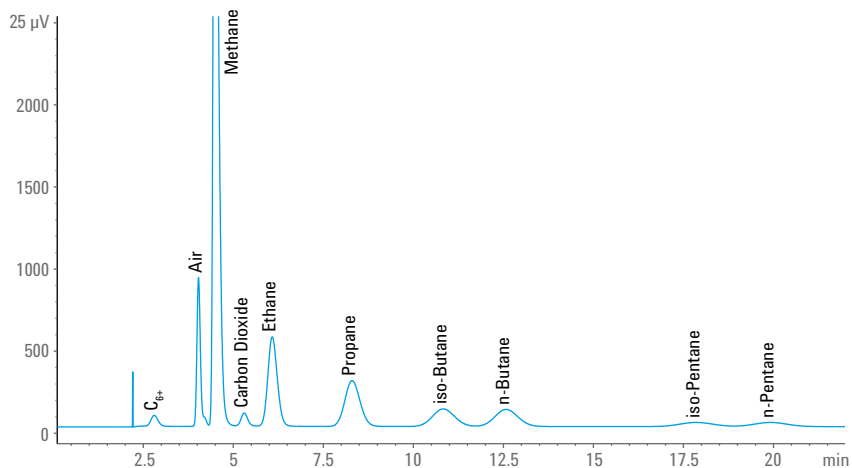
- C<sub>1</sub>-C<sub>5</sub>
- C<sub>6+</sub> as backflush
- Air composite, CO<sub>2</sub>

### Typical quantification range:

- 0.01 mol% for all components

### Configured per method:

- GPA 2177



## ► KEY BENEFITS AND FEATURES

- Single TCD channel
- Rugged packed columns
- Simple and lowest cost
- Liquid sample valve for liquefied natural gas
- 22 minute analysis time

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# Permanent Gas and Hydrocarbons in Natural Gas Analyzer (7890-0610)

## Analyzer Description

### Configuration:

- 1-valve/2-column (capillary), 2-TCD

### Sample type:

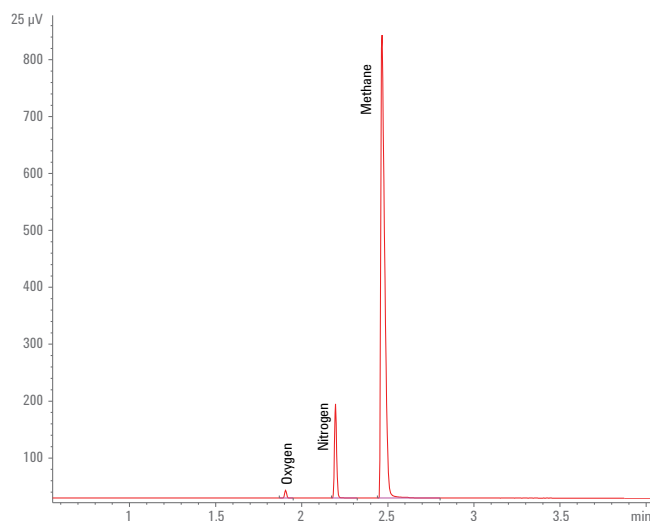
- Natural gas and similar process gas mixtures

### Compounds analyzed:

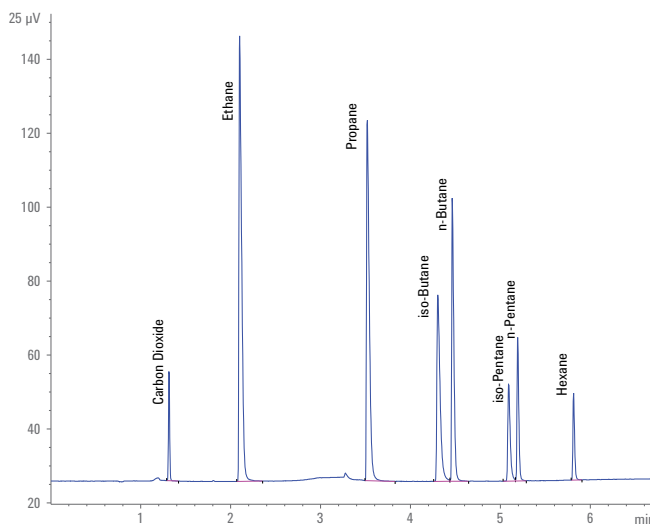
- C<sub>1</sub>-C<sub>6</sub>
- N<sub>2</sub>, O<sub>2</sub>, CO, CO<sub>2</sub>, H<sub>2</sub>S

### Typical quantification range:

- 0.01 mol% for all components except H<sub>2</sub>S
- 0.05 mol% for H<sub>2</sub>S



Permanent gases in natural gas



Hydrocarbons (to C6) in natural gas

## ► KEY BENEFITS AND FEATURES

- Capillary columns with Deans Switch and dual TCD
- Easy maintenance
- 5 minute analysis time
- H<sub>2</sub>S analysis
- O<sub>2</sub> and N<sub>2</sub> separation
- Handles gas and liquefied gases (with optional LSV)

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# Natural Gas Analyzer: Permanent Gas and Extended Hydrocarbons (7890-0611)

## Analyzer Description

### Configuration:

- 1-valve/3-column (packed)/TCD (2)/FID

### Sample type:

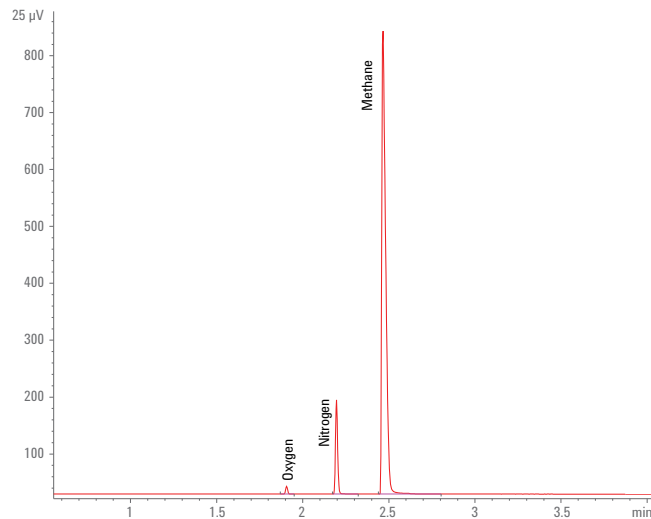
- Natural gas and similar process gas mixtures
- Liquefied Gas with optional LSV

### Compounds analyzed:

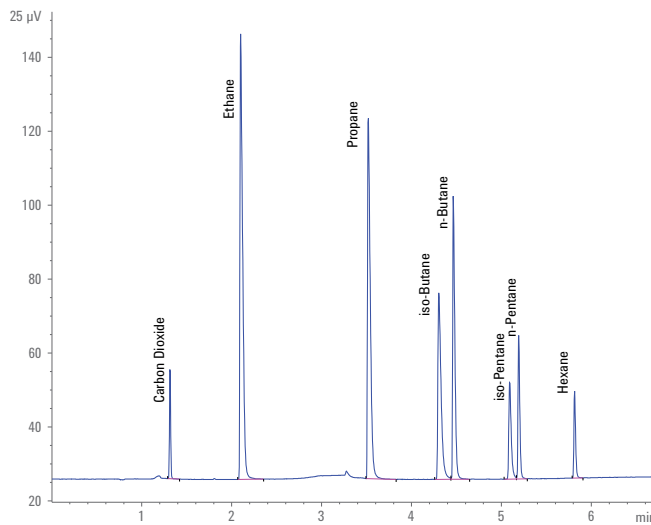
- C<sub>1</sub>-C<sub>15</sub>
- O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, CO and H<sub>2</sub>S

### Typical quantification range:

- 0.01 mol% for all components except H<sub>2</sub>S
- 0.05 mol% except H<sub>2</sub>S



Permanent gases in natural gas

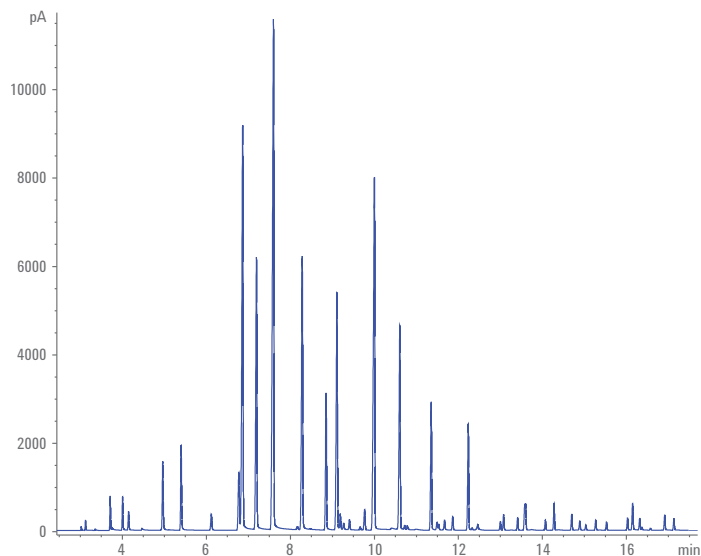


Hydrocarbons (to C6) in natural gas

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Extended Hydrocarbons (to C<sub>15</sub>) in real world liquefied gas sampled, peaks unlabelled



**Agilent analyzers help extend the analytical capabilities of your laboratory.** Customization through the addition of a liquid sampling valve has expanded natural gas analyzers to include liquefied gas samples. To find out more, visit [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## ► KEY BENEFITS AND FEATURES

- Capillary columns with Deans Switch/dual TCD/FID
- Easy maintenance
- 5 minute analysis time for permanent gases
- 20 minute analysis time for hydrocarbons to C<sub>15</sub>
- H<sub>2</sub>S analysis
- O<sub>2</sub> and N<sub>2</sub> separation
- Handles gas and liquefied gases (with optional LSV)
- For permanent gases and hydrocarbons to C<sub>6</sub> in natural gas, please consider 7890-0610

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# SOLUTIONS FOR REFORMULATED FUEL



## Conform to strict octane and emissions regulations

The 1990 US EPA Clean Air Act sets strict limits on volatile organic compounds (VOCs) and other toxic chemicals that emit from gasoline engine exhaust.

To reach these target levels, fuel producers must reformulate their gasoline to increase octane levels. This is accomplished through catalytic restructuring of hydrocarbon molecules in naphtha feedstock to produce a more complex structure and increase oxygen content through oxygenate blending. The resulting fuels have higher octane ratings, and combust more efficiently and thoroughly.

Agilent, together with our Channel Partners, offer a portfolio of **Reformulated Gasoline (RFG) Analyzers** that are factory configured to meet standards such as ASTM and CEN—and are chemically tested for analyzing oxygenate concentrations, benzene, and heavier aromatic content in RFG.

Learn more about Analyzer Solutions for the energy and chemical industry at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## Solutions for Oxygenates and Aromatics in Fuel

| Analyzer Number | Configuration   | Capability  |
|-----------------|---|---|
| G3445 #611      | 1-valve, 2-column (micro-packed and capillary), and FID/TCD   | Oxygenates and aromatics in finished gasoline per ASTM D4815 and ASTM D5580       |
| G3445 #612      | 2-valve, 4-column (micro-packed and capillary) and dual FID   | Parallel channel oxygenates and aromatics per ASTM D4815 and ASTM D5580           |
| G3445 #615      | 1-valve, 2-column (packed column), TCD or FID   | Benzene in finished motor and aviation fuels per ASTM D3606                       |
| G3445 #616      | 1-valve, 2-column (micro-packed and capillary), 2-FID (or FID/TCD)  | Aromatics in finished gasoline per ASTM D5580                                     |
| G3445 #617      | Deans Switching/2-column/dual FID   | Oxygenates and aromatics in commercial and raw gasoline per EN 13132 and EN 12177 |
| G3445 #618      | Capillary flow technology micro volume tee/2-column/FID/autosampler (for liquid samples), gas sampling valve (for gas samples), LSV (for liquefied gases) | Low level oxygenates in light hydrocarbons per ASTM D7423                         |
| G3445 #621      | 3-in-1 reformulated fuel analyzer with large valve oven (LVO)   | ASTM D3606, ASTM D4815, and ASTM D5580  |
| 7890-0340       | 1-valve/2-column/FID  | Trace oxygenates in reformulated gasoline per ASTM D7754                          |

## Reference Methods for Oxygenates: Quantitation Ranges for Compounds of Interest

| ASTM D7423          |                          |
|---------------------|--------------------------|
| Analyte             | The linear working range |
| Oxygenate compounds | 0.50 mg/kg to 100 mg/kg  |

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# Single Channel Oxygenates and Aromatics in Fuel Analyzer (G3445 #611)

## Analyzer Description

### Configuration:

- 1-valve/2-column (micro-packed and capillary)/FID/TCD

### Sample type:

- Finished gasoline

### Compounds analyzed:

- ASTM D4815: MTBE, ETBE, TAME, DIPE, methanol, ethanol, isopropanol, *n*-propanol, isobutanol, *tert*-butanol, *sec*-butanol, *n*-butanol, *tert*-pentanol
- ASTM D5580: benzene, toluene, ethylbenzene, xylene, C<sub>9</sub> and heavier aromatics, total aromatics

### Typical quantification range:

- 0.1 to 20 Wt% for individual ethers, 0.1 to 12 Wt% for individual alcohols
- 0.1 to 5 Vol% for benzene, 1 to 15 Vol% for toluene
- 0.5 to 10 Vol% for individual C<sub>8</sub> aromatics, 5 to 30 Vol% for total C<sub>9</sub> and heavier aromatics, 10 to 80 Vol% for total aromatics

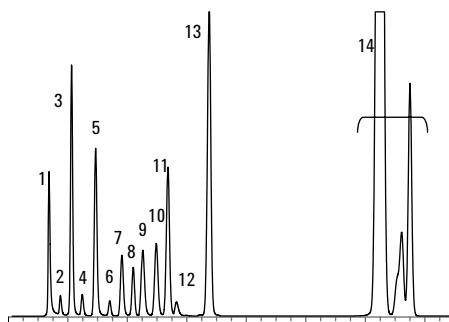
### Configured per method:

- ASTM D4815, ASTM D5580

### ASTM D4815

#### Peak Identification

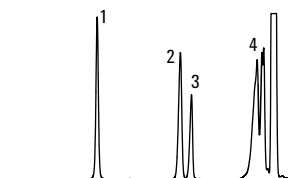
- |                         |                           |
|-------------------------|---------------------------|
| 1. methanol             | 8. DIPE                   |
| 2. ethanol              | 9. isobutanol             |
| 3. isopropanol          | 10. <i>tert</i> -pentanol |
| 4. <i>tert</i> -butanol | 11. DME                   |
| 5. <i>n</i> -propanol   | 12. <i>n</i> -butanol     |
| 6. MTBE                 | 13. TAME                  |
| 7. <i>sec</i> -butanol  | 14. heavier hydrocarbon   |



### ASTM D5580 - 1st run

#### Peak Identification

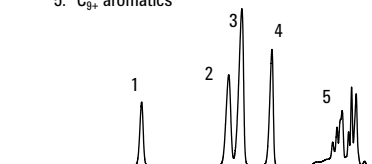
1. benzene
2. toluene
3. 2-hexanone
4. backflush peaks



### ASTM D5580 - 2nd run

#### Peak Identification

1. 2-hexanone
2. ethylbenzene
3. *m/p*-xylene
4. *o*-xylene
5. C<sub>9</sub>, aromatics



## ► KEY BENEFITS AND FEATURES

- Designed for both ASTM D4815 and ASTM D5580 methods, uses same hardware configuration
- Configured to determine oxygenates (ASTM D4815) and aromatics (ASTM D5580) in gasoline by using either helium or nitrogen (which is lower cost) carrier gas

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## Dual Parallel Channel Oxygenates and Aromatics in Fuel Analyzer (G3445 #612)

### Analyzer Description

#### Configuration:

- 2-valve/4-column (micro-packed and capillary)/2-FID

#### Sample type:

- Finished gasoline

#### Compounds analyzed:

- ASTM D4815: MTBE, ETBE, TAME, DIPE, methanol, ethanol, isopropanol, *n*-propanol, isobutanol, *tert*-butanol, *sec*-butanol, *n*-butanol, *tert*-pentanol
- ASTM D5580: benzene, toluene, ethylbenzene, xylene, C<sub>9</sub> and heavier aromatics, total aromatics

#### Typical quantification range:

- 0.1 to 20 Wt% for individual ethers, 0.1 to 12 Wt% for individual alcohols
- 0.1 to 5 Vol% for benzene, 1 to 15 Vol% for toluene
- 0.5 to 10 Vol% for individual C<sub>8</sub> aromatics, 5 to 30 Vol% for total C<sub>9</sub> and heavier aromatics, 10 to 80 Vol% for total aromatics

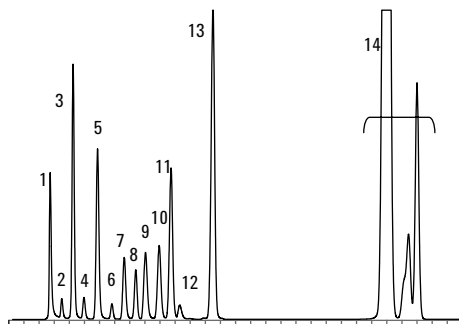
#### Configured per method:

- ASTM D4815, ASTM D5580

#### ASTM D4815

##### Peak Identification

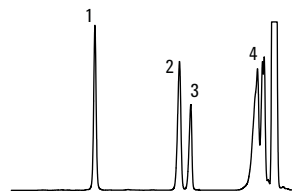
- |                         |                           |
|-------------------------|---------------------------|
| 1. methanol             | 8. DIPE                   |
| 2. ethanol              | 9. isobutanol             |
| 3. isopropanol          | 10. <i>tert</i> -pentanol |
| 4. <i>tert</i> -butanol | 11. DME                   |
| 5. <i>n</i> -propanol   | 12. <i>n</i> -butanol     |
| 6. MTBE                 | 13. TAME                  |
| 7. <i>sec</i> -butanol  | 14. heavier hydrocarbon   |



