

GO.

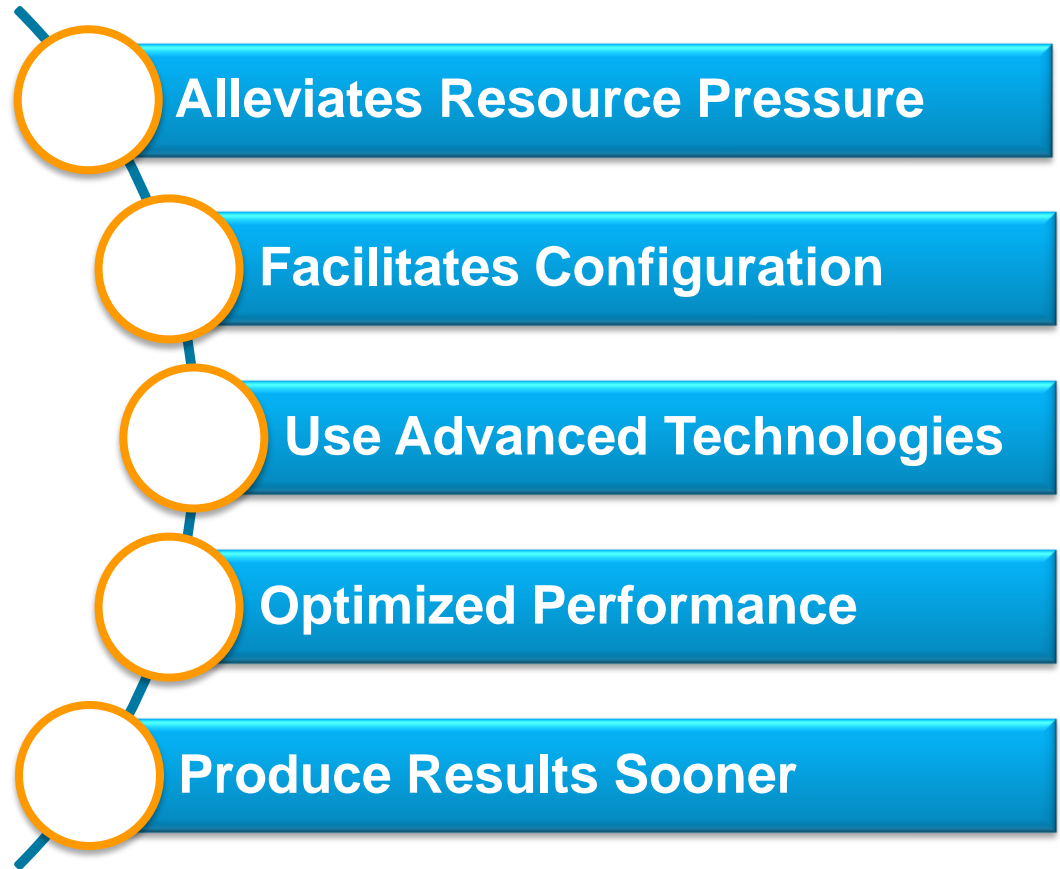


Get on the Analyzer “***FAST TRACK***”

Transformer Oil Gas Analysis

... Helping customers protect the environment!

Why Analyzers – Value to Customers



Agilent Analyzer Concept

Common Components



Std. HW, SW

w/o Analyzer



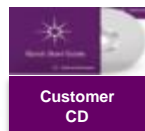
App. optimized consumables

Customer's Responsibility

Factory Configured with Chemical Testing Field Verification



System with application setup



Familiarization

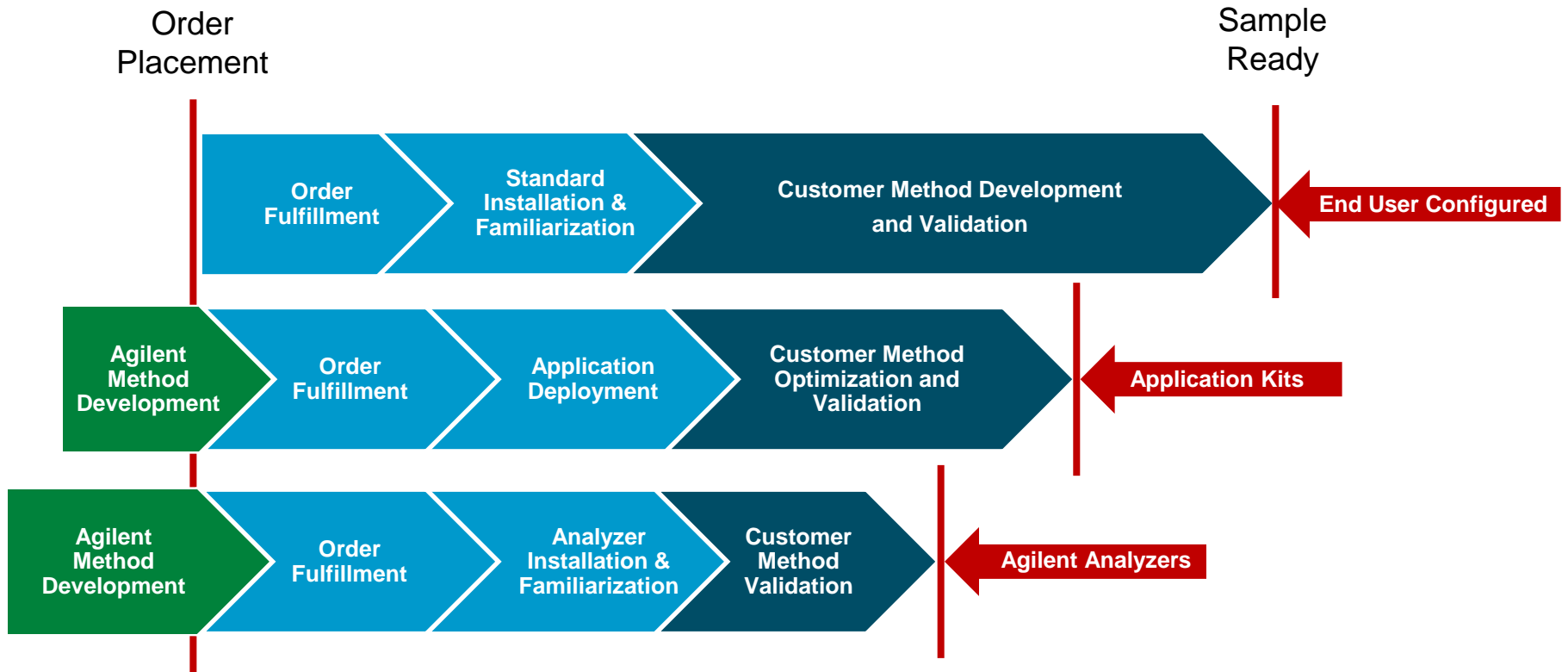
Sample	Peak	Area	Height	Width	Retention	Concentration
1	1.234	123456	1000	0.1	1.234	0.1
2	2.345	234567	2000	0.1	2.345	0.2
3	3.456	345678	3000	0.1	3.456	0.3
4	4.567	456789	4000	0.1	4.567	0.4
5	5.678	567890	5000	0.1	5.678	0.5