#### ASTM D5580 - 1st run

##### Peak Identification

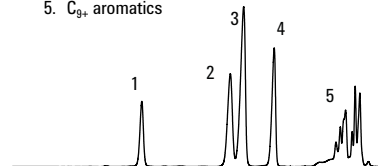
1. benzene
2. toluene
3. 2-hexanone
4. backflush peaks



#### ASTM D5580 - 2nd run

##### Peak Identification

1. 2-hexanone
2. ethylbenzene
3. *m/p*-xylene
4. *o*-xylene
5. C<sub>9</sub>, aromatics



### ► KEY BENEFITS AND FEATURES

- Dual parallel channels are configured on one GC system; one channel for ASTM D4815 and one for ASTM D5580
- Analyzer has the capability to determine oxygenates (ASTM D4815) and aromatics (ASTM D5580) in gasoline

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## Benzene in Gasoline Analyzer (G3445 #615)

### Analyzer Description

#### Configuration:

- 1-valve/2-column/TCD or FID

#### Sample type:

- Finished motor and aviation gasoline

#### Compounds analyzed:

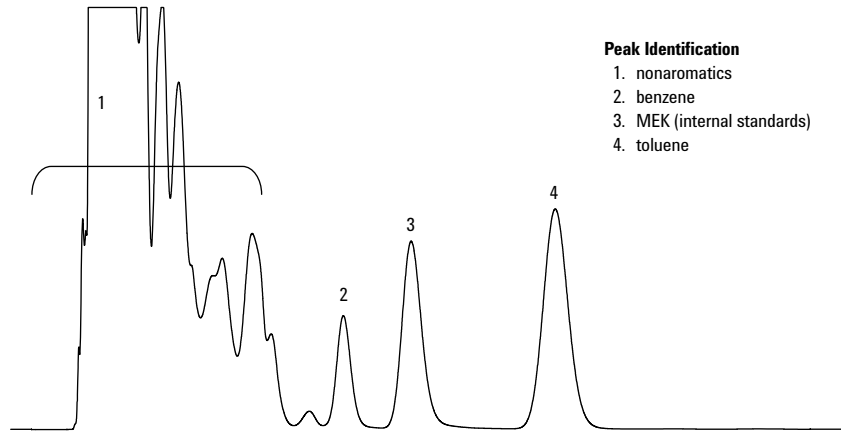
- Benzene, toluene

#### Typical quantification range:

- 0.1 to 5 Vol% for benzene
- 2 to 20 Vol% for toluene

#### Configured per method:

- ASTM D3606



#### Peak Identification

1. nonaromatics
2. benzene
3. MEK (internal standards)
4. toluene

### ► KEY BENEFITS AND FEATURES

- Single channel with dual packed-column configured to determine benzene and toluene in finished motor and aviation gasoline
- Independently heated valve system prevents condensation of heavy components in the sample

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# Aromatics in Fuel Analyzer (G3445 #616)

## Analyzer Description

### Configuration:

- 1-valve/2-column (micro-packed and capillary), 2-FID (or FID/TCD)

### Sample type:

- Finished gasoline

### Compounds analyzed:

- Benzene, toluene, ethylbenzene, xylene, C<sub>9</sub> and heavier aromatics, total aromatics

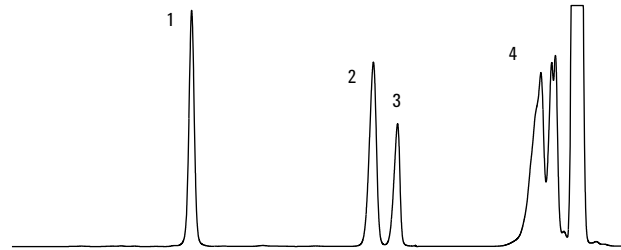
### Typical quantification range:

- 0.1 to 5 Vol% for benzene, 1 to 15 Vol% for toluene
- 0.5 to 10 Vol% for individual C<sub>8</sub> aromatics
- 5 to 30 Vol% for total C<sub>9</sub> and heavier aromatics
- 10 to 80 Vol% for total aromatics

### Configured per method:

- ASTM D5580

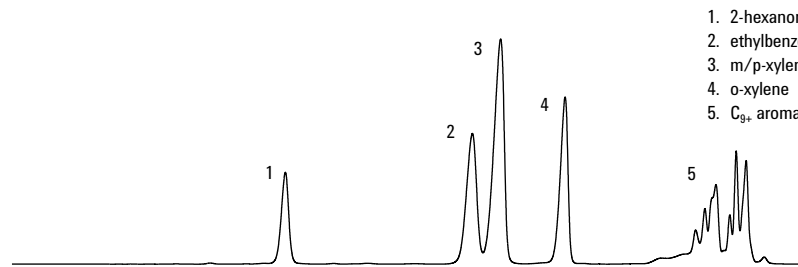
ASTM D5580 - 1st run



#### Peak Identification

1. benzene
2. toluene
3. 2-hexanone
4. backflush peaks

ASTM D5580 - 2nd run



#### Peak Identification

1. 2-hexanone
2. ethylbenzene
3. m/p-xylene
4. o-xylene
5. C<sub>9</sub>, aromatics

## ► KEY BENEFITS AND FEATURES

- Dual-column system configured to determine benzene, toluene, ethylbenzene, and xylene in finished gasoline
- System configuration uses improved TCEP column mounting to greatly improve method stability

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# Oxygenates and Aromatics in Gasoline by Deans Switch Analyzer (G3445 #617)

## Analyzer Description

### Configuration:

- Deans Switching/2-column/2-FID

### Sample type:

- Commercial or raw gasoline

### Compounds analyzed:

- Benzene, toluene, ethylbenzene, and oxygenates: MTBE, ETBE, TAME, DIPE, ethanol, isopropanol, *n*-propanol, isobutanol, *tert*-butanol, *sec*-butanol, *n*-butanol, and *tert*-pentanol

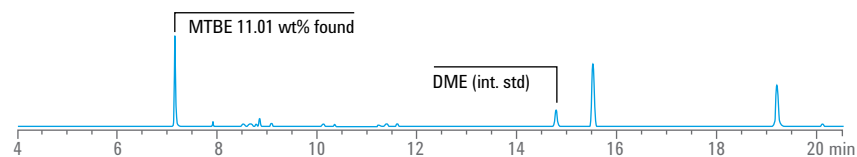
### Typical quantification range:

- 0.05 to 6 Vol% for benzene, 0.17 to 15 Vol% for individual organic oxygenates

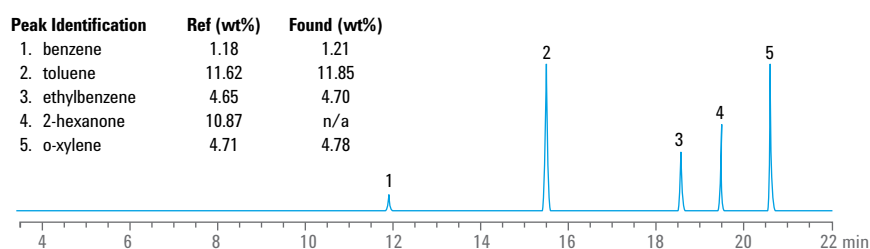
### Configured per method:

- EN 13132, EN 12177

### DB-1 Column (FID B)



### DB-1 Column (FID B)



## ► KEY BENEFITS AND FEATURES

- Configured to determine the oxygenates (EN 13132) and benzene (EN 12177) in gasoline
- Capillary Flow Technology (CFT) Deans Switch provides easier method setup and reliable performance by eliminating carry-over and minimizing peak tailing for very polar compounds
- Uses backflush to reduce analysis time

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## Low Level Oxygenates in Light Hydrocarbons Analyzer by Capillary Flow Technology Micro Volume Tee (G3445 #618)

### Analyzer Description

#### Configuration:

- Capillary Flow Technology micro-volume tee/2-column/FID/Autosampler (for liquid samples), gas sampling valve (for gas samples), LSV (for liquefied gases)

#### Sample type:

- Ethene, propene, hydrocarbon matrices that do not have a final boiling point greater than 200 °C

#### Compounds analyzed:

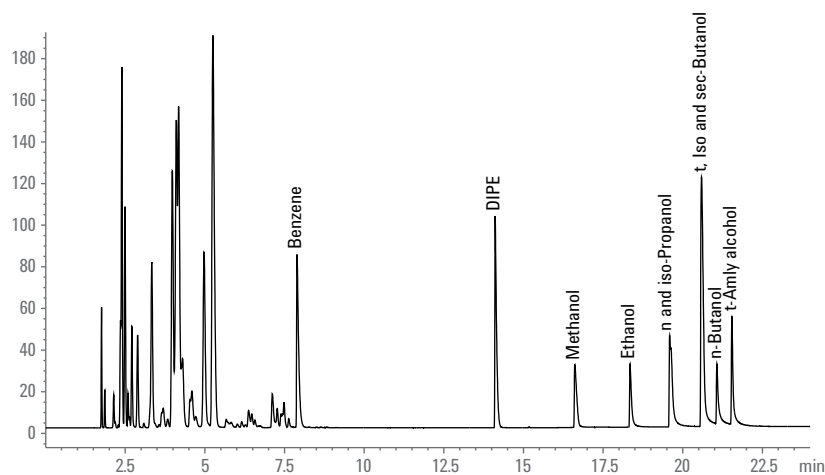
- MTBE, ETBE, DIPE, TAME, methanol, *n*-propanol and *i*-propanol, *n*-butanol, *i*-butanol, *tert*-butyl alcohol, *sec*-butyl alcohol, and *tert*-pentanol

#### Typical quantification range:

- 0.5 ppm for MTBE

#### Configured per method:

- ASTM D7423



### ► KEY BENEFITS AND FEATURES

- Analyzer configured to determine low level oxygenates in any hydrocarbon matrix with final boiling point <200 °C
- Capillary Flow Technology (CFT) fluidic switch with backflush used to remove hydrocarbons with higher boiling points
- Agilent GS-OxyPLOT column separates light hydrocarbons from oxygenates
- GS-OxyPLOT is surprisingly inert to polar compounds and is an excellent column for quantitative analysis of oxygenates at low concentrations

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## 3-in-1 Reformulated Fuel Analyzer with Large Valve Oven (LVO) (G3445 #621)

### Analyzer Description

#### Configuration:

- 3-valves/5-columns (capillary, packed), and micro-packed), TCD/FID

#### Sample type:

- Finished gasoline

#### Compounds analyzed:

- ASTM D4815: MTBE, ETBE, TAME, DIPE, methanol, ethanol, isopropanol, *n*-propanol, isobutanol, *tert*-butanol, *sec*-butanol, *n*-butanol, *tert*-pentanol
- ASTM D3606/D5580: benzene, toluene, ethylbenzene, xylene, C<sub>9</sub> and heavier aromatics, total aromatics

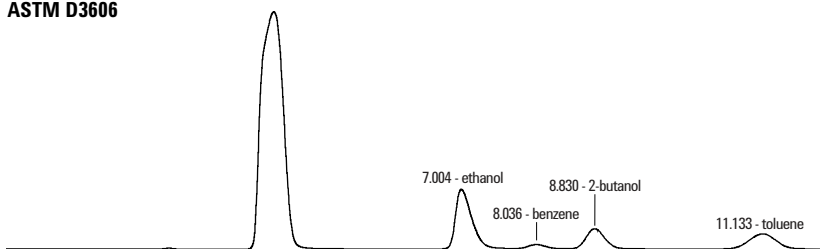
#### Typical quantification range:

- ASTM D3606
  - 0.1-5.0 Vol% benzene
  - 2-20 Vol% toluene
- ASTM D4815
  - 0.1-15 Wt% ethers and alcohols
- ASTM D5580
  - 0.1-5% benzene
  - 1-15% toluene
  - 0.5-10% C8 aromatics
  - 5-30% C9 plus aromatics
  - 10-80% total aromatics

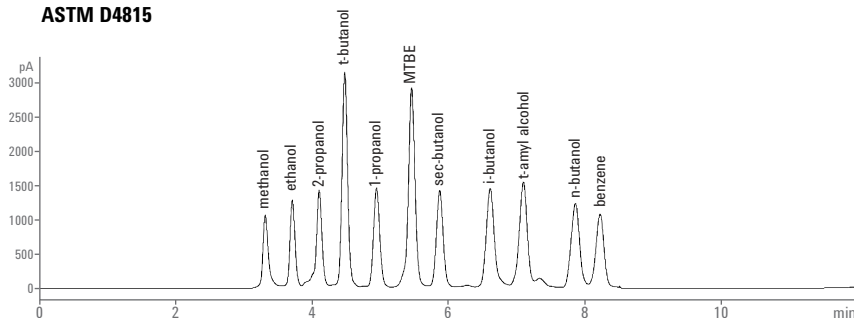
#### Configured per method:

- ASTM D3606, ASTM D4815, ASTM D5580

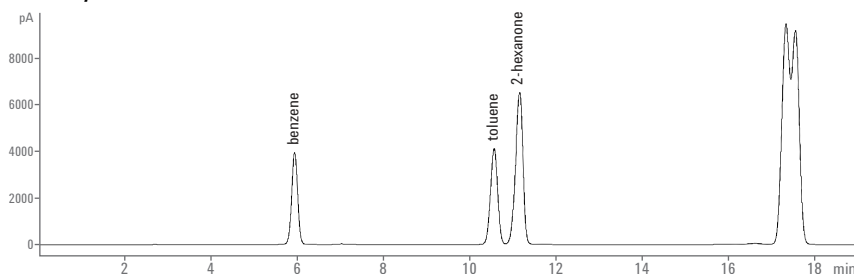
ASTM D3606



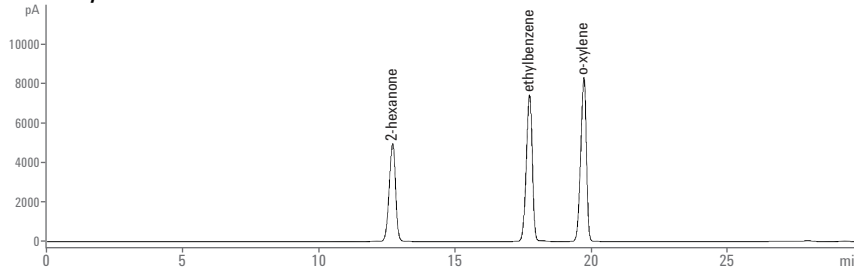
ASTM D4815



ASTM D5580  
Analysis 1



ASTM D5580  
Analysis 2



### ► KEY BENEFITS AND FEATURES

- Solution for 3 ASTM methods for oxygenates and aromatics in gasoline
- Capable of running one method at a time

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## Trace Oxygenates in Reformulated Gasoline Analyzer (7890-0340)

### Analyzer Description

#### Configuration:

- 1-valve/2-column/FID

#### Sample type:

- Reformulated gasoline, ethanol/gasoline blends, naphtha

#### Compounds analyzed:

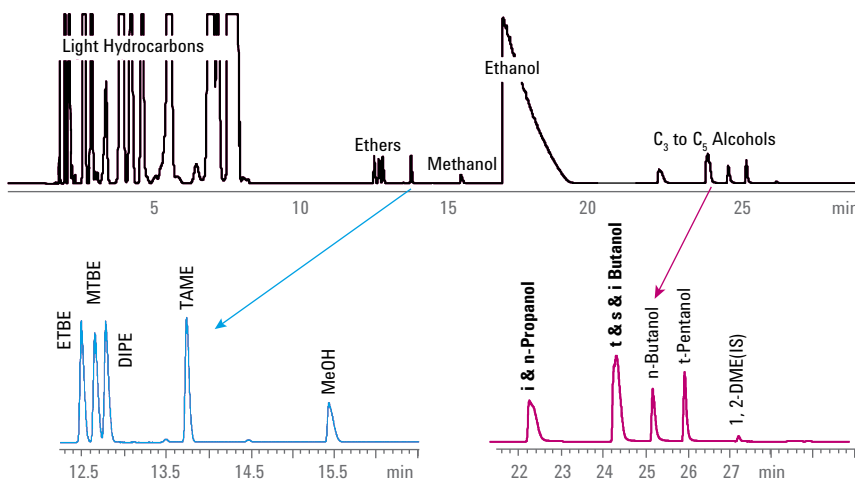
- MTBE, ETBE, DIPE, TAME, methanol, *n*-propanol, *i*-propanol, *n*-butanol, *i*-butanol, *tert*-butyl alcohol, *sec*-butyl alcohol, *tert*-pentanol

#### Typical quantification range:

- 10 to 1,000 ppm (wt/wt) for oxygenates
- 1 to 15 Vol% for ethanol

#### Configured per method:

- ASTM D7754



### ► KEY BENEFITS AND FEATURES

- Analyzer configured to analyze oxygenates (at the 10 to 1,000 ppm level) in gasoline containing 1 to 15 Wt% ethanol additive
- Excellent separation of oxygenates from light hydrocarbons
- Resolves all ethers (ETBE, MTBE, DIPE, and TAME)
- High quantitative precision for high and low ether concentrations in the presence of 1 to 15 Wt% ethanol

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## SOLUTIONS FOR BIOFUEL/RENEWABLE FUEL



### Ensure the highest quality standards from feedstock to final product

Global pressure to reduce our dependence on fossil fuels is driving the demand for sustainable, reliable, and clean alternative energy sources. It has also fueled a steady increase in research involving the conversion of biomass to biofuels.

In recent years, vegetable oil derivatives (*biodiesel*) have successfully powered automobiles, public transportation systems, and long-haul trucking fleets, while providing a fuel source—*produced from locally available feedstock*—that reduces engine wear and generates lower sulfur and CO<sub>2</sub> emissions.

While there is no question that biodiesel benefits our environment, producing biodiesel from many different oils does create product quality and uniformity challenges. Success depends upon characterizing raw materials, monitoring chemical conversions, ensuring process efficiency, and validating product quality.

To help you meet these challenges, Agilent has expanded our Alternative Energy Analyzer Portfolio to include **Biofuel GC Analyzers and Renewable Energy GC Analyzers**. These “ready-to-go” systems include proven analytical methods and advanced features that enable your lab to quickly validate methods that conform to ASTM and CEN standards for FAMEs, glycerin/glyceride, and trace methanol measurements.

Learn more about Analyzer Solutions for the energy and chemical industry at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## Solutions for Biofuel/Renewable Fuel

| Analyzer Number | Configuration   | Capability  |
|-----------------|---|---|
| G3445 #631      | On-column capillary inlet/FID with optional liquid autosampler  | Free glycerin, monoglycerides, diglycerides, triglycerides, bound glycerin, and total glycerin in B100 biodiesel per ASTM D6584   |
| G3445 #633      | Split/splitless inlet/FID with optional liquid autosampler  | FAME content between C <sub>6</sub> -C <sub>24</sub> in B100 biodiesel per EN 14103:2011  |
| G3445 #634      | Split/splitless inlet/FID with optional methods for automated sample preparation                            | Glycerol, monoglycerides, diglycerides, triglycerides in B100 biodiesel per EN14105:2011  |
| G3582A #110     | 2-channel Micro GC<br>- Channel 1: CP-molsieve 5Å<br>- Channel 2: CP PoraPLOT U                             | Compounds analyzed in biogas:<br>- Channel 1: C <sub>1</sub> , H <sub>2</sub> , O <sub>2</sub> , N <sub>2</sub> and CO<br>- Channel 2: C <sub>2</sub> -C <sub>3</sub> , H <sub>2</sub> S and CO <sub>2</sub>  |
| G3582A #111     | 3-channel Micro GC<br>- Channel 1: CP-molsieve 5Å<br>- Channel 2: CP PoraPLOT U<br>- Channel 3: CP-Sil 5 CB | Compounds analyzed in biogas:<br>- Channel 1: C <sub>1</sub> , H <sub>2</sub> , O <sub>2</sub> , N <sub>2</sub> and CO<br>- Channel 2: C <sub>2</sub> -C <sub>3</sub> , H <sub>2</sub> S and CO <sub>2</sub><br>- Channel 3: C <sub>4</sub> -C <sub>7</sub> |
| 7890-0295       | Headspace/FID with optional liquid autosampler  | Methanol in B100 biodiesel per EN 14110:2003  |
| M7482A          | GC/MSD operating in Scan/SIM mode with optional 7896A WorkBench for fully automated analysis                | Trace fatty acid methyl esters per IP 585   |

From the laboratory to the field, Agilent Technologies can provide analytical solutions to address your requirements for Renewable Energy Research.

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## Glycerin in Biodiesel Analyzer (G3445 #631)

### Analyzer Description

#### Configuration:

- On-column capillary inlet/FID

#### Sample type:

- B100 biodiesel
- Not applicable to vegetable oil methyl esters obtained from lauric oils, such as coconut oil and palm kernel oil

#### Compounds analyzed:

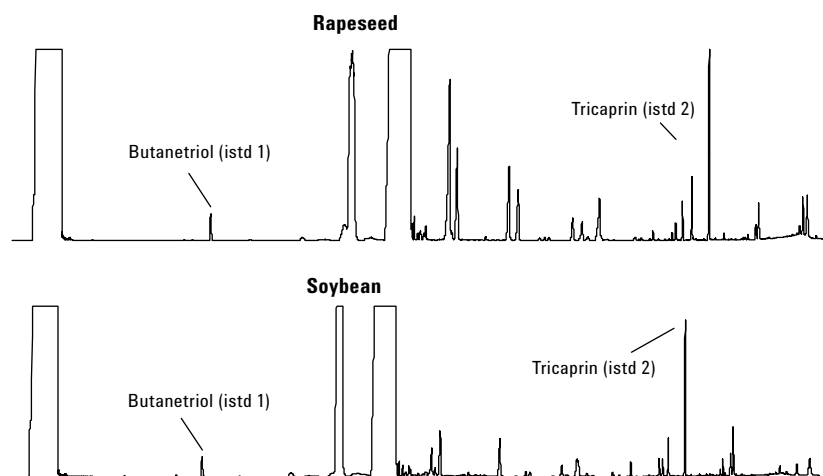
- Free glycerin, monoglycerides, diglycerides, triglycerides, bound glycerin, total glycerin

#### Typical quantification range:

- 0.005 to 0.05 Wt% for free glycerin, 0.05 to 0.5 Wt% for total glycerin

#### Configured per method:

- ASTM D6584



### ► KEY BENEFITS AND FEATURES

- Configured with COC inlet with a retention gap column in front of the analytical column
  - Significantly improves peak shape for better accuracy and reproducibility
  - Use of standard syringes instead of special narrow-bore syringes
- Uses Agilent “Ultimate Union” to connect retention gap to column
  - Reliable, leak-free, high-temperature connection
- Exceeds ASTM and CEN specifications for calibration and precision

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## FAME Content in Biodiesel Analyzer (G3445 #633)

### Analyzer Description

#### Configuration:

- Split/splitless inlet/FID

#### Sample type:

- B100 biodiesel, which contains methyl esters between C<sub>6</sub>-C<sub>24</sub>

#### Compounds analyzed:

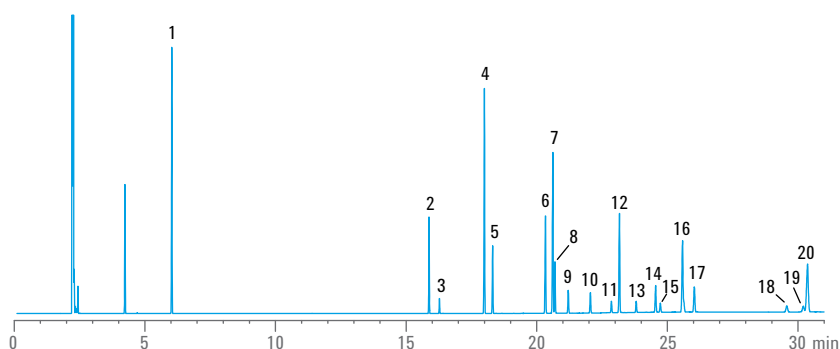
- Methyl esters between C<sub>6</sub>-C<sub>24</sub>

#### Typical quantification range:

- > 90 Wt% for esters, 1 to 15 Wt% for linoleic acid content

#### Configured per method:

- EN 14103:2011



| Peak No. | Name                | RT (min)     | Peak no. | Name   | RT (min.)                    |
|----------|---------------------|--------------|----------|--|------------------------------|
| 1.       | methyl hexanoate    | C6:0 6.031   | 11.      | methyl arachidate                              | C20:0 22.857                 |
| 2.       | methyl myristate    | C14:0 15.878 | 12.      | methyl eicosonate                              | C20:1 23.166                 |
| 3.       | methyl myristoleate | C14:1 16.275 | 13.      | methyl eicosadienoate                          | C20:2 23.808                 |
| 4.       | methyl palmitate    | C16:0 17.996 | 14.      | methyl arachidonate                            | C20:4 24.551                 |
| 5.       | methyl palmitoleate | C16:1 18.311 | 15.      | methyl eicosatrienoate                         | C20:3 24.730                 |
| 6.       | methyl stearate     | C18:0 20.332 | 16.      | methylbehenate and<br>methyl eicosapentaenoate | C22:0 25.582<br>C20:5 25.582 |
| 7.       | methyl oleate (9)   | C18:1 20.617 | 17.      | methyl erucate                                 | C22:1 26.031                 |
| 8.       | methyl oleate (11)  | C18:1 20.697 | 18.      | methyl lignocerate                             | C24:0 29.574                 |
| 9.       | methyl linoleate    | C18:2 21.205 | 19.      | methyl nervonate                               | C24:1 30.203                 |
| 10.      | methyl linolenate   | C18:3 22.052 | 20.      | methyl docosahexaenoate                        | C22:6 30.365                 |

### ► KEY BENEFITS AND FEATURES

- Excellent precision with a very simple, easy-to-use method
- Esters separated on wax-type column
- Internal standard (methyl nonadecanoate) used for quantification
- Analysis time about 35 minutes

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# Biodiesel Analyzer per EN 14105:2011 (G3445 #634)

## Analyzer Description

### Configuration:

- Split/splitless inlet/FID

### Sample type:

- B100 biodiesel

### Compounds analyzed:

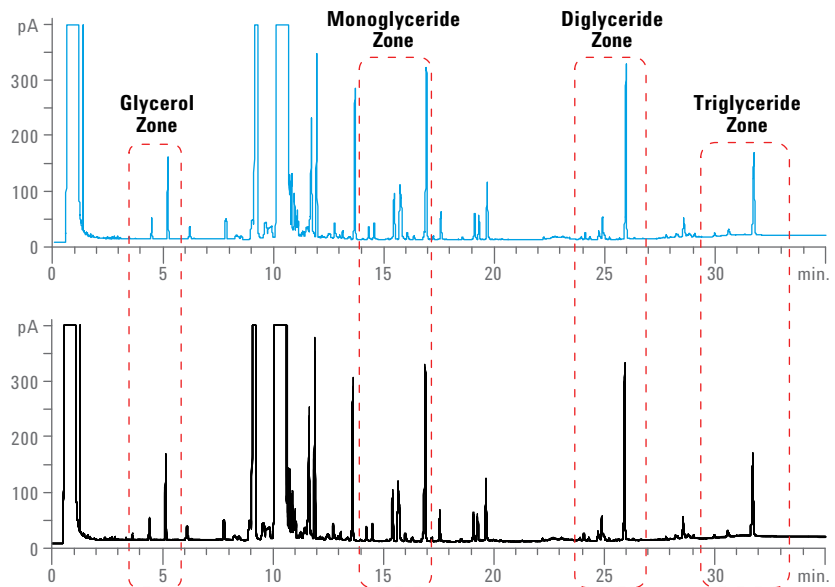
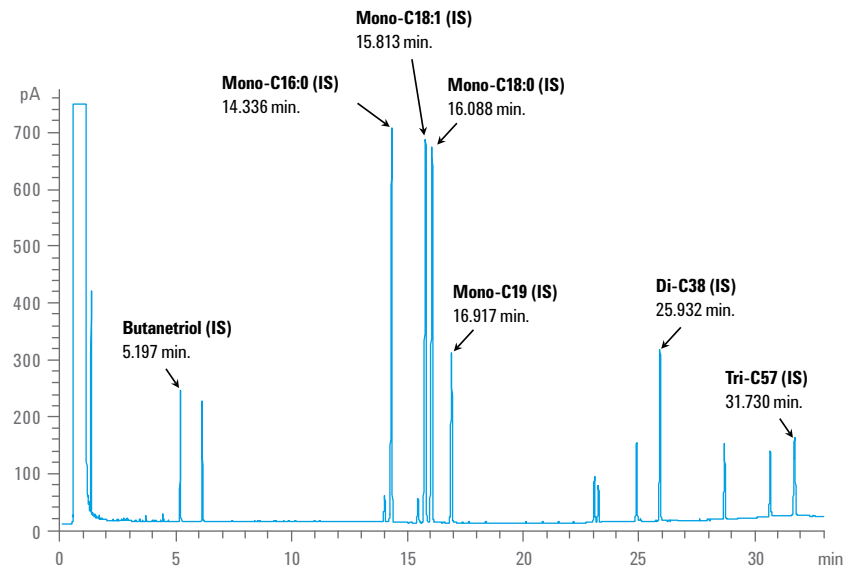
- Glycerol, monoglycerides, diglycerides, triglycerides

### Typical quantification range:

- 0.001 to 0.05 Wt% for free glycerin, 0.1 to 0.5 Wt% for all glycerides

### Configured per method:

- EN 14105:2011



Automated preparation of B100 Biodiesel sample with Agilent WorkBench (Upper chromatogram: Single run, Lower chromatogram: Overlay of 10 separate samples preparations)

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## ► KEY BENEFITS AND FEATURES

- Configured for automated sample preparation with Agilent 7696A Sample Prep WorkBench
  - Automation reduces reagent consumption by up to 10x
  - WorkBench not included with system, must be purchased separately
- Exceeds CEN specifications for calibration and precision for method EN 14105:2011
  - Automated prep of calibration standard sample prep exceeds method performance criteria
  - Automated prep of B100 samples exceeds method precision requirement
- Includes macro for data calculation and reporting per method EN 14105:2011, requires Microsoft Excel®



### **Are your analysts manually preparing samples and standards?**

Automate workflow using the Agilent 7696A Sample Prep WorkBench—precise sample prep per compliance method requirements.

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# Biogas Analyzer: 2-Channel Micro GC (G3582A #110)

## Analyzer Description

**Configuration:**

- 2-Channel Micro GC
- Channel 1: CP-molsieve 5Å
- Channel 2: CP PoraPLOT U

**Sample type:**

- Biogas

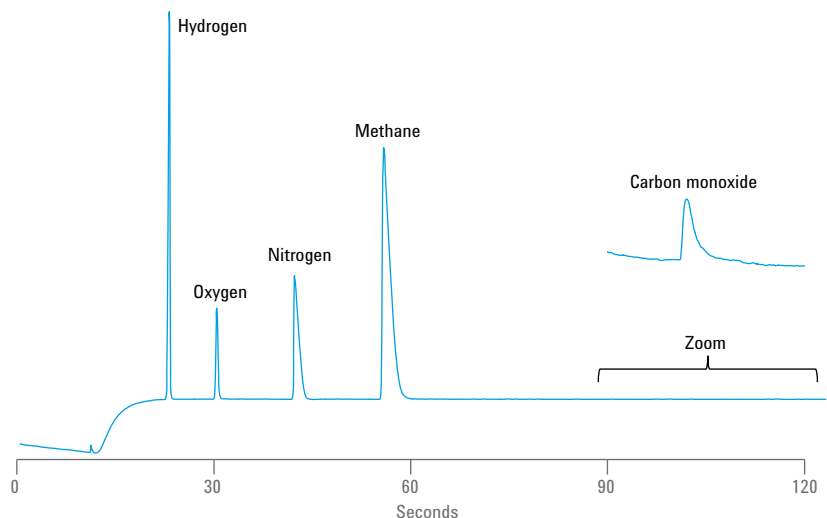
**Compounds analyzed:**

- Channel 1: C<sub>1</sub>, H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub> and CO
- Channel 2: C<sub>2</sub>-C<sub>3</sub>, H<sub>2</sub>S and CO<sub>2</sub>

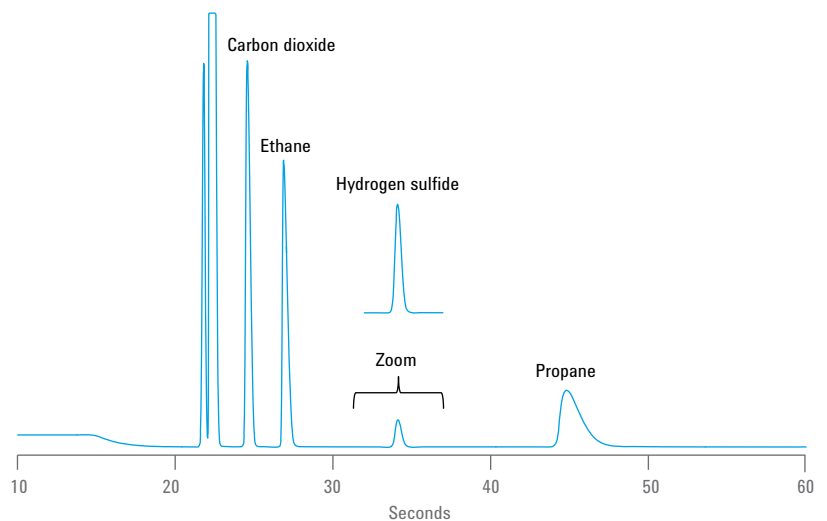
**Typical quantification range:**

- 1-10 ppm

**Channel 1 – Permanent gases**



**Channel 2 – CO<sub>2</sub>, C<sub>2</sub>, H<sub>2</sub>S, and C<sub>3</sub>**



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## ► KEY BENEFITS AND FEATURES

- Optimized for the rapid analysis of biogas composition in 120 seconds
  - Characterizes permanent gases, hydrocarbons C<sub>1</sub>-C<sub>3</sub> and H<sub>2</sub>S concentrations
- Preconfigured with analytical method
  - Injection parameters
  - Analytical parameters
- Excellent repeatability:
  - Retention time: RSD 0.1%
  - Peak area: RSD 0.5%
- Dual carrier gas for optimal detection



**Rapid, reliable results for laboratory, process, or field analysis.** Micro GC analyzers provide chromatographic results in seconds instead of minutes.