Application report

Agilent's Analyzers Provide

The Value of Analyzers and Application Kits

Reduce the time required for system deployment



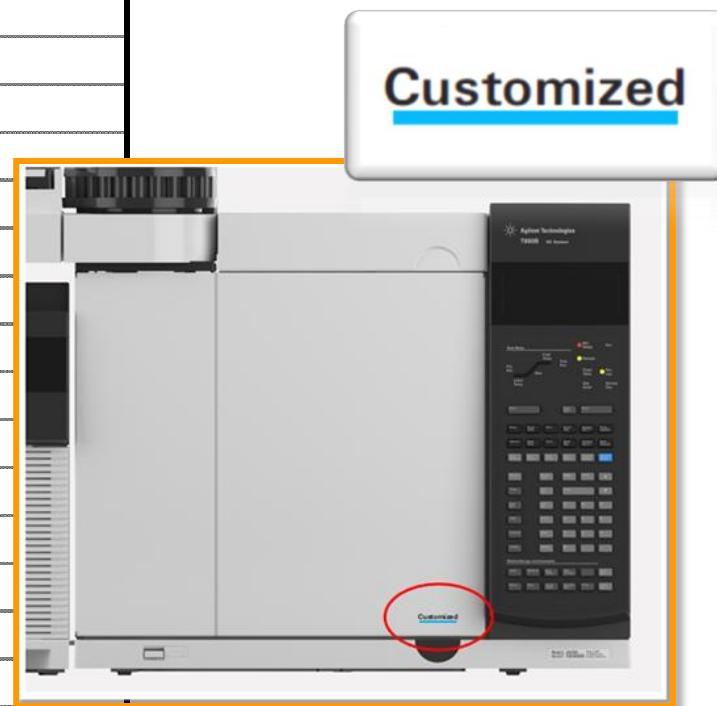
...Faster Application Startup with a Quality Method

Easy-to-Order New Analyzer Process:

Repackaged 50 Analyzers – G3445B

G3445A Opt.	Analyzer Description
	GC/MS/MS Analyzers
41x	GC/MS/MS Pesticide Analyzers (2 versions)
42x	GC/MS/MS PAH Analyzer
	GC/MSD/DRS Analyzers
45x	GC/MSD Pesticide DRS Screening Analyzers (2 versions)
46x	GC/MSD Environmental DRS Analyzers (2 versions)
47x	GC/MSD Toxicology DRS Analyzers (2 versions)
48x	HSS GCMSDFID Residual Solvents Analyzer
	GC Gas Analysis Analyzers
52x	GC Refinery Gas Analyzers (6 versions)
54x	GC Natural Gas Analyzers (7 versions)
56x	GC Greenhouse Gas Analyzers (3 versions)
57x	TOGA Analyzer for use with HSS
	GC Gasoline, Fuel Analysis Analyzers
61x	Gasoline Analyzer (incl. Oxygenates, Aromatics, 7 versions)
63x	Biodiesel Analyzers (4 versions)
64x	CO & CO ₂ Analyzer w Methanizer (2 versions)
65x	Sim Dis Analyzers (4 versions)
66x	S analysis with SCD Analyzer (2 versions)
68x	Residual Solvents GC-HSS analyzers (2 versions)

With noticeable identification on GC



Analyzer Solutions – Transformer Oil Gas Analysis

Energy and Chemical Industry



Transformer Oil Gas

Confirm Oil Integrity and Prevent Catastrophic Failure

- Transformer oil insulates and a cools internal components
- Exposure to electrical and thermal stress
 - Affects long term stability
- With time chemical properties of oil change
 - Aging, oxidation, vaporization, electrolytic action, and
 - Decomposition results in gas formation
- Analyzing dissolved gases provides diagnostic information
 - Current and future stability
 - Helps determine timing for decommissioning

Transformer Oil Gas

Confirm Oil Integrity and Prevent Catastrophic Failure

Analyzers measure:

- H₂, N₂, O₂, CO, and CO₂
- C₂ (ethane, ethylene, acetylene)
- C₃ (propane, propylene),
- C₄ (1-butene)

Reference Methods for TOGA

Quantitation Ranges for Compounds of Interest

ASTM D3612-A Component	Minimum Detection Limits for Gases Dissolved in Oil, ppm	ASTM D3612-C Compound	Detection Limits, ppm (signal/noise = 3)
H2	5	H2	0.6
Hydrocarbons	1	O2	11.0*
CO2	25	N2	11.2
Atmospheric gases	50	CH4	0.06
		CO	0.09
		CO2	0.1
		C2H2	0.05
		C2H4	0.04
		C2H6	0.04
		C3H8	0.2

*Estimated from the H2 response.

Transformer Oil Gas Analysis

Automated sample handling with optional HSS sampler.