## Biogas Analyzer: 3-Channel Micro GC (G3582A #111)

### Analyzer Description

#### Configuration:

- 3-Channel Micro GC
  - Channel 1: CP-molsieve 5Å
  - Channel 2: CP-PoraPLOT U
  - Channel 3: CP-Sil 5 CB

#### Sample type:

- Biogas mixed with hydrocarbon streams, e.g., LPG, Natural Gas

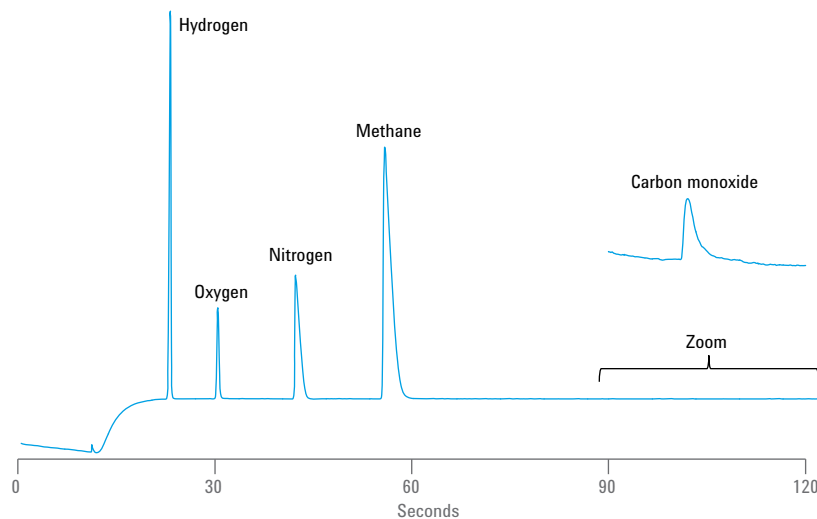
#### Compounds analyzed:

- Channel 1: C<sub>1</sub>, H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub> and CO
- Channel 2: C<sub>2</sub>-C<sub>3</sub>, H<sub>2</sub>S and CO<sub>2</sub>
- Channel 3: C<sub>4</sub>-C<sub>7</sub>

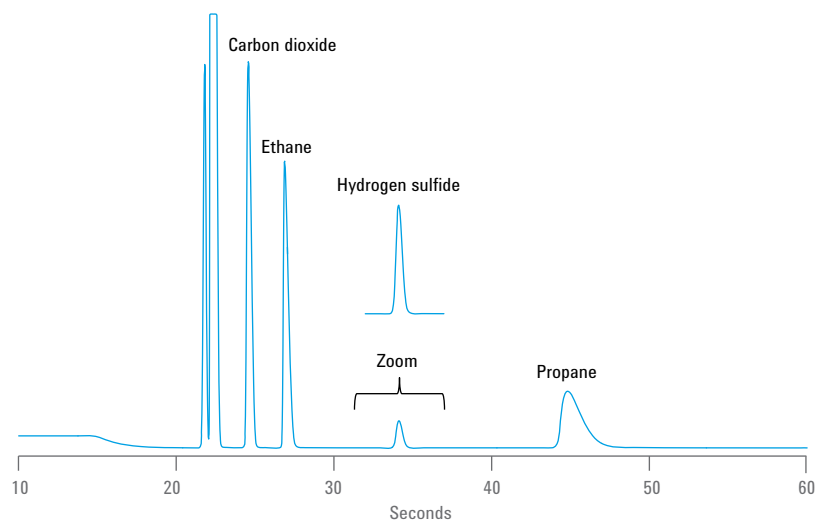
#### Typical quantification range:

- 1-10 ppm

#### Channel 1 – Permanent gases



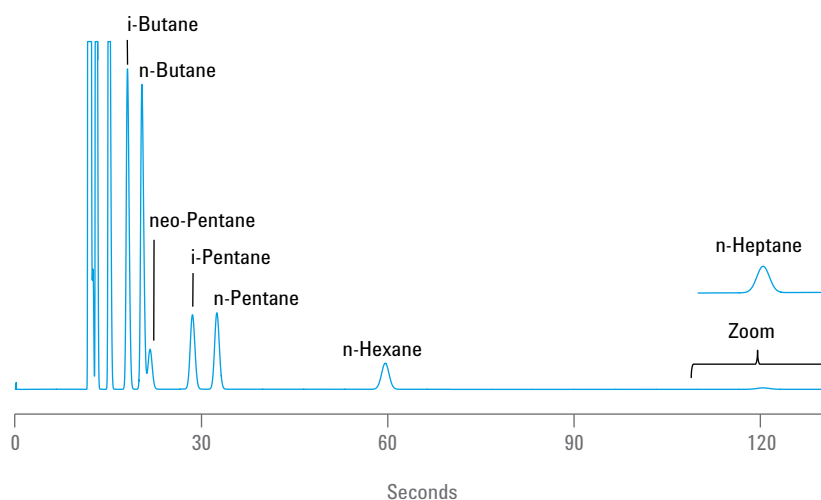
#### Channel 2 – CO<sub>2</sub>, C<sub>2</sub>, H<sub>2</sub>S, and C<sub>3</sub>



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Channel 3 – C<sub>4</sub> – C<sub>7</sub> hydrocarbons

Take the quick, cost-effective path through your toughest challenges. Contact Agilent to discuss an Analyzer or custom GC for your specific need at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## ► KEY BENEFITS AND FEATURES

- Optimized for the rapid analysis of biogas composition in 120 seconds
  - Characterizes permanent gases, hydrocarbons C<sub>1</sub>-C<sub>7</sub> and H<sub>2</sub>S concentrations
- Preconfigured with analytical method
  - Injection parameters
  - Analytical parameters
- Excellent repeatability:
  - Retention time: RSD 0.1%
  - Peak area: RSD 0.5%
- Dual carrier gas for optimal detection

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## Methanol in Biodiesel Analyzer (7890-0295)

### Analyzer Description

**Configuration:**

- Headspace/FID

**Sample type:**

- B100 biodiesel

**Compounds analyzed:**

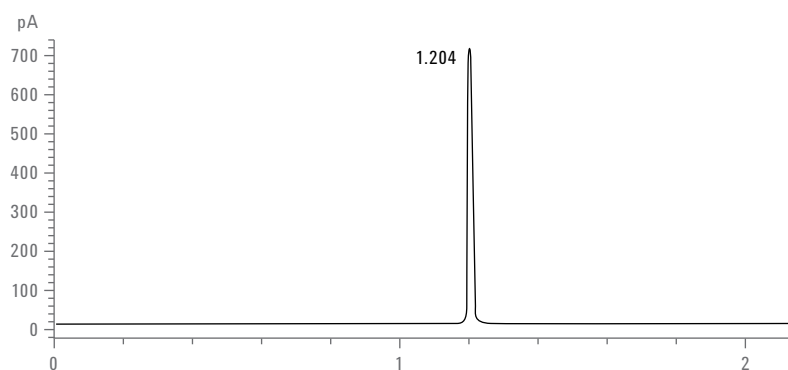
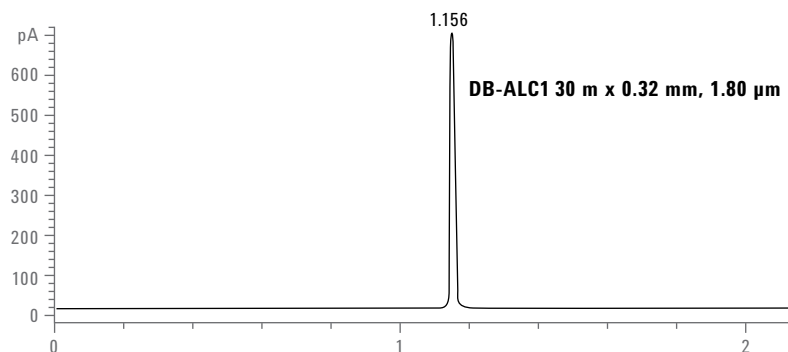
- Methanol

**Typical quantification range:**

- 0.01 to 0.5 Wt% for methanol

**Configured per method:**

- EN 14110:2003



### ► KEY BENEFITS AND FEATURES

- Uses Agilent 7697A headspace sampler for automated sample preparation
- Enhanced precision through backpressure regulation of headspace gas sampling valve loop
- Increased sensitivity for low concentration methanol through pressurization of the headspace sample loop
- Quantitative analysis using external calibration, no internal standard required
- Agilent J&W DB-ALC columns optimized for alcohol analysis by headspace GC
- Improved peak shape for easy quantification

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## FAMEs in Jet Fuel Analyzer (M7482A)

### Analyzer Description

#### Configuration:

- GC/MSD operating in Scan/SIM mode
- Optional 7896A WorkBench for fully automated analysis

#### Sample type:

- Jet fuel

#### Compounds analyzed:

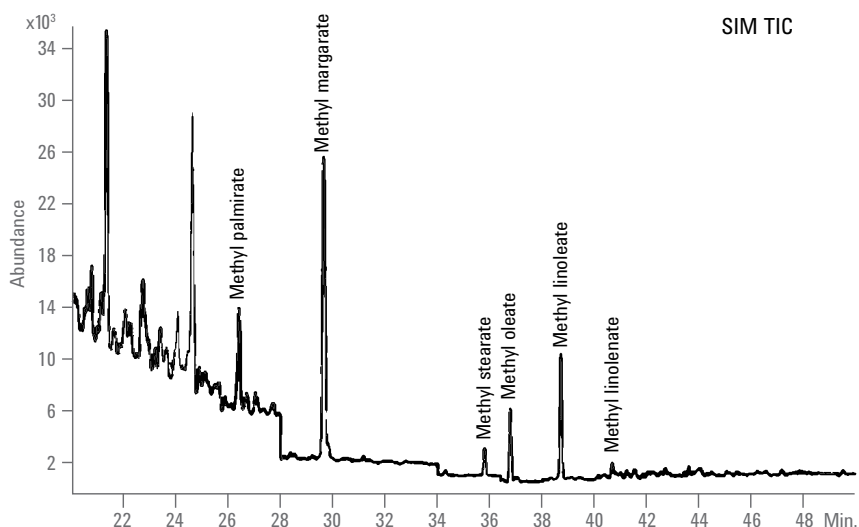
- Trace fatty acid methyl esters

#### Typical quantification range:

- 4.5 mg/kg to 150 mg/kg of selected FAME species

#### Configured per method:

- IP 535



### ► KEY BENEFITS AND FEATURES

- Helps to control adherence to limit of 5 mg/kg of total FAME content established by the Joint Inspection Group
- Optimized simultaneous SCAN/SIM maximizes sensitivity and selectivity
- Optional 7896A WorkBench reduces chemical resource need by 10x and improves calibration performance and sample precision

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## SOLUTIONS FOR LIQUEFIED PETROLEUM GAS



### Accurately measure calorific value and cleanliness during consumption

Synthesized by refining petroleum (or natural gas) derived from fossil fuels, Liquefied Petroleum Gas (LPG) is used to power vehicles and heat appliances.

LPG contains a flammable mixture of hydrocarbon gases—primarily propane, butane, or a mixture of the two. However, because LPG is usually odorless, low concentrations of sulfur are also added to facilitate leak detection.

Gas composition directly affects both the calorific value and burning cleanliness of LPG. **Agilent LPG Analyzers** conform to strict industry standards for determining LPG composition and performing fast analysis of hydrocarbon content from C<sub>1</sub>-C<sub>6</sub> in LPG samples.

Learn more about Analyzer Solutions for the energy and chemical industry at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## Solutions for Liquefied Petroleum Gas (LPG)

| Analyzer Number | Configuration                                 | Factory checkout per method                    |
|-----------------|---|--|
| 7890-0138       | LPG composition analyzer                      | ASTM D2163, ASTM D2593, ASTM D2712, ASTM D4424 |
| 7890-0188       | Commercial propane and butane LPG analyzer    | ISO 7941, EN 27941, and IP 405                 |
| 7890-0397       | Hydrocarbons in LPG analyzer                  | ASTM D2163                                     |
| Contact Agilent | Ethane composition and impurities by Micro GC |  |
| Contact Agilent | Propane and butane streams by Micro GC        |  |

## Reference Methods for LPG: Quantitation Ranges for Compounds of Interest

| Compound                         | ASTM D1945<br>mol % | ASTM D1946<br>mol % | ASTM D2163<br>mol % | UOP 539<br>mol % | GPA 2186     | GPA 2286     | ISO 6974-6    |
|----------------------------------|---------------------|---------------------|---------------------|------------------|--------------|--------------|---------------|
| H <sub>2</sub> S                 | 0.3 to 30           |                     | –                   | 0.1 to 25        | –            | 0.1 to 100   | –             |
| O <sub>2</sub>                   | 0.01 to 20          |                     | –                   | 0.1 to 99.9      | –            | 0.005 to 20  | 0.007 to 5    |
| N <sub>2</sub>                   | 0.01 to 100         | –                   | –                   |                  | 0.005 to 5   | 0.005 to 100 | 0.007 to 40   |
| CH <sub>4</sub>                  | 0.01 to 100         | –                   | –                   |                  | 0.001 to 5   | 0.001 to 100 | 40 to 100     |
| CO                               | –                   | –                   | –                   |                  | –            | –            | 0.001 to 1    |
| CO <sub>2</sub>                  | 0.01 to 20          | –                   | –                   |                  | 0.005 to 5   | 0.005 to 100 | 0.001 to 10   |
| He                               | 0.01 to 10          | –                   | –                   |                  | –            | –            | 0.002 to 0.5  |
| H <sub>2</sub>                   | 0.01 to 10          | –                   | –                   |                  | –            | –            | 0.001 to 0.5  |
| Ethane                           | 0.01 to 100         | –                   | 0.1 and above       | 0.1 to 99.9      | 0.001 to 95  | 0.001 to 100 | 0.002 to 15   |
| Propane                          | 0.01 to 100         | –                   | 0.1 and above       |                  | 0.001 to 100 | 0.001 to 100 | 0.001 to 5    |
| C <sub>4</sub> isomers           | 0.01 to 10          | –                   | 0.1 and above       |                  | 0.001 to 100 | 0.001 to 10  | 0.0001 to 1   |
| C <sub>5</sub> isomers           | 0.01 to 2           | –                   | 0.1 and above       |                  | 0.001 to 50  | 0.001 to 5   | 0.0001 to 0.5 |
| C <sub>6</sub> isomers           | 0.01 to 2           | –                   | –                   | –                | 0.001 to 30  | 0.001 to 5   | 0.0001 to 0.5 |
| C <sub>6+</sub>                  | –                   | –                   | –                   | 0.1 to 99.9      | –            | –            | –             |
| C <sub>7+</sub>                  | 0.01 to 1           | –                   | –                   | –                | 0.001 to 30  | –            | –             |
| C <sub>7</sub> -C <sub>8</sub>   | –                   | –                   | –                   | –                | –            | 0.001 to 2   | 0.0001 to 0.5 |
| C <sub>9</sub>                   | –                   | –                   | –                   | –                | –            | 0.001 to 2   | –             |
| C <sub>10</sub> -C <sub>14</sub> | –                   | –                   | –                   | –                | –            | 0.001 to 1   | –             |

Note: In the table above the symbol "–" indicates that this parameter was not specified.

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# LPG Composition Analyzer (7890-0138)

## Analyzer Description

### Configuration:

- Liquid valve/1-column (PLOT Alumina)/FID

### Sample type:

- LPG

### Compounds analyzed:

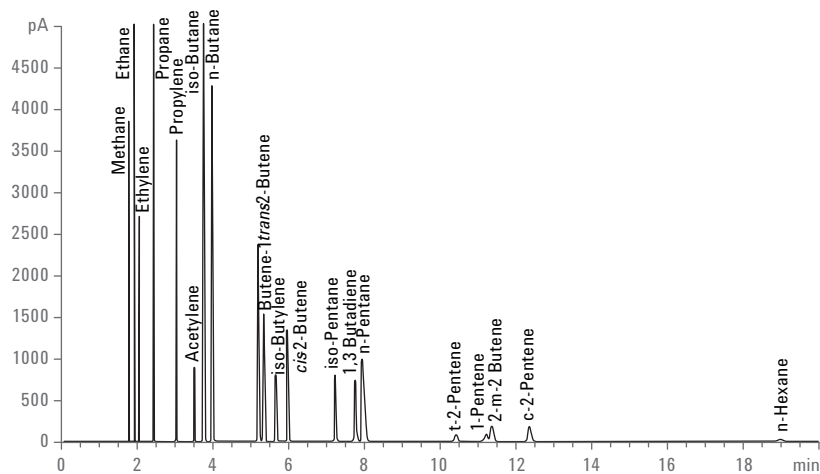
- C<sub>1</sub>-C<sub>6</sub>

### Typical quantification range:

- 10 ppm for hydrocarbons

### Configured per method:

- ASTM D2163, ASTM D2593, ASTM D2712, ASTM D4424



## ► KEY BENEFITS AND FEATURES

- Single channel with single LSV
- PLOT Alumina is ideal for separation of the C<sub>1</sub> to C<sub>8</sub> isomers; especially for separation of cyclopropane and propylene

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# Commercial Propane and Butane LPG Analyzer (7890-0188)

## Analyzer Description

**Configuration:**

- Liquid valve/1-column (packed column)/FID

**Sample type:**

- LPG, commercial propane and butane

**Compounds analyzed:**

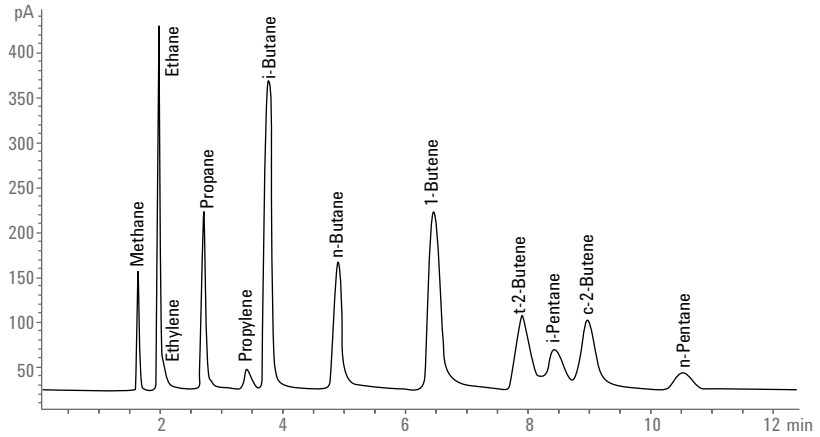
- C<sub>1</sub>-C<sub>6</sub>

**Typical quantification range:**

- 10 ppm for hydrocarbons

**Configured per method:**

- ISO 7941, EN 27941, and IP 405



## ► KEY BENEFITS AND FEATURES

- Single channel with single LSV
- Rugged packed column
- Configured to analyze liquefied petroleum gas, specifically propane and butane for commercial use

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# Hydrocarbons in LPG Analyzer (7890-0397)

## Analyzer Description

### Configuration:

- 1-liquid valve/2-valve/  
2-column/FID

### Sample type:

- LPG (liquefied petroleum gases),  
propane/propylene mixture

### Compounds analyzed:

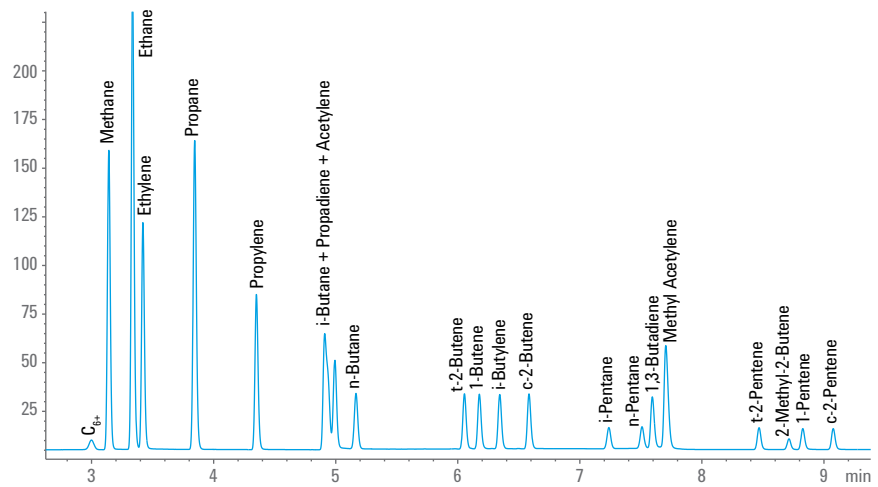
- C<sub>1</sub>-C<sub>5</sub>
- C<sub>6+</sub> as backflush

### Typical quantification range:

- 10 ppm for hydrocarbons

### Configured per method:

- ASTM D2163



## ► KEY BENEFITS AND FEATURES

- Single channel with single LSV valve
- Configured to analyze liquefied petroleum gas, specifically propane and butane for commercial use

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## Liquefied Petroleum Micro GC Analyzer: Ethane Composition and Impurities (Contact Agilent)

### Analyzer Description

#### Configuration:

- Single channel Micro GC
- Agilent J&W PoraPLOT Q column

#### Sample type:

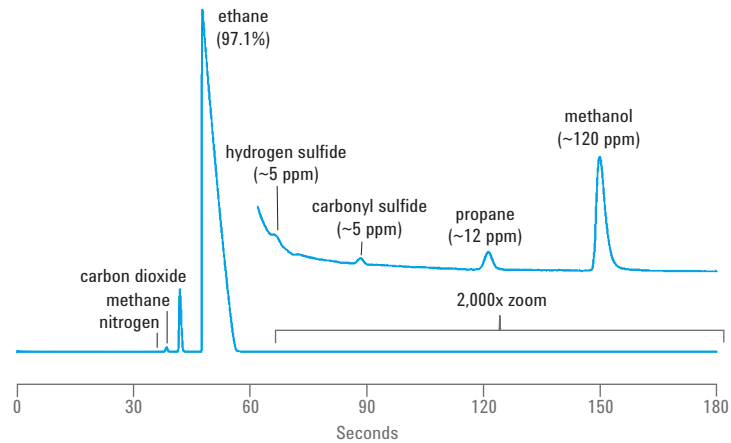
- Ethane

#### Compounds analyzed:

- Nitrogen, methane, ethane, propane, hydrogen sulfide, carbonyl sulfide, methanol

#### Typical quantification range:

- 5 ppm to % for impurities
- Up to 100% for bulk



### ► KEY BENEFITS AND FEATURES

- Sample preparation is done via a Micro Gasifier
  - Heated pressure reducer to turn LPG liquid into gas of the required sample pressure
- Very fast analysis
  - Typically 3 minute analysis time
  - Isothermal analysis ensures very fast run-to-run times
- Compositional and impurity analysis in a single run
- Very good detection limits (typically low ppm range)

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## Liquefied Petroleum Micro GC Analyzer: Propane and Butane Streams (Contact Agilent)

### Analyzer Description

#### Configuration:

- Single channel Micro GC
- Agilent J&W CP-Sil 5 CB column

#### Sample type:

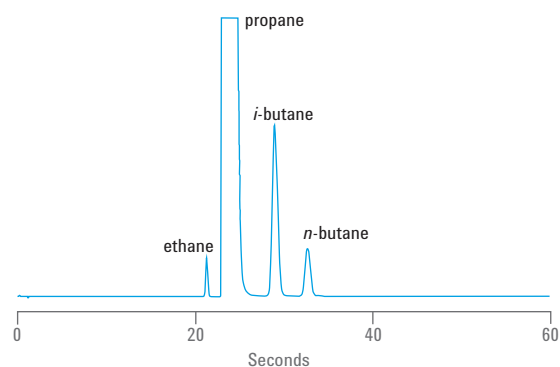
- Propane and Butane streams

#### Compounds analyzed:

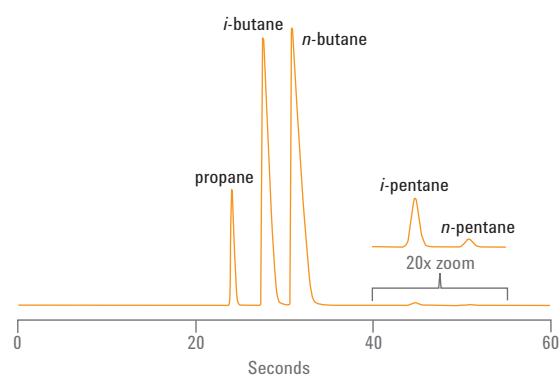
- Ethane, propane, *i*-butane, *n*-butane, *i*-pentane, *n*-pentane

#### Typical quantification range:

- 5 ppm to % for impurities
- Up to 100% for bulk



Propane stream



Butane stream

### ► KEY BENEFITS AND FEATURES

- Sample preparation is done via a Micro Gasifier
  - Heated pressure reducer to turn LPG liquid into gas of the required sample pressure
- Very fast analysis
  - Typically 60 seconds analysis time
  - Isothermal analysis ensures very fast run-to-run times
- Compositional and impurity analysis in a single run
- Very good detection limits (typically low ppm range)

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# SOLUTIONS FOR TRACE IMPURITIES



## Meet the stringent demands of both regulators and customers

Accurately measuring feedstock impurities at increasingly lower concentrations is critical to process efficiency and profitability. For example, producers of high-purity monomers (such as ethylene and propylene) face stiff competition and tight customer specifications.

Purity is also a must for researchers and production operations in the food, pharmaceutical, chemical, and semi-conductor industries. Failure to fully characterize the impurity content of N, Ar, H<sub>2</sub>, and CO<sub>2</sub> can render the gas unfit for a given application.

Trace contaminants also contribute to equipment corrosion and reduced polymer yields. Even worse, they can cause catalyst degradation, poisoning, and contamination, which can lead to costly, time-consuming catalyst bed replacement.

With their innovative hardware configurations, **Agilent Trace Impurities Analyzers** reliably confirm the purity of raw materials provided by your suppliers, so you can detect contaminants with confidence at trace (ppb) levels.

Learn more about Analyzer Solutions for the energy and chemical industry at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## Solutions for Trace Impurities

| Analyzer Number    | Configuration   | Capability   |   |
|--------------------|---|--|---|
|                    |   | Suitable for process gas containing high levels of CH <sub>4</sub>   | Suitable for process gas containing O <sub>2</sub>  |
| G3445 #646         | 2-valve/2-column/methanizer/FID   | Yes  | No  |
| G3445 #647         | 1-valve/2-column/methanizer/FID   | No   | No  |
| 7890-0191          | 3-valve/5-column (packed)/<br>2-TCD/Hastelloy valve, inlet tubing,<br>sample filter and nickel stripper   | H <sub>2</sub> , O <sub>2</sub> , N <sub>2</sub> , CH <sub>4</sub> , CO <sub>2</sub> , and CO in pure chlorine gas       |   |
| 7890-0237          | 1-valve/2-column (packed column)/PDHID  | H <sub>2</sub> , O <sub>2</sub> + N <sub>2</sub> composite peak, CH <sub>4</sub> ,<br>CO, CO <sub>2</sub> in monomer gas |   |
| 7890-0355          | 2-valve/2-column/methanizer/FID   | No   | Yes<br>• Separates O <sub>2</sub> from CO with backflush<br>• High level of O <sub>2</sub> will not impact CO |
| 7890-0366          | 2-valve/2-column/methanizer/FID   | No   | Yes<br>• Separates O <sub>2</sub> from CO   |
| 7890-0409          | 1-valve/2-column (packed column)/PDHID  | H <sub>2</sub> , O <sub>2</sub> , N <sub>2</sub> , CO, CH <sub>4</sub> in ethylene/<br>propylene                         |   |
| M7484AA or M7474AA | 2-valve/1-column GC/MSD with high efficiency<br>source using self cleaning ion source option<br><br>- M7484AA includes permeation tube dilution<br>block for built-in calibration |  |   |

## Reference Methods for CO/CO<sub>2</sub> Analysis: Quantitation Ranges for Compounds of Interest

| UOP 603            |                     |
|--------------------|---------------------|
| Component Gas      | Concentration Range |
| CO/CO <sub>2</sub> | 0.5 to 500 mol-ppm  |

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## Low CO and CO<sub>2</sub> in Process Gases Containing High CH<sub>4</sub> Analyzer (G3445 #646)

### Analyzer Description

#### Configuration:

- 2-valve/2-column (packed column)/Methanizer/FID

#### Sample type:

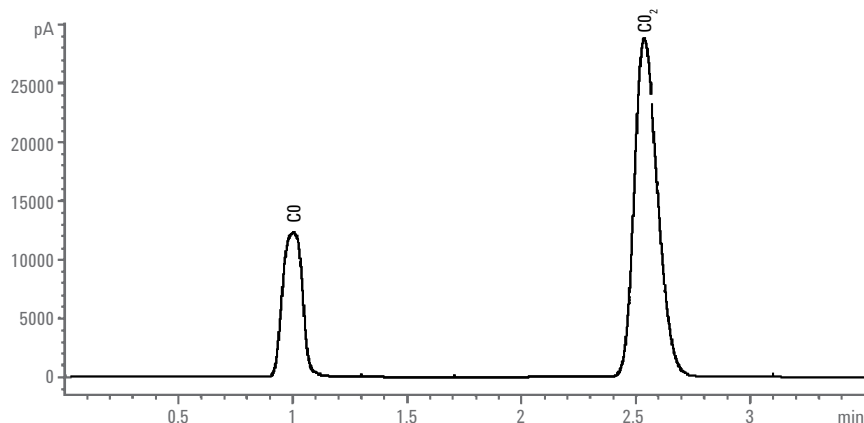
- Process gas containing high levels of methane, natural gas

#### Compounds analyzed:

- CO<sub>2</sub> and CO

#### Typical quantification range:

- 0.2 ppm for CO
- 0.4 ppm for CO<sub>2</sub>



### ► KEY BENEFITS AND FEATURES

- Single channel with packed columns
- High concentration hydrocarbons cut on the pre-column; CH<sub>4</sub> vented during the analysis through use of a 4-port valve
- Trace levels of CO and CO<sub>2</sub> can be analyzed by conversion to CH<sub>4</sub> and detection with FID
- 3 minute analysis time

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## Low CO and CO<sub>2</sub> in Process Gas Analyzer (G3445 #647)

### Analyzer Description

#### Configuration:

- 1-valve/2-column (packed column)/Methanizer/FID

#### Sample type:

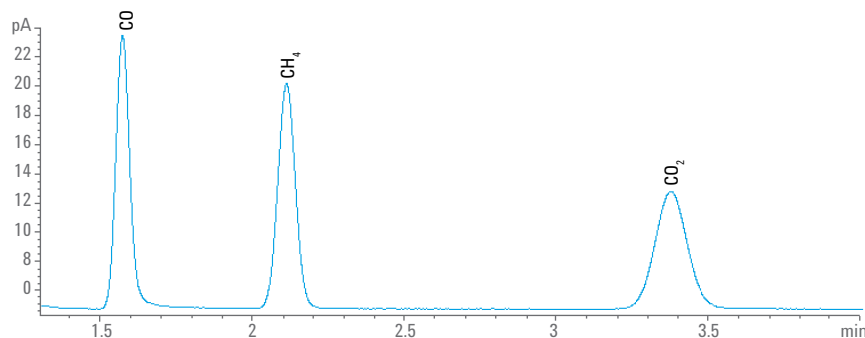
- Ethylene, propylene, or process gas streams containing low concentrations of methane

#### Compounds analyzed:

- CO<sub>2</sub> and CO

#### Typical quantification range:

- 0.2 ppm for CO
- 0.4 ppm for CO<sub>2</sub>



### ► KEY BENEFITS AND FEATURES

- Single channel with packed columns
- Hydrocarbons cut on the pre-column while trace levels of CO and CO<sub>2</sub> pass through Methanizer for conversion to CH<sub>4</sub> and detection with FID
- 4 minute analysis time

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## 2-Channel Inert Impurities in Pure Chlorine Analyzer (7890-0191)

### Analyzer Description

#### Configuration:

- 3-valve/5-column (packed column)/2-TCD/Hastelloy valve, inlet tubing, sample filter, nickel stripper

#### Sample type:

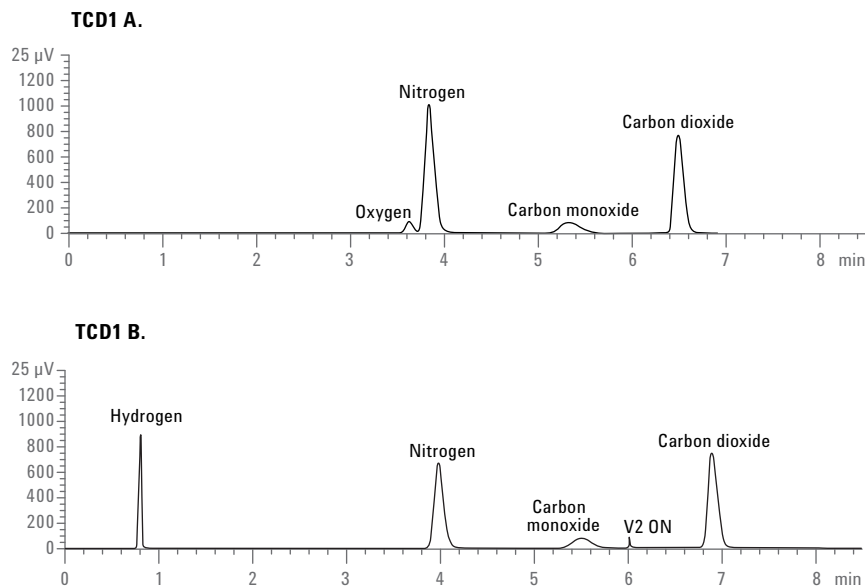
- Pure chlorine gas

#### Compounds analyzed:

- H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, CO<sub>2</sub>, and CO

#### Typical quantification range:

- 50 ppm for fixed gases



### ► KEY BENEFITS AND FEATURES

- Dual TCD channels with packed column system measures low levels of inert impurities in pure chlorine
- Chlorine is cut to the vent at the sampling
- Hastelloy valve, inlet tubing, sample filter, nickel stripper to avoid corrosion
- Full-range capability, including H<sub>2</sub> by the use of second TCD with argon carrier gas

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## Impurities in Monomers Analyzer by PDHID (7890-0237)

### Analyzer Description

#### Configuration:

- 1-valve/2-column (packed column)/PDHID

#### Sample type:

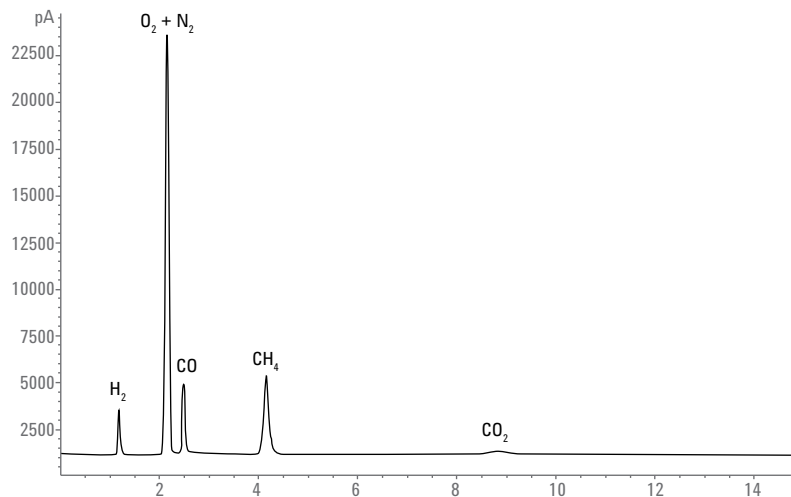
- Monomers (gas)

#### Compounds analyzed:

- H<sub>2</sub>, O<sub>2</sub> + N<sub>2</sub> composite peak, CH<sub>4</sub>, CO, CO<sub>2</sub>