**G3445B
Option
#571**

7890 GC System, Column, c/o Sample

Option 210 FID with EPC

Option 220 TCD with EPC

G7697A Headspace Sampler

Option 002 or 003 Fast Oven

Option 311 and 312 Cryo

Configured per ASTM D3612-C

Transformer Oil Gas Analyzer

G3445B#571

Configuration:

- 1-valve/2-column/TCD/FID/ Methanizer/Headspace

Sample type:

- Gas

Compounds analyzed:

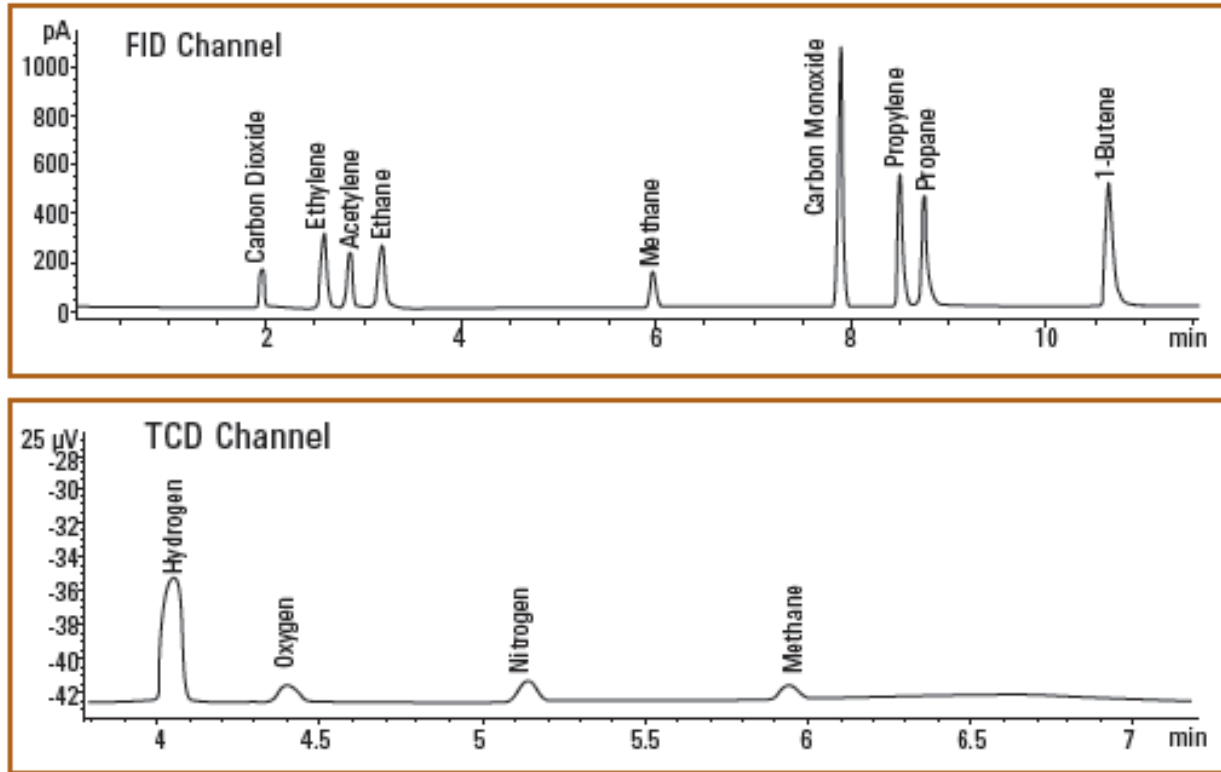
- H₂, O₂, N₂, CH₄, CO and CO₂,
- C₂ (ethane, ethylene, acetylene), C₃ (propane, propylene), C₄ (1-butene)

Configured per method:

- ASTM D3612-C

Transformer Oil Gas Analysis

G3445B#571 Chromatography



Includes: 1-valve, 2-column, TCD, FID, Methanizer, Headspace

Transformer Oil Gas Analyzer

G3445B#571

Key Benefits and Features

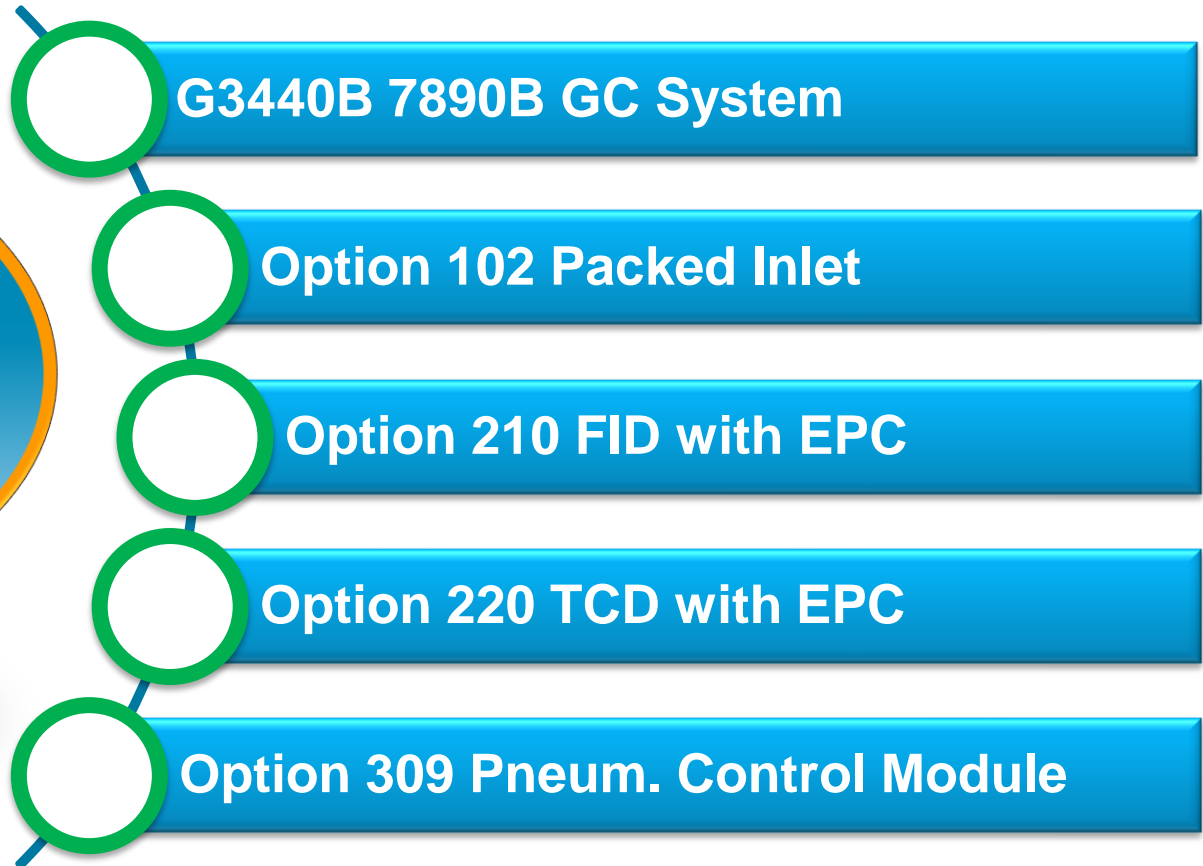
- Single channel with PLOT columns
- Use direct transfer line to column connection
- Trace levels of CO and CO₂ measured by conversion to CH₄ and detection with FID
- Ten (10) minute analysis time
- Improved precision through 7890 PCM backpressure regulation of headspace gas sampling valve loop



Transformer Oil Gas Analysis

Manual sample handling; self-extraction by customer

7890-0047



Configured per: ASTM D3612-A

Transformer Oil Gas Analysis Cont...