#### Typical quantification range:

- 1.5 ppm for O<sub>2</sub> + N<sub>2</sub> composite peak
- 0.1 ppm for H<sub>2</sub>, CO and CO<sub>2</sub>



### ► KEY BENEFITS AND FEATURES

- Single-valve, dual-column system using PDHID in helium ionization mode allows determination of impurities at 0.1 ppm level
- Uses a 10-port, low-leakage valve
- Matrix effects are eliminated by “cutting out” the light components on a packed pre-column
- Inert impurities including H<sub>2</sub>, O<sub>2</sub>+N<sub>2</sub>, CO, CH<sub>4</sub>, and CO<sub>2</sub> are separated on micro-packed column and detected at 0.1 ppm and higher

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## Low CO and CO<sub>2</sub> in Process Gases with Nicat Bypass to Detector (7890-0355)

### Analyzer Description

#### Configuration:

- 2-valve/2-column (packed column)/Methanizer/FID

#### Sample type:

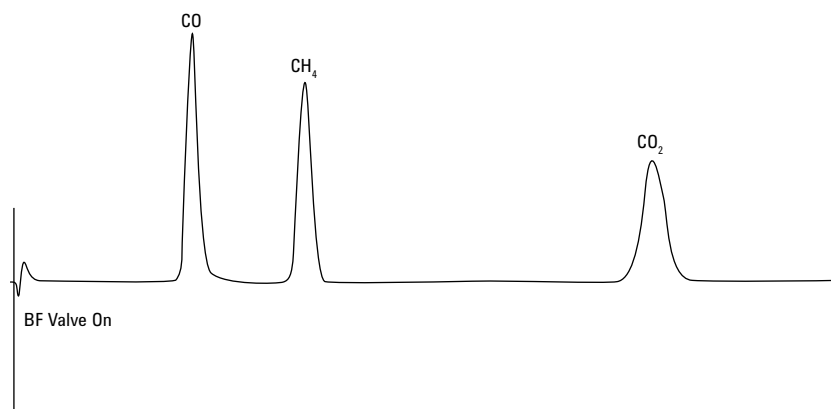
- Process gas containing air

#### Compounds analyzed:

- CO, CO<sub>2</sub>

#### Typical quantification range:

- 0.2 ppm for CO
- 0.4 ppm for CO<sub>2</sub>



### ► KEY BENEFITS AND FEATURES

- Single channel with packed columns
- Hydrocarbon components heavier than CO<sub>2</sub> are backflushed to vent
- Air or other non-backflushed gases can be by-passed to the FID without flowing through the nickel catalyst
- Trace levels of CO and CO<sub>2</sub> can be analyzed by conversion to CH<sub>4</sub> and detection with FID
- 6 minute analysis time

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## Trace CO and CO<sub>2</sub> in Hydrogen and Light Gaseous Hydrocarbons Analyzer (7890-0366)

### Analyzer Description

#### Configuration:

- 2-valve/2-column (packed column)/Methanizer/FID

#### Sample type:

- H<sub>2</sub>/Light gaseous hydrocarbons

#### Compounds analyzed:

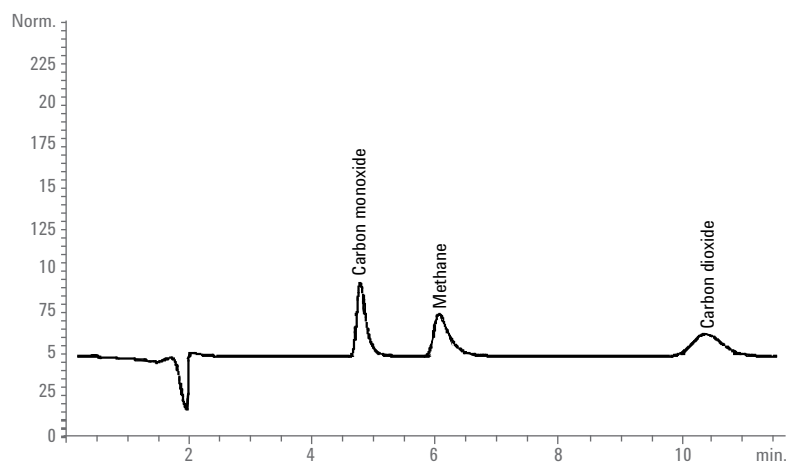
- CO, CO<sub>2</sub>, and CH<sub>4</sub>

#### Typical quantification range:

- 0.2 ppm for CO
- 0.4 ppm for CO<sub>2</sub>

#### Configured per method:

- UOP 603



### ► KEY BENEFITS AND FEATURES

- Single channel with packed columns
- Trace levels of CO and CO<sub>2</sub> can be analyzed by conversion to CH<sub>4</sub> and detection with FID
- 12 minute analysis time

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## Impurities in Ethylene/Propylene Analyzer by PDHID (7890-0409)

### Analyzer Description

#### Configuration:

- Valve/2-column (packed column)/PDHID

#### Sample type:

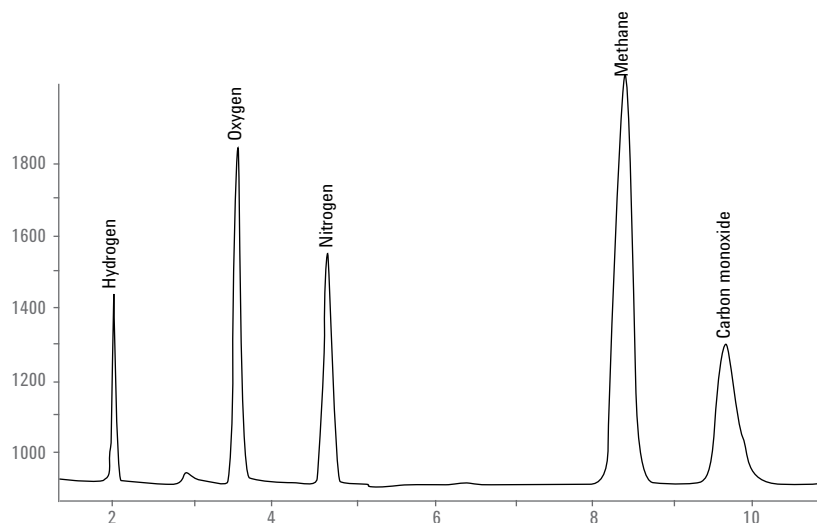
- Ethylene/Propylene

#### Compounds analyzed:

- H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, CO, CH<sub>4</sub>

#### Typical quantification range:

- H<sub>2</sub>: 0.1-40 ppm
- N<sub>2</sub>, CO: 0.1-10 ppm



### ► KEY BENEFITS AND FEATURES

- Single-valve, dual-column system using PDHID in helium ionization mode allows determination of impurities at 0.1 ppm level
- Use a 10-port, low-leakage valve
- Matrix effects are eliminated by “cutting out” the matrix on a packed pre-column
- Inert impurities including H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, CO, CH<sub>4</sub> are separated on packed column and detected at 0.1 ppm and higher

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## Impurities in ethylene/propylene by GC/MS (M7484AA or M7474AA)

### Analyzer Description

#### Configuration:

- 2-valve/1-column GC/MSD with high efficiency source using self cleaning ion source option
- M7484AA includes permeation tube dilution block for built-in calibration

#### Sample type:

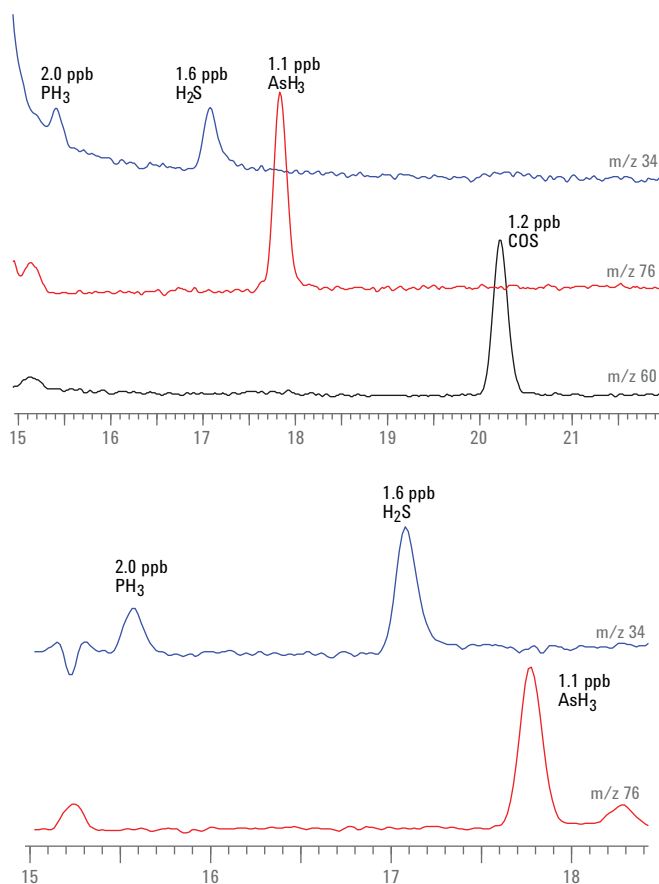
- High purity ethylene and propylene

#### Compounds analyzed:

- Arsine, phosphine, hydrogen sulfide, and carbonyl sulfide in ethylene matrix
- Arsine, phosphine, and hydrogen sulfide in propylene matrix

#### Typical quantification range:

- ~5-50 ppb



### ► KEY BENEFITS AND FEATURES

- Automated analyzer with simplified usability enables in-house analysis of impurities for quicker decisions and less reliance on external contract labs
- High efficiency source with self cleaning ion source for highest sensitivity, low maintenance, and long-term precision
- Uses a 4-port stream selector valve to choose between calibrants or sample and connects to a 6-port gas sampling valve with 50  $\mu$ L sample loop
- Integrated permeation tube dilution block (M7484AA only) enables fully automated calibration for improved efficiencies

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# SOLUTIONS FOR SIMULATED DISTILLATION



## Perform fast, accurate calculations that conform to ASTM methods

Hydrocarbon processors use distillation as their primary separation technique in crude oil refining. Understanding the boiling point distribution of hydrocarbon fractions and crude oil improves production efficiency, quality control, and commercialization of petroleum streams.

Simulated Distillation (Sim. Dist.), which is far less labor intensive than physical distillation, is the preferred method for characterizing boiling point distributions. Built around a GC analyzer equipped with a temperature-programmable inlet and FID, Sim. Dist. determines quantitative mass yield based on the boiling points for the components in hydrocarbon samples. Based on these results, producers can make informed decisions about process optimization and efficiency.

Agilent was one of the first companies to provide Sim. Dist. as a commercially available tool for hydrocarbon analysis. Our current **Simulated Distillation Analyzer** portfolio leverages cutting-edge technologies, such as a high-performance Multimode Inlet and user-friendly software for fast analysis, quick calculations, and detailed presentation of sample profiles. These complete, ready-to-use systems address ASTM methods D2887, D7213 (extended D2887), D6352, and D7169.

Learn more about Analyzer Solutions for the energy and chemical industry at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## Solutions for Simulated Distillation

| Analyzer Number                | ASTM Method | Carbon Number    | Sample Range         | Boiling Range |
|--------------------------------|-------------|------------------|----------------------|---------------|
| G3440 #653                     | ASTM D2887  | C <sub>44</sub>  | Jet fuel diesel      | 55-538 °C     |
| G3445 #654<br>(D2887 extended) | ASTM D7213  | C <sub>60</sub>  | Lube oil base stocks | 100-615 °C    |
| G3445 #655                     | ASTM D6352  | C <sub>100</sub> | Lube oil base stock  | 174-700 °C    |

Agilent's Multimode Inlet expands the range of applications for your laboratory GC; including suitability for Simulated Distillation.



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## Simulated Distillation Analyzer: Boiling Range from 55 to 538 °C (G3445 #653)

### Analyzer Description

#### Configuration:

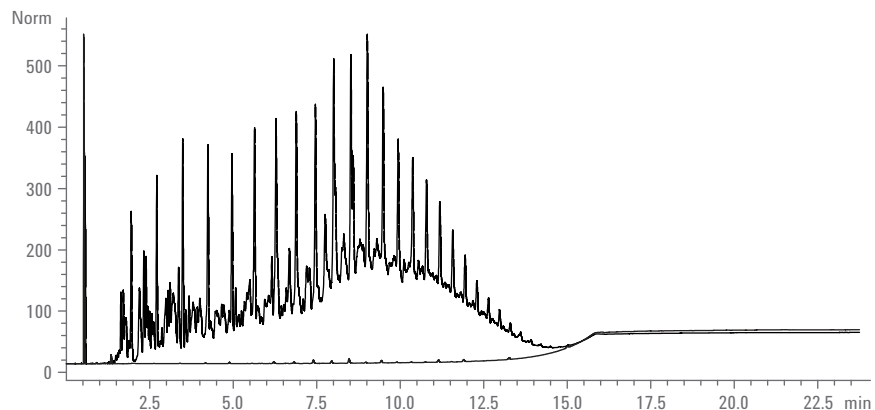
- Multimode inlet/FID/Sim. Dist. software

#### Sample type:

- Jet fuel, diesel, petroleum fraction with boiling range from 55 to 538 °C

#### Configured per method:

- ASTM D2887



### ► KEY BENEFITS AND FEATURES

- Easy-to-use software
- Flexible reporting options allow the user to customize reports to meet laboratory requirements
- Cost effective
- 6 minute fast Sim. Dist. can be achieved by use of short, small-diameter capillary column, 5 m × 180 µm, 0.4 µm

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## Simulated Distillation Analyzer: Boiling Range from 100 to 615 °C (G3445 #654)

### Analyzer Description

#### Configuration:

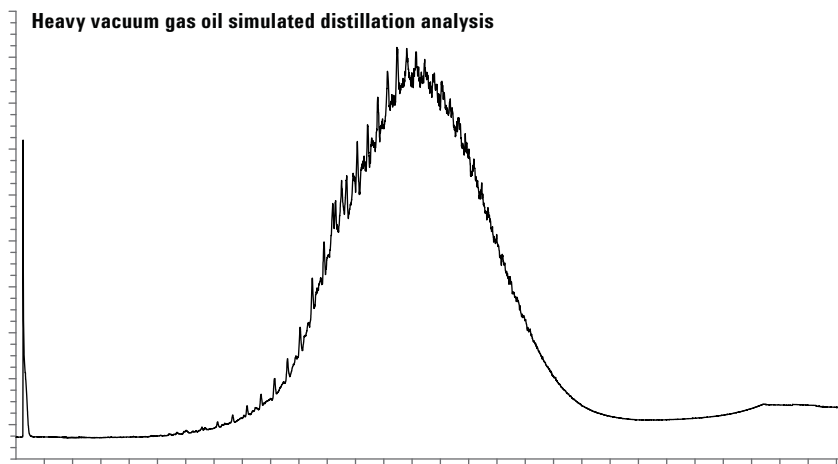
- Multimode Inlet/FID/Sim. Dist. software

#### Sample type:

- Lube oil, base stocks and petroleum distillate fractions having a boiling range from 100 to 615 °C

#### Configured per method:

- ASTM D7213 (D2887 extended)



### ► KEY BENEFITS AND FEATURES

- Configured with Multimode Inlet
  - No syringe-needle discrimination
  - Minimizes inlet discrimination
  - Solvent vent/matrix vent decreases interference and maintenance
  - Flexible modes of operation: hot/cold, split/splitless, and temperature programmed vaporization
  - Cold trapping in liner improves chromatographic peak shape, resolution
- Easy-to-use software
- User defined reporting options allow you to generate reports that meet the requirements for your laboratory

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## Simulated Distillation Analyzer: Boiling Range from 174 to 700 °C (G3445 #655)

### Analyzer Description

#### Configuration:

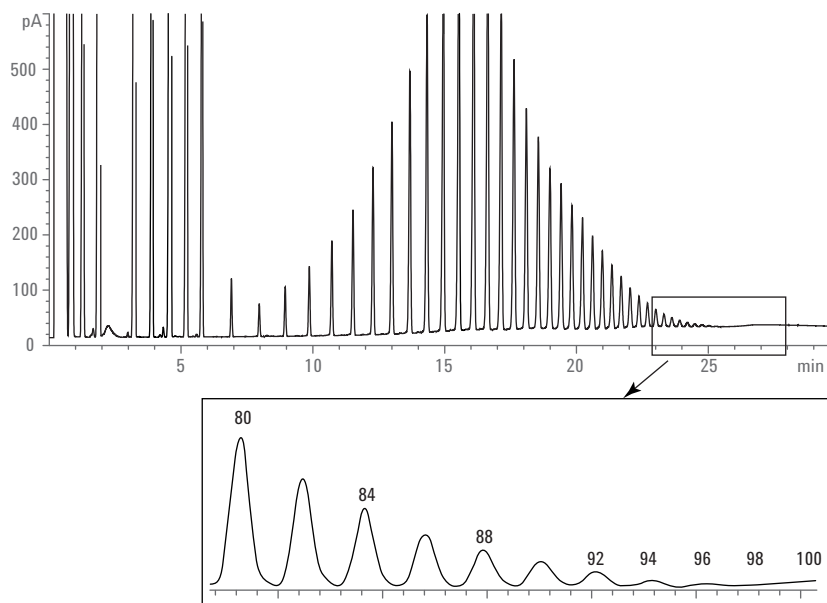
- Multimode Inlet/FID/Sim. Dist. software

#### Sample type:

- Lube oil, base stocks and petroleum distillate fractions having a boiling range from 174 to 700 °C

#### Configured per method:

- ASTM D6352



### ► KEY BENEFITS AND FEATURES

- Complete solution for extended ASTM D2887 (ASTM D7213), and ASTM D6352 on one GC
- High-performance Multimode Inlet
- Columns designed and perfected for Sim. Dist.
- Sim. Dist. software partially integrated with ChemStation
- Multiple reporting options

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# SOLUTIONS FOR SULFUR AND NITROSAMINE



## Optimize product quality and promote good environmental stewardship

The analysis of sulfur-containing compounds, usually at low concentrations, is a critical step in quality control and assurance throughout the energy and chemical industry. Sulfur occurs naturally in crude oil and natural gas; therefore, sulfur-containing hydrocarbons are ubiquitous in refinery and petrochemical products.

Because sulfur species are small, polar and reactive, sulfur contaminants in concentrations as low as parts-per-billion (ppb) can corrode process hardware, and permanently poison expensive catalysts used to refine and downstream processes. Failure to quickly detect and accurately quantify a “sulfur event” could cause significant financial loss due to contamination and production downtime.

Increased sulfur emissions from hydrocarbon products also contribute to “acid rain,” which can corrode vegetation, building materials, and structures with its high concentrations of  $\text{SO}_2$ . Accordingly, regulatory bodies such as the EPA and CEN have imposed legislation to reduce the presence of sulfur contaminants in hydrocarbon products.

Based on our most selective, sensitive detectors, **Agilent Sulfur Analyzers** are factory configured and chemically tested to reliably quantify trace-level sulfur compounds in a wide range of matrices.

Learn more about Analyzer Solutions for the energy and chemical industry at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## Solutions for Sulfur and Nitrosamine

| Analyzer Number | Configuration   | Capability   |
|-----------------|---|--|
| G3445 #661      | 1-valve/capillary column/SCD  | Sulfur compounds in natural gas or gaseous fuels; H <sub>2</sub> S, CS <sub>2</sub> , COS, mercaptans, aromatic sulfur compounds, sulfides per ASTM D5504  |
| G3445 #662      | Capillary inlet/capillary column/SCD (requires additional automatic liquid sampler for handling liquid sample analysis) | Volatile sulfur-containing compounds in light petroleum liquids, such as CS <sub>2</sub> , COS, mercaptans, aromatic sulfur compounds, sulfides per ASTM D5623 and UOP 791   |
| 7890-0167       | 3-valve/2-column/2-VI (volatile inlets)/2-FPD   | Volatile sulfur such as H <sub>2</sub> S, COS, MeSH, EtSH, DMS, CS <sub>2</sub> , t-BuSH and THT per ASTM D6228  |
| 7890-0460       | On-column capillary inlet/capillary column/NCD  | N-Nitrosodimethylamine, N-Nitrosopyrrolidine, N-Nitrosodibutylamine, N-Nitrosopiperidine, N-Nitrosomorpholine, N-Nitrosomethylethylamine, N-Nitrosodiethylamine, N-Nitrosodipropylamine, N-Nitrosodiphenylamine in liquids |

## Reference Methods for Sulfur and Nitrosamine: Quantitation Ranges for Compounds of Interest

| ASTM D5504 (SCD)   | ASTM D5623 (SCD)  | ASTM D6228 (FPD)  |
|--|---|---|
| Detection range for sulfur compounds<br>10-1,000,000 pg of sulfur equivalent<br>0.01 to 1000 mg/m <sup>3</sup> | Detection range for individual sulfur species<br>0.1 to 100 mg/kg | Detection range for sulfur compounds<br>20-20,000 pg of sulfur equivalent<br>0.02 to 20 mg/m <sup>3</sup> |

Inert treatment of sample pathways and detector components used in Agilent analyzers ensure your laboratory's success with trace impurity analysis.



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## Sulfur Analyzer by SCD (G3445 #661)

### Analyzer Description

#### Configuration:

- 1-valve/Capillary column/SCD

#### Sample type:

- Natural gas and other gaseous fuels

#### Compounds analyzed:

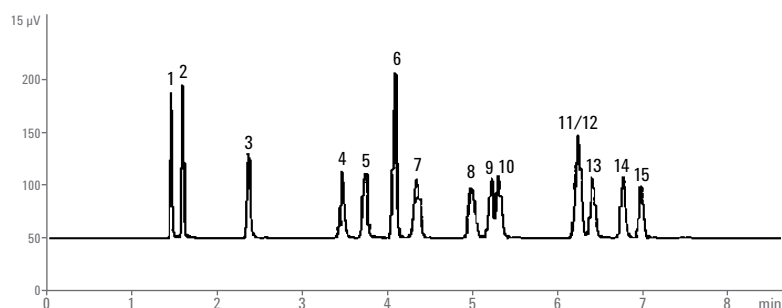
- Sulfur compounds in Natural Gas or Gaseous fuels
- H<sub>2</sub>S, CS<sub>2</sub>, COS, mercaptans, aromatic sulfur compounds, sulfides

#### Typical quantification range:

- 100 ppb of H<sub>2</sub>S
- 20-40 ppb for other S components (depends on different compounds)

#### Configured per method:

- ASTM D5504



| Components          | Formula   | Components                  | Formula  |
|---------------------|---|-----------------------------|--|
| 1. Hydrogen sulfide | H <sub>2</sub> S                                | 8. Tert-butyl mercaptan     | (CH <sub>3</sub> ) <sub>3</sub> CSH                              |
| 2. Carbonyl sulfide | COS   | 9. 1-propanethiol           | CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> SH               |
| 3. Methyl mercaptan | CH <sub>3</sub> SH                              | 10. Thiophene               | C <sub>4</sub> H <sub>4</sub> S                                  |
| 4. Ethyl mercaptan  | CH <sub>3</sub> SH                              | 11. n-butanethiol           | CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> SH               |
| 5. Dimethyl sulfide | CH <sub>3</sub> SCH <sub>3</sub>                | 12. Diethyl sulfide         | CH <sub>3</sub> CH <sub>2</sub> SCH <sub>2</sub> CH <sub>3</sub> |
| 6. Carbon disulfide | CS <sub>2</sub>                                 | 13. Methyl ethyl sulfide    | CH <sub>3</sub> SCH <sub>2</sub> CH <sub>3</sub>                 |
| 7. 2-propanethiol   | CH <sub>3</sub> SHC <sub>2</sub> H <sub>5</sub> | 14. 2-methyl-1-propanethiol | (CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> SH             |
|                     |   | 15. 1-methyl-1-propanethiol | CH <sub>3</sub> CH <sub>2</sub> CHSHCH <sub>3</sub>              |

### ► KEY BENEFITS AND FEATURES

- 7890 GC with Sulfur Chemiluminescence Detector-SCD for sulfur analysis in natural gas and gaseous fuels
- High Selectivity: higher selectivity for sulfur over carbon
- Equimolar: simplifies quantification of unknowns
- Linear: simplifies calibration
- UltiMetal hardware to enhance sulfur analysis without corrosion
- Dynamic detection range with GC-integrated 8355 SCD

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## Sulfur Analyzer by SCD (G3445 #662)

### Analyzer Description

#### Configuration:

- Capillary inlet/Capillary column/SCD (Requires additional Automatic Liquid Sampler for liquid sample analysis)

#### Sample type:

- Gasoline motor fuels, petroleum liquids with a final boiling point of approximately 230 °C or lower at atmospheric pressure

#### Compounds analyzed:

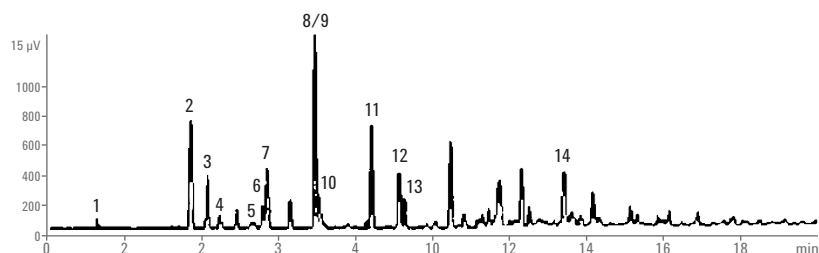
- Volatile sulfur-containing compounds in light petroleum liquids, such as CS<sub>2</sub>, COS, mercaptans, aromatic sulfur compounds, sulfides

#### Typical quantification range:

- 20 ppb of sulfur in gasoline

#### Configured per method:

- ASTM D5623, UOP 791



| Components                | Formula  | Components             | Formula  |
|---------------------------|--|------------------------|--|
| 1. Ethyl mercaptan        | CH <sub>3</sub> CH <sub>2</sub> SH               | 8. Thiophene           | C <sub>4</sub> H <sub>4</sub> S                              |
| 2. Dimethyl sulfide       | (CH <sub>3</sub> ) <sub>2</sub> S                | 9. Sec-butyl mercaptan | CH <sub>3</sub> CH <sub>2</sub> CH(SH)CH <sub>3</sub>        |
| 3. Carbondisulfide        | C <sub>2</sub> S                                 | 10. n-Butyl mercaptan  | CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> SH           |
| 4. Isopropyl mercaptan    | (CH <sub>3</sub> ) <sub>2</sub> CHSH             | 11. Dimethyl disulfide | CH <sub>3</sub> SSCH <sub>3</sub>                            |
| 5. t-Butyl mercaptan      | (CH <sub>3</sub> ) <sub>3</sub> CSH              | 12. 2-Methyl thiophene | C <sub>5</sub> H <sub>6</sub> S                              |
| 6. n-Propyl mercaptan     | CH <sub>3</sub> CH <sub>2</sub> SCH <sub>2</sub> | 13. 3-Methyl thiophene | C <sub>5</sub> H <sub>6</sub> S                              |
| 7. Methyleneethyl sulfide | CH <sub>3</sub> CH <sub>2</sub> SCH <sub>3</sub> | 14. Dimethyl disulfide | (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> S <sub>2</sub> |

### ► KEY BENEFITS AND FEATURES

- 7890 GC with Sulfur Chemiluminescence Detector (SCD) for sulfur analysis in natural gas and gaseous fuels
- High Selectivity: higher selectivity for sulfur over carbon
- Equimolar: simplifies quantification of unknowns
- Linear: simplifies calibration
- UltiMetal hardware to enhance sulfur analysis without corrosion
- Dynamic detection range with GC-integrated 8355 SCD

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# Volatile Sulfur Analyzer (7890-0167)

## Analyzer Description

### Configuration:

- 3-valve/2-column/2-VI (volatile inlets)/2-FPD

### Sample type:

- 7890-0148: C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub> monomers
- 7890-0167: Natural gas and fuel gas streams

### Compounds analyzed:

- Volatile sulfur such as H<sub>2</sub>S, COS, MeSH, EtSH, DMS, CS<sub>2</sub>, t-BuSH and THT

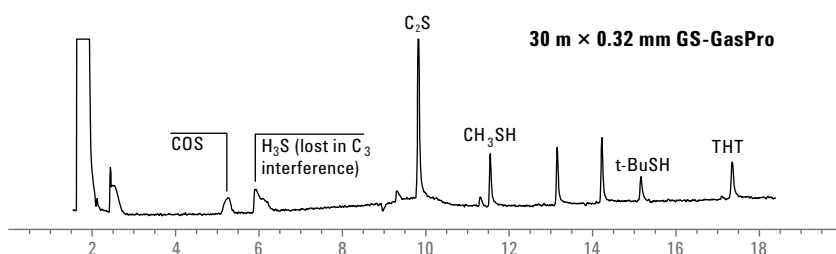
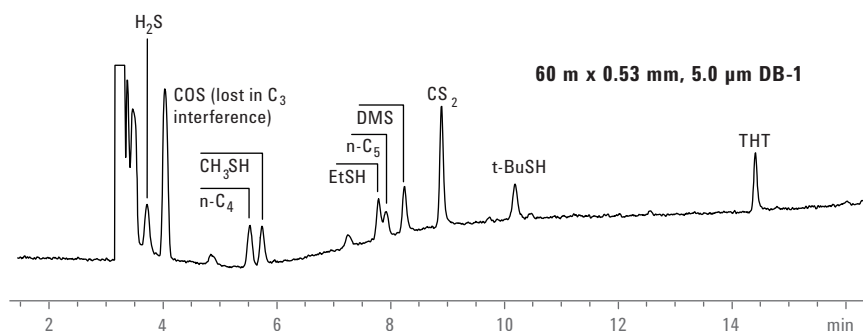
### Typical quantification range:

- 50 ppb for sulfur compounds

### Configured per method:

- ASTM D6228

45 ppb (v/v) each of the eight sulfur compounds in natural gas, split ratio: 0.5:1



## ► KEY BENEFITS AND FEATURES

- Dual-channel FPD system utilizing DB1 and GasPro column allows simultaneous determination of COS and H<sub>2</sub>S in propylene and other light hydrocarbon streams
- Same GC configuration for two methods:
  1. 7890-0167: natural gas, fuel gas streams
  2. 7890-0148: C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub> monomers (uses a longer column)
- Can also be used to measure S and P
- Dynamic blending system (7890-0130) provides easy calibration and assists with method development
- System passivation with UltiMetal® for enhanced sulfur analysis
- Excellent alternative to more expensive specialty detectors SCD, PFPD, MSD

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## Nitrosamine in Liquids Analyzer by NCD (7890-0460)

### Analyzer Description

#### Configuration:

- On-column capillary inlet/Capillary column/NCD

#### Sample type:

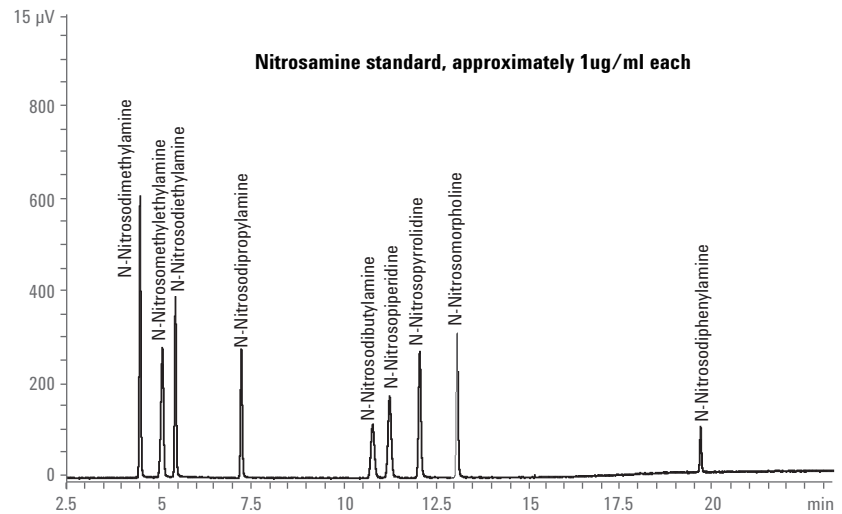
- Liquid samples

#### Compounds analyzed:

- N-Nitrosodimethylamine
- N-Nitrosomethylethylamine
- N-Nitrosodiethylamine
- N-Nitrosodipropylamine
- N-Nitrosodibutylamine
- N-Nitrosopiperidine
- N-Nitrosopyrrolidine
- N-Nitrosomorpholine
- N-Nitrosodiphenylamine

#### Typical quantification range:

- 10 ppb for N-Nitrosodimethylamine



### ► KEY BENEFITS AND FEATURES

- 7890 GC with Nitrogen Chemiluminescence Detector (NCD) in nitrosamine mode for nitrosamine analysis in liquids
- High Selectivity: higher selectivity for nitrosamine to low ppb level
- Equimolar: simplifies quantification of unknowns
- Linear: simplifies calibration

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# SOLUTIONS FOR TRANSFORMER OIL GAS



## Confirm oil integrity and prevent catastrophic failure

Electrical transformers, which literally *transform* voltage from one level to another, use oil as both an insulator and a coolant for internal components. Because transformer operation subjects the oil to electrical and mechanical stresses, the oil must be able to maintain its stability at high temperatures for extended periods of time.

Factors such as aging, oxidation, vaporization, electrolytic action, and decomposition can change the oil's chemical properties, resulting in gas formation. Information derived by analyzing these dissolved gases provides considerable diagnostic information about the transformer's current and future stability—helping operators determine whether a transformer should be decommissioned.

The following pages give you an in-depth look at **Agilent Transformer Oil Gas (TOGA) Analyzers**. Configured per ASTM standards, these analyzers harness advanced technologies such as headspace sampling, traditional packed columns, capillary columns, and TCD/FID detectors (following methanization) to deliver rugged, reliable TOGA analysis.

Learn more about Analyzer Solutions for the energy and chemical industry at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)

## Solutions for Transformer Oil Gas (TOGA)

| Analyzer Number | Configuration                                 | Capability  |
|-----------------|---|---|
| G3445 #571      | 1-valve/2-column/TCD/FID/methanizer/headspace | H <sub>2</sub> , O <sub>2</sub> , N <sub>2</sub> , CH <sub>4</sub> , CO and CO <sub>2</sub> , C <sub>2</sub> (ethane, ethylene, acetylene), C <sub>3</sub> (propane, propylene), and C <sub>4</sub> (1-butene) per ASTM D3612-C |
| 7890-0552       | 3-valve/3-column/TCD/FID/methanizer/headspace | H <sub>2</sub> , O <sub>2</sub> , N <sub>2</sub> , CH <sub>4</sub> , CO, CO <sub>2</sub> , C <sub>2</sub> (ethane, ethylene, acetylene), C <sub>3</sub> (propane, propylene), and C <sub>4</sub> (1-butene) per ASTM D3612-C    |

## Reference Methods for TOGA: Quantitation Ranges for Compounds of Interest

| Component Gas     | ASTM D3612-A   | ASTM D3612-C                  |  |
|-------------------|--|-------------------------------|--|
|                   | Minimum Detection Limits for Gases Dissolved in Oil, ppm | Compound                      | Detection Limits, ppm (signal/noise = 3) |
| H <sub>2</sub>    | 5  | H <sub>2</sub>                | 0.6                                      |
| Hydrocarbons      | 1  | O <sub>2</sub>                | 11.0*                                    |
| CO <sub>2</sub>   | 25   | N <sub>2</sub>                | 11.2                                     |
| Atmospheric gases | 50   | CH <sub>4</sub>               | 0.06                                     |
|                   |  | CO                            | 0.09                                     |
|                   |  | CO <sub>2</sub>               | 0.1                                      |
|                   |  | C <sub>2</sub> H <sub>2</sub> | 0.05                                     |
|                   |  | C <sub>2</sub> H <sub>4</sub> | 0.04                                     |
|                   |  | C <sub>2</sub> H <sub>6</sub> | 0.04                                     |
|                   |  | C <sub>3</sub> H <sub>8</sub> | 0.2                                      |

\*Estimated from the H<sub>2</sub> response. The detection limits were obtained from the analysis of a dissolved gas standard of 1 ppm for all gases, except for O<sub>2</sub>, N<sub>2</sub>, CO, and CO<sub>2</sub>, where the concentration was 17, 24, 1.6, and 8.8 ppm, respectively. These results were obtained with a headspace sampler coupled with a gas chromatograph of one commercial source; other devices can be used but the analytical performance may be somewhat different than that specified in Method C.