Manual sample handling; self-extraction by customer

7890-0047

Option 307 Nickel Catalyst Tube

Option 504 Gas Sampling Valve

Option 701 6-Pt Gas Sample Valve

Option 702 6-Pt Column Isol. Valve

Option 752 Automate Two Valves

Configured per: ASTM D3612-A

Transformer Oil Gas Analyzer

7890-0047

Configuration:

- 2-valve/2-column/TCD/FID/Methanizer

Sample type:

- Gas

Compounds analyzed:

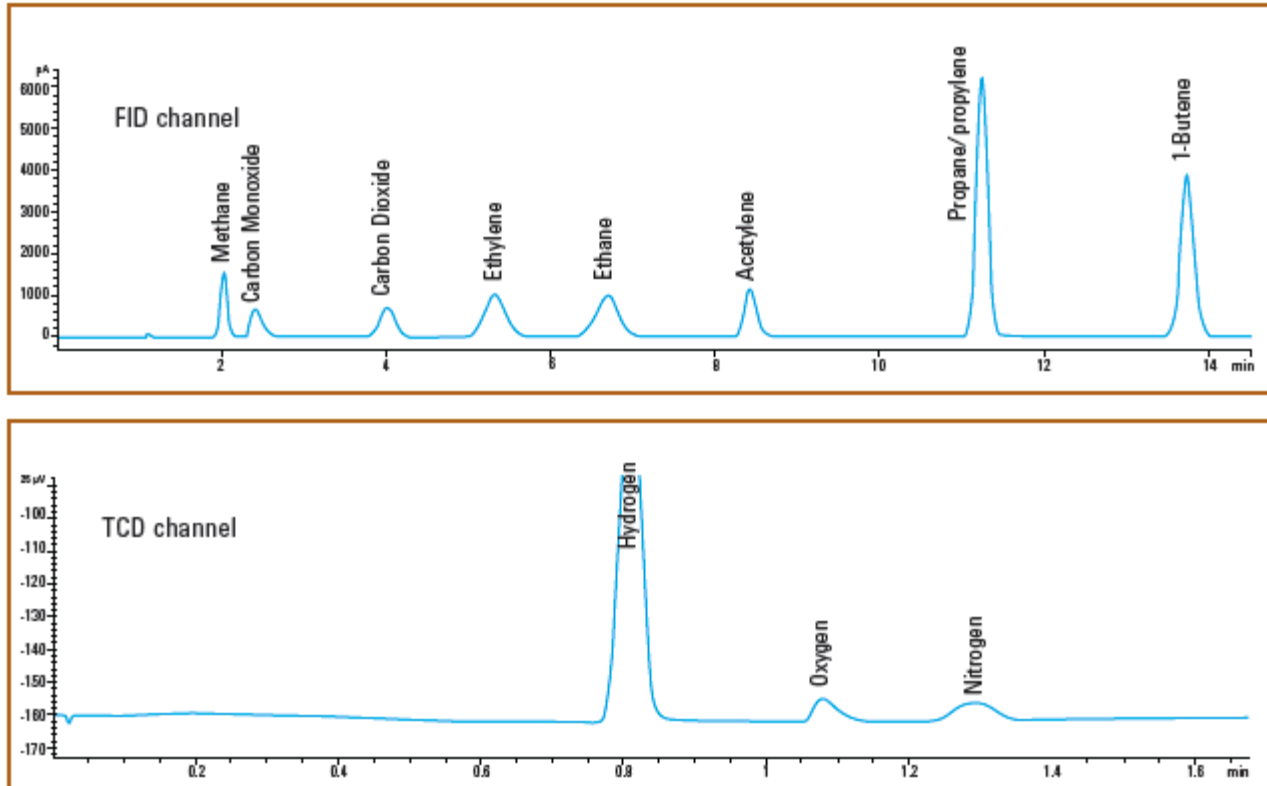
- H₂, O₂, N₂, CH₄, CO and CO₂,
- C₂ (ethane, ethylene, acetylene), C₃ (propane, propylene), C₄ (1-butene)

Configured per method:

- ASTM D3612-A

Transformer Oil Gas Analysis

7890-0047 Chromatography



Includes: 2-valve, 2-column, TCD, FID, Methanizer

Transformer Oil Gas Analyzer

7890-0047

Key Benefits and Features

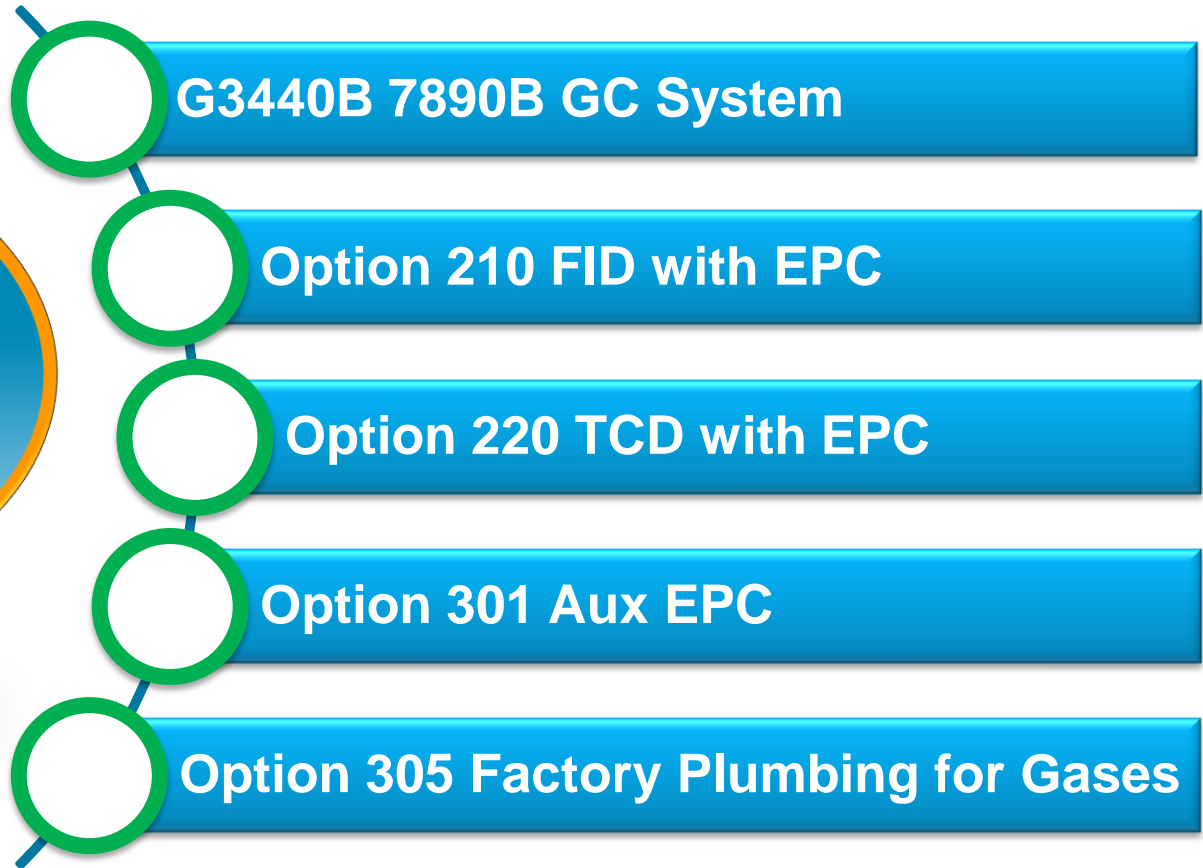
- Single channel with packed columns
- Trace levels of CO and CO₂ can be analyzed by conversion to CH₄ and detection with FID
- Fifteen (15) minute analysis time
- Includes macros for data reporting per ASTM D3612-A, requires Microsoft Excel



Transformer Oil Gas Analysis

Includes back-flush valve and methanizer by-pass

7890-0552



Configured per: ASTM D3612-C

Transformer Oil Gas Analysis

Includes back-flush valve and methanizer by-pass

7890-0552

Option 307 Nickel Catalyst Tube

Option 504 Gas Sampling Valve

Option 700 6-Pt Gas SmpI Vlv (2x)

Option 702 6-Pt Column Isol. Valve

Option 753 Automate Three Valves

Option 872 Interface Column

Also Order: G7697A Headspace Sampler

Transformer Oil Gas Analysis

Includes back-flush valve and methanizer by-pass

7890-0552

Option 307 Nickel Catalyst Tube

Option 504 Gas Sampling Valve

Option 700 6-Pt Gas Smpl Vlv (2x)

Option 702 6-Pt Column Isol. Valve

Option 753 Automate Three Valves

Configured per: ASTM D3612-C

Transformer Oil Gas Analyzer

7890-0552

Configuration:

- 3-Valve/3-Column/TCD/FID/ Methanizer/Headspace

Sample type:

- Gas

Compounds analyzed:

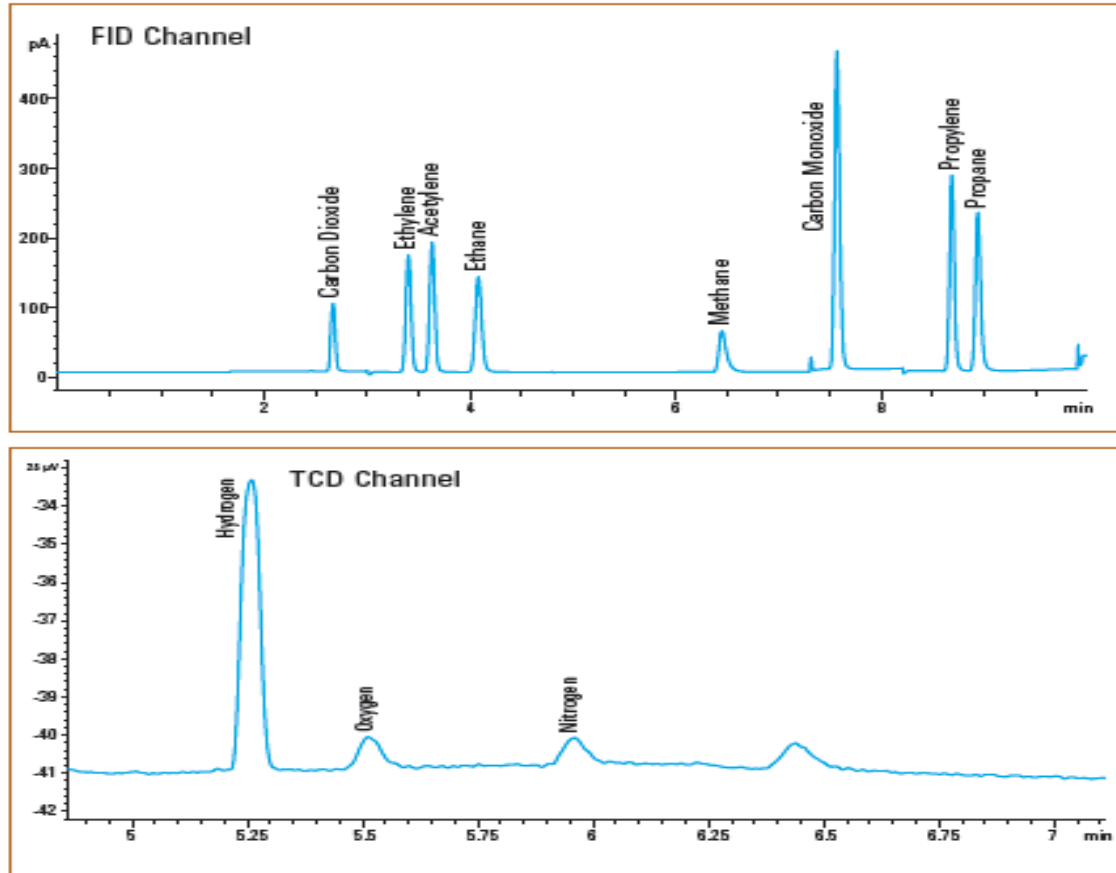
- H₂, O₂, N₂, CH₄, CO and CO₂,
- C₂ (ethane, ethylene, acetylene), C₃ (propane, propylene), C₄ (1-butene)

Configured per method:

- ASTM D3612-C

Transformer Oil Gas Analysis

7890-0552 Chromatography



Includes: 3-Valve/3-Column/TCD/FID/ Methanizer/Headspace

Transformer Oil Gas Analyzer

7890-0552

Key Benefits and Features

- Trace levels of CO and CO₂ can be analyzed by conversion to CH₄ and detection with FID
- Backflush of C₄₊ hydrocarbons present through pre-column to shorten analysis time
- Through additional valve switching C₂, C₃, C₄ hydrocarbons bypass nickel catalyst for FID detection
- Ten (10) minute analysis time



Why Analyzers? Benefit!



- Cutting Edge Technology
- Reduced Development Cost
- Install w/ Performance Verification
- Addresses Learning Curve
- Resource Allocation
- Faster Return on Capital Investment

GO.



Get on the Analyzer “*FAST TRACK*”

Simultaneous Analysis of Greenhouse Gases by Gas Chromatography

... Helping customers protect the environment!

Background: Greenhouse Gases (GHG)

Importance of GHG Analysis

- Comprised of Carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O)
- Presence traps heat in the atmosphere thereby affecting the earth's temperature.
- Fossil fuels consumption contributes to increasing concentration of GHG.

Industry Regulation

- EPA and CEN have initiated programs to inventory GHG emissions through continuous measurement.
- Continuous measurement provides meaningful information to track trends and help in the fight against climate change.