**Why spend time configuring hardware and developing methods?** Let Agilent implement the latest advances in GC to provide your team with the tools it requires to quickly analyze trace target compounds in complex matrices.

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# Transformer Oil Gas Analyzer (G3445 #571)

## Analyzer Description

### Configuration:

- 1-valve/2-column/TCD/FID/methanizer/headspace

### Sample type:

- Gas

### Compounds analyzed:

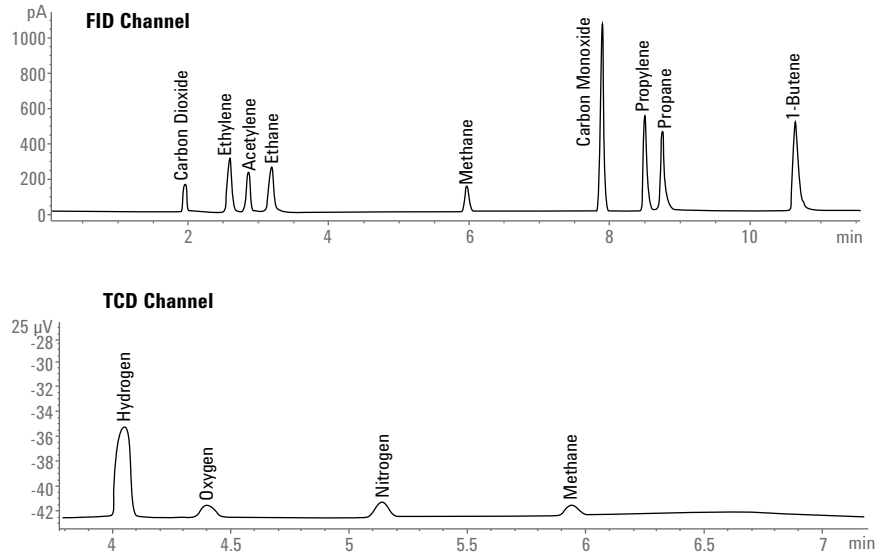
- H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, CO and CO<sub>2</sub>,
- C<sub>2</sub> (ethane, ethylene, acetylene),
- C<sub>3</sub> (propane, propylene),
- C<sub>4</sub> (1-butene)

### Typical quantification range:

- Meet the specifications listed in table 3 in ASTM D3612-C

### Configured per method:

- ASTM D3612-C



## ► KEY BENEFITS AND FEATURES

- Single channel with PLOT columns
- Use direct transfer line to column connection
- Trace levels of CO and CO<sub>2</sub> can be analyzed by conversion to CH<sub>4</sub> and detection with FID
- 10 minute analysis time
- Improved precision through 7890 PCM backpressure regulation of headspace gas sampling valve loop

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# Transformer Oil Gas Analyzer (7890-0552)

## Analyzer Description

### Configuration:

- 3-valve/3-column/TCD/FID/methanizer/headspace

### Sample type:

- Gas

### Compounds analyzed:

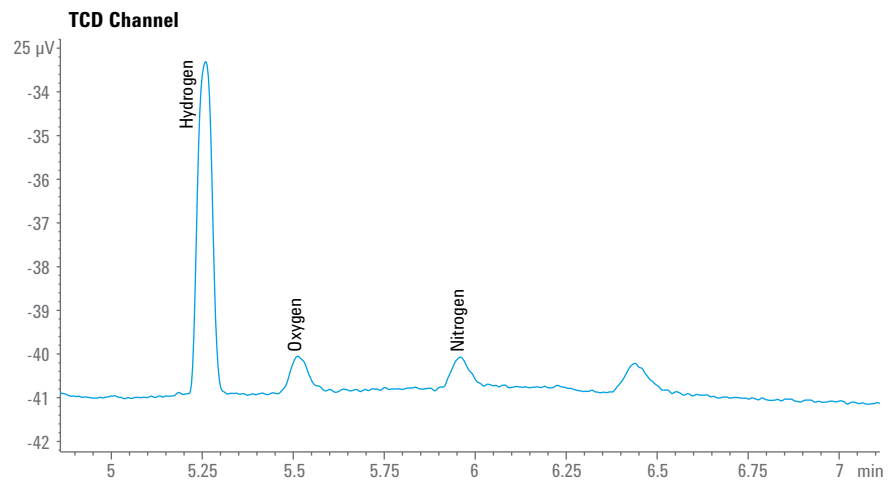
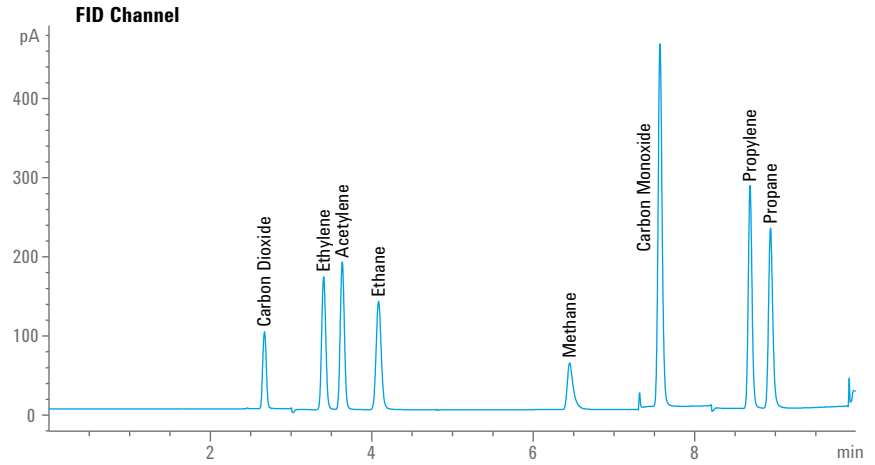
- H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, CO and CO<sub>2</sub>
- C<sub>2</sub> (ethane, ethylene, acetylene), C<sub>3</sub> (propane, propylene), C<sub>4</sub> (1-butene)

### Typical quantification range:

- Meet the specifications listed in table 3 in ASTM D3612-C

### Configured per method:

- ASTM D3612-C



## ► KEY BENEFITS AND FEATURES

- Trace levels of CO and CO<sub>2</sub> can be analyzed by conversion to CH<sub>4</sub> and detection with FID
- Backflush of C<sub>4+</sub> hydrocarbons present through pre-column to shorten analysis time
- Through additional valve switching C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub> hydrocarbons bypass nickel catalyst for FID detection
- 10 minutes analysis time

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# SOLUTIONS FOR GREENHOUSE GAS



## Monitor and measure gases that contribute to climate change

Fossil fuel consumption increases the concentration of Greenhouse Gases (GHGs)—such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O)—in Earth's atmosphere. These gases trap heat, thereby affecting our planet's temperature.

To help fight climate change caused by increased concentrations of atmospheric GHGs, regulatory institutions (such as the EPA and CEN) have initiated programs to inventory GHG emissions through continuous measurement.

Agilent can help you track GHG emissions with our comprehensive portfolio of factory-configured, chemically tested **Greenhouse Gas (GHG) Analyzers**.

Learn more about Analyzer Solutions for the energy and chemical industry at [www.agilent.com/chem/energy](http://www.agilent.com/chem/energy)



## Solutions for Greenhouse Gas Analysis with Quantitation Ranges for Compounds of Interest

| Configuration   |                  |                   |            | Capability             |                  |  |  |                 |                 |
|-----------------|------------------|-------------------|------------|------------------------|------------------|--|--|-----------------|-----------------|
| Analyzer Number | Valve/<br>Column | Detector          | Methanizer | Autosampler<br>HSS/CTC | Fast<br>Analysis | O <sub>2</sub> /N <sub>2</sub><br>Separation | N <sub>2</sub> O<br>(Lowest<br>Detection<br>Limit) | CH <sub>4</sub> | CO <sub>2</sub> |
| G3445 #561      | 3/2              | FID/Micro-ECD     | YES        | HSS (optional)         | NO               | NO   | 50 ppb   | 0.2 ppm-20%     | 0.4 ppm-0.2%    |
| G3445 #562      | 4/4              | FID/Micro-ECD/TCD | YES        | NO                     | YES              | NO   | 50 ppb   | 0.2 ppm-20%     | 0.4 ppm-20%     |
| G3445 #563      | 3/2              | FID/Micro-ECD     | YES        | HSS                    | NO               | NO   | 50 ppb   | 0.2 ppm-20%     | 0.4 ppm-0.2%    |

Don't stretch your resources for method development. Agilent energy and chemical solutions let you quickly implement new technologies for analyzing difficult matrices!

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# Greenhouse Gas Analyzer (G3445 #561)

## Analyzer Description

### Configuration:

- 3-valve/2-packed column/  
Micro-ECD/FID/methanizer

### Sample type:

- Greenhouse gases and soil gases with compounds of interest contain gases such as CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>

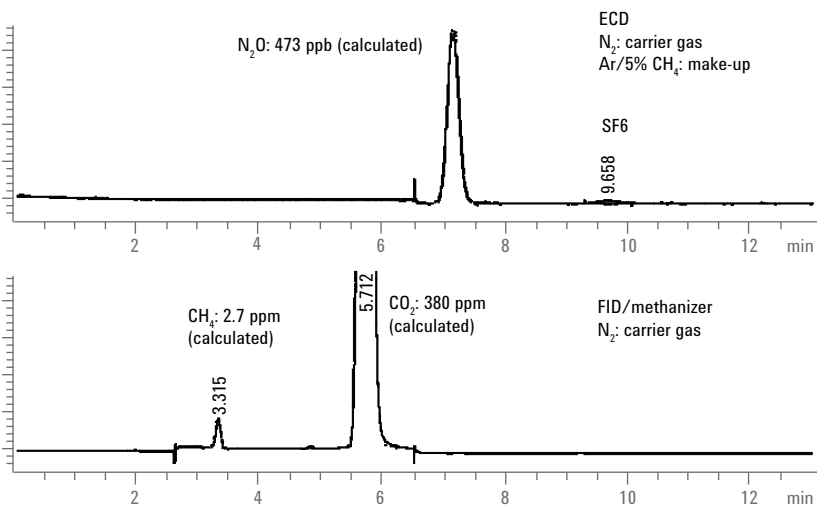
### Compound analyzed:

- CH<sub>4</sub>, N<sub>2</sub>O, CO<sub>2</sub>

### Typical quantification range:

- 50 ppb for N<sub>2</sub>O
- 0.2 ppm-20% for CH<sub>4</sub>
- 0.4 ppm-0.2% for CO<sub>2</sub>

Chromatogram for real sample (laboratory air)



## ► KEY BENEFITS AND FEATURES

- Configured for simultaneous analysis of greenhouse gas with one injection
- Sensitivity of Micro-ECD ensures the detection of N<sub>2</sub>O at ppb level
- An easy-to-use union based on Capillary Flow Technology connects valves and Micro-ECD to improve chromatographic performance, including the peak shape
- Easily expanded to include the determination of SF<sub>6</sub>
- Single channel with a simple valve configuration
  - Possible to use 6-port valve instead of a 10-port for automated headspace sampling (see G3445 #563)

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# Greenhouse Gas Analyzer (G3445 #562)

## Analyzer Description

### Configuration:

- 4-valve/4-packed column/  
Micro-ECD/TCD/FID/methanizer

### Sample type:

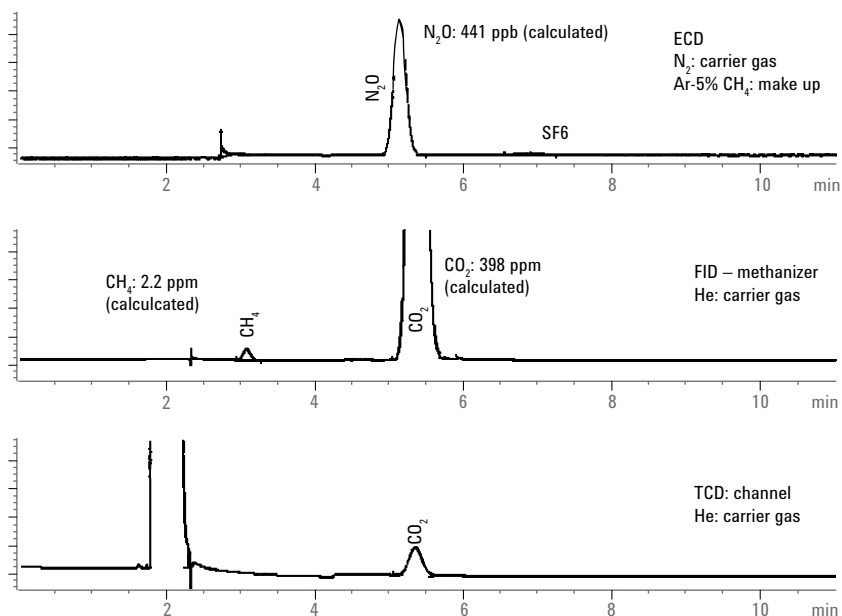
- Greenhouse gases and soil gases with compounds of interest contain gases such as CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>

### Compound analyzed:

- CH<sub>4</sub>, N<sub>2</sub>O, CO<sub>2</sub>

### Typical quantification range:

- 50 ppb for N<sub>2</sub>O
- 0.2 ppm-20% for CH<sub>4</sub>
- 0.4 ppm-20% for CO<sub>2</sub>



## ► KEY BENEFITS AND FEATURES

- Configured for simultaneous analysis of greenhouse gas with one injection
- Sensitivity of Micro-ECD ensures the detection of N<sub>2</sub>O at ppb level
- An easy-to-use union based on Capillary Flow Technology connects valves and Micro-ECD to improve chromatographic performance, including the peak shape
- Easily expanded to include the determination of SF<sub>6</sub>
- Uses 2 separate channels with three detectors
  - Achieve faster results
  - Increases flexibility reducing critical nature timing for valve switching
  - Facilitates method setup
  - Uses third TCD to expand concentration range for CO<sub>2</sub> determinations

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# Greenhouse Gas Analyzer (G3445 #563)

## Analyzer Description

### Configuration:

- 3-valve/2-packed column/Micro-ECD/FID/methanizer

### Sample type:

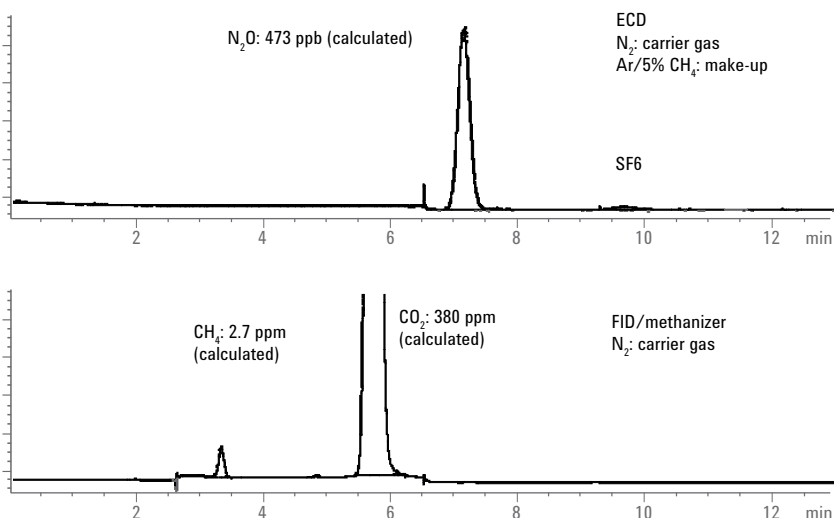
- Greenhouse gases, soil gases where the compounds of interest include gases such as CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>

### Compound analyzed:

- CH<sub>4</sub>, N<sub>2</sub>O, CO<sub>2</sub>

### Typical quantification range:

- 50 ppb for N<sub>2</sub>O
- 0.2 ppm-20% for CH<sub>4</sub>
- 0.4 ppm-0.2% for CO<sub>2</sub>



## ► KEY BENEFITS AND FEATURES

- Analyzer configured for simultaneous analysis of greenhouse gas with one injection
- Sensitivity of Micro-ECD ensures the detection of N<sub>2</sub>O at ppb level
- An easy-to-use union based on Capillary Flow Technology connects valves and Micro-ECD to improve chromatographic performance, including the peak shape
- Single channel with a simplified valve configuration
- Easily expanded to include the determination of SF<sub>6</sub>
- Modification to G3445 #561 that allows for automated headspace sampling
  - Headspace sampler and Interface not included: HSS must be ordered separately

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- ✓ PIONA/Reformulyzer M<sub>3</sub>
- ✓ Olefins Analyzer
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- ✓ Oxygenates Analyzer
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