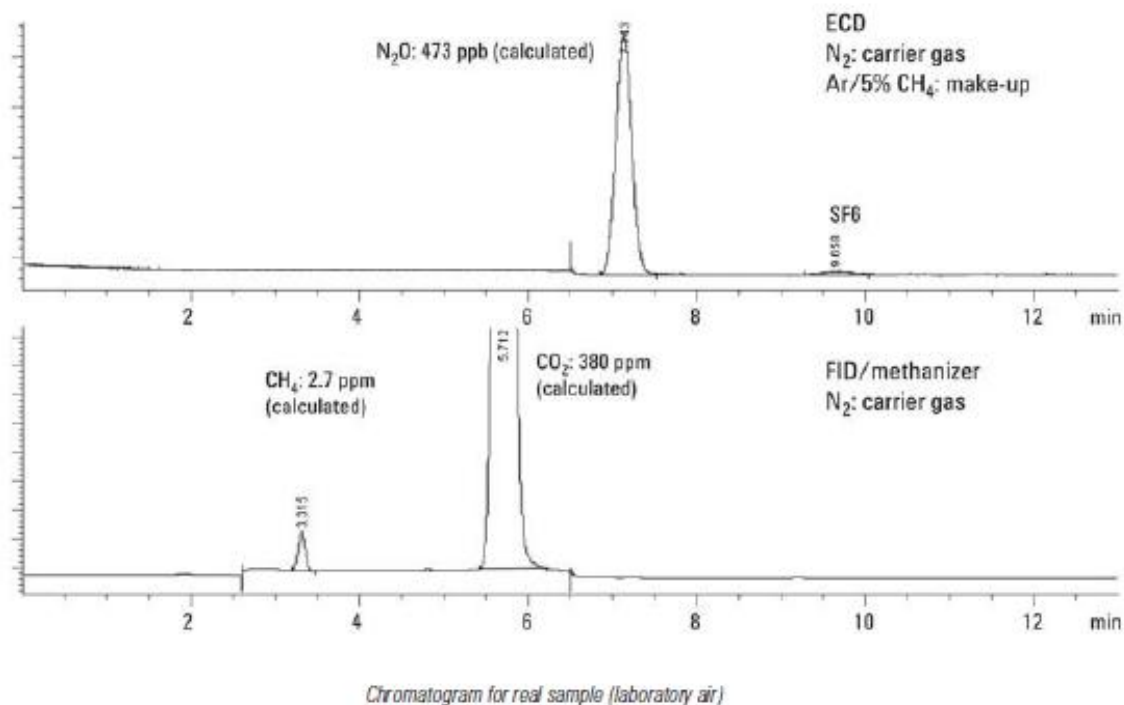


Greenhouse Gas Analyzers

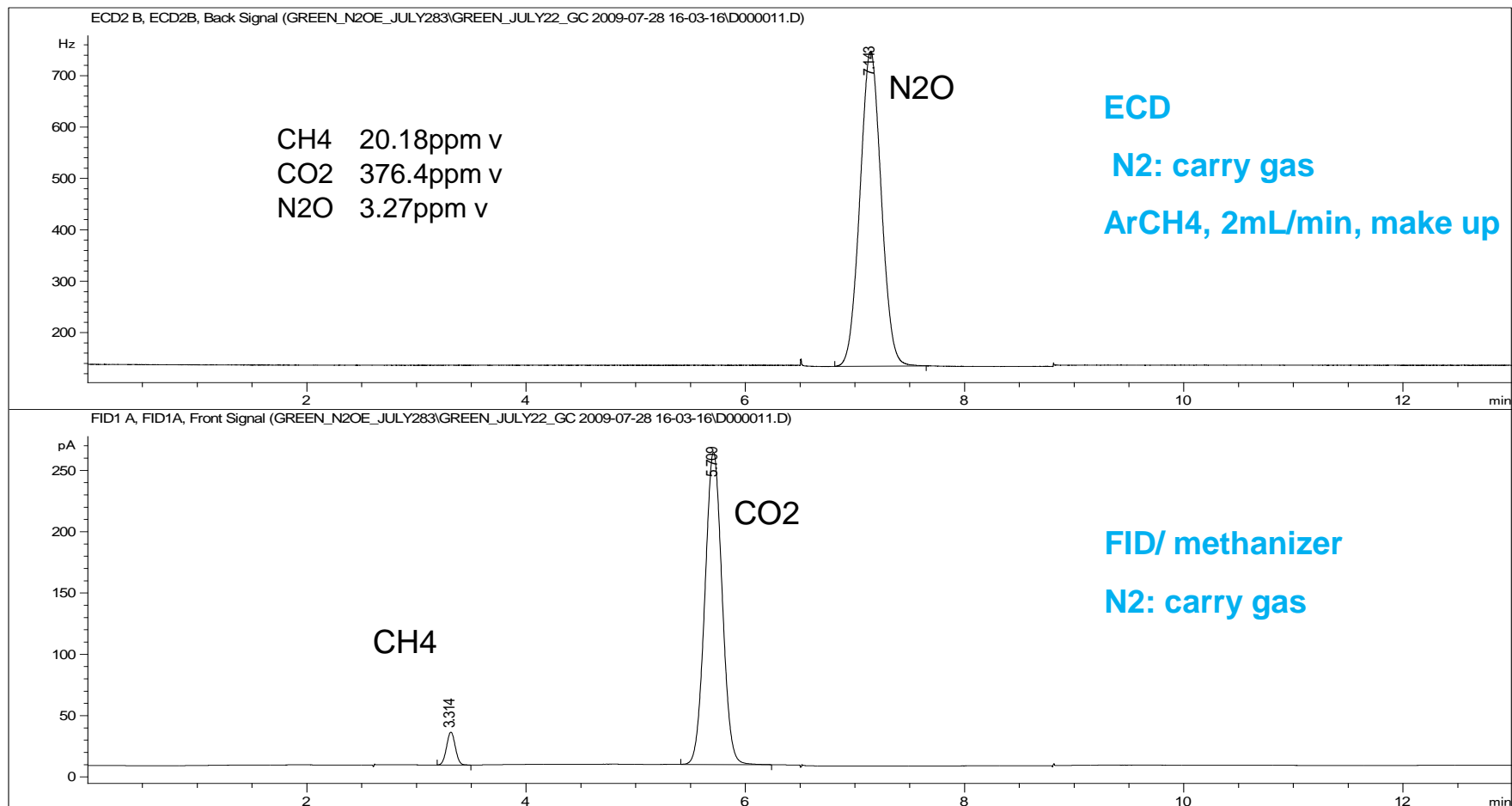
SP1 Number	G3554B Number	Title
7890-0467		Greenhouse Gas Analyzer with the Detection of 0.4 PPM to 20% Carbon Dioxide, 0.2 PPM to 20% Methane, and down to 30 PPB Nitrous Oxide, expandable to include SF6, not HSS compatible
7890-0468	G3445B#561	Greenhouse Gas Analyzer with the Detection of 0.4 PPM to 0.2% Carbon Dioxide, 0.2 PPM to 20% Methane, and down to 30 PPB Nitrous Oxide, expandable to include SF6, HSS compatible
7890-0504		Modified 7890-0467 Greenhouse Gas Analyzer with Oxygen/Nitrogen Separation, not HSS compatible
7890-0505		Modified 7890-0468 Greenhouse Gas Analyzer with Headspace Interface
7890-0542		Fast Greenhouse Gas Analyzer, setup for atmospheric air

Greenhouse Gas Analyzer (G3445B#561/7890-0468)

Typical Chromatogram



Chromatogram for Greenhouse Gases Standards



Quantitative precision

Repeatability for Greenhouse Gases Standards (n=21)

Name	Average (Area)	STD DEV	RSD%
CH4	149.26	0.29	0.20
CO2	2779.04	17.16	0.62
N2O	8253.96	11.06	0.13

Greenhouse gases standards concentration, ppm V
CH4: 20.18, CO2: 376.4, N2O:3.27

... Excellent quantitative precision

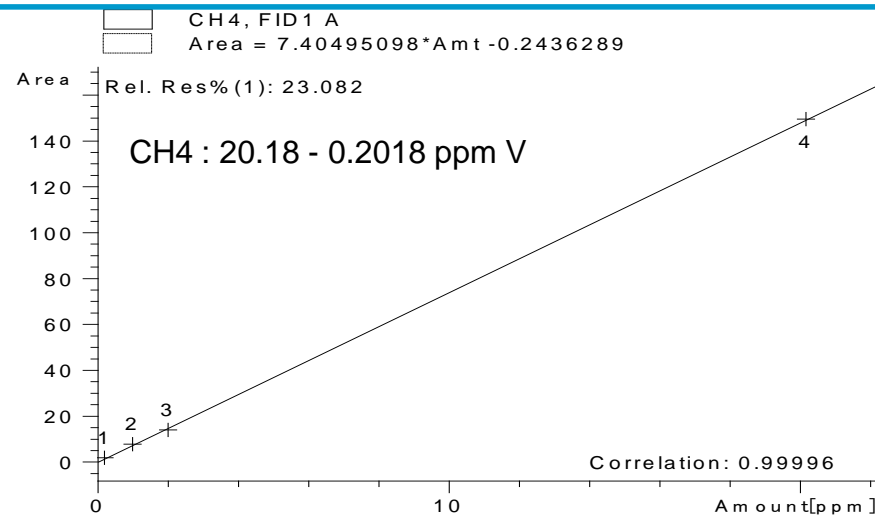
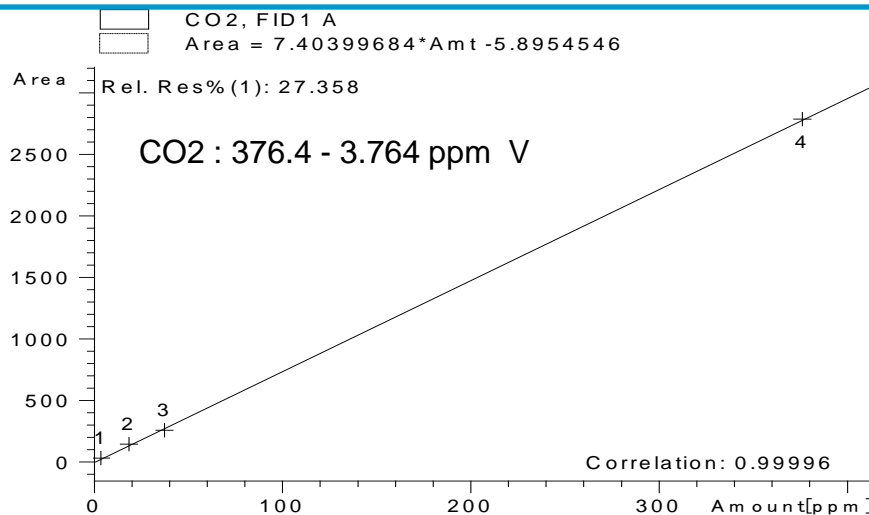
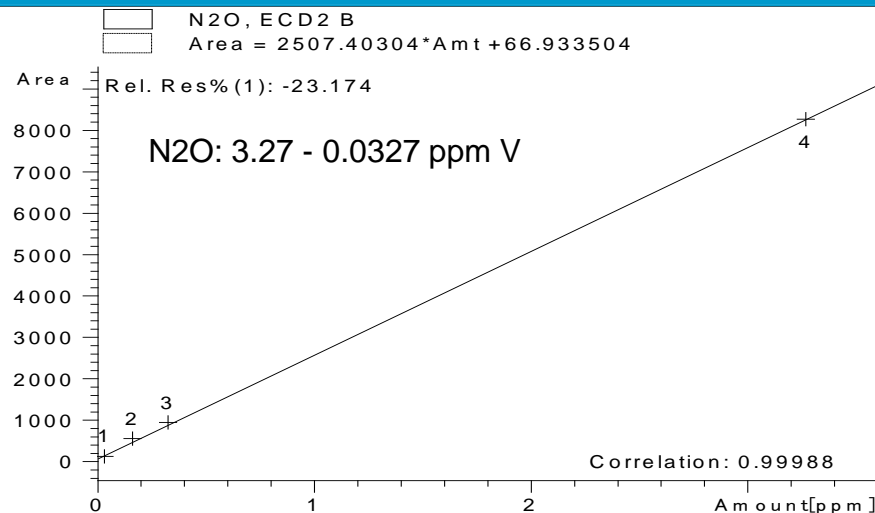
Multi-level Calibration for Greenhouse Gases Standards Using Dynamic Blending System

Standards sample information

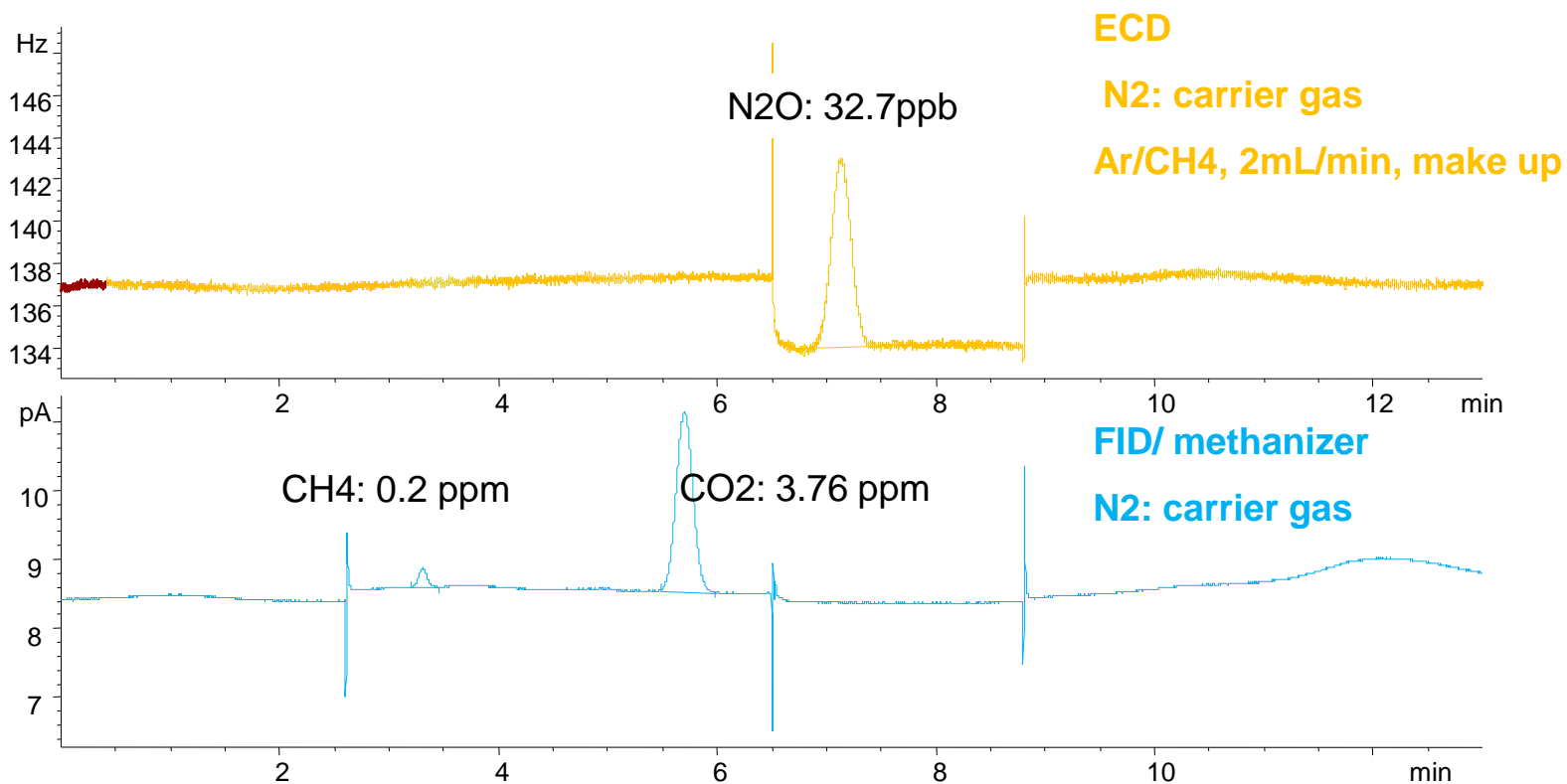
Greenhouse gases standards are diluted for multi-level calibration by dynamic blending

Concentration, ppm V

	Original	10 X diluting	20 X diluting	100X diluting
CH4	20.18	2.018	1.009	0.2018
CO2	376.4	37.64	18.82	3.764
N2O	3.27	0.327	0.1635	0.0327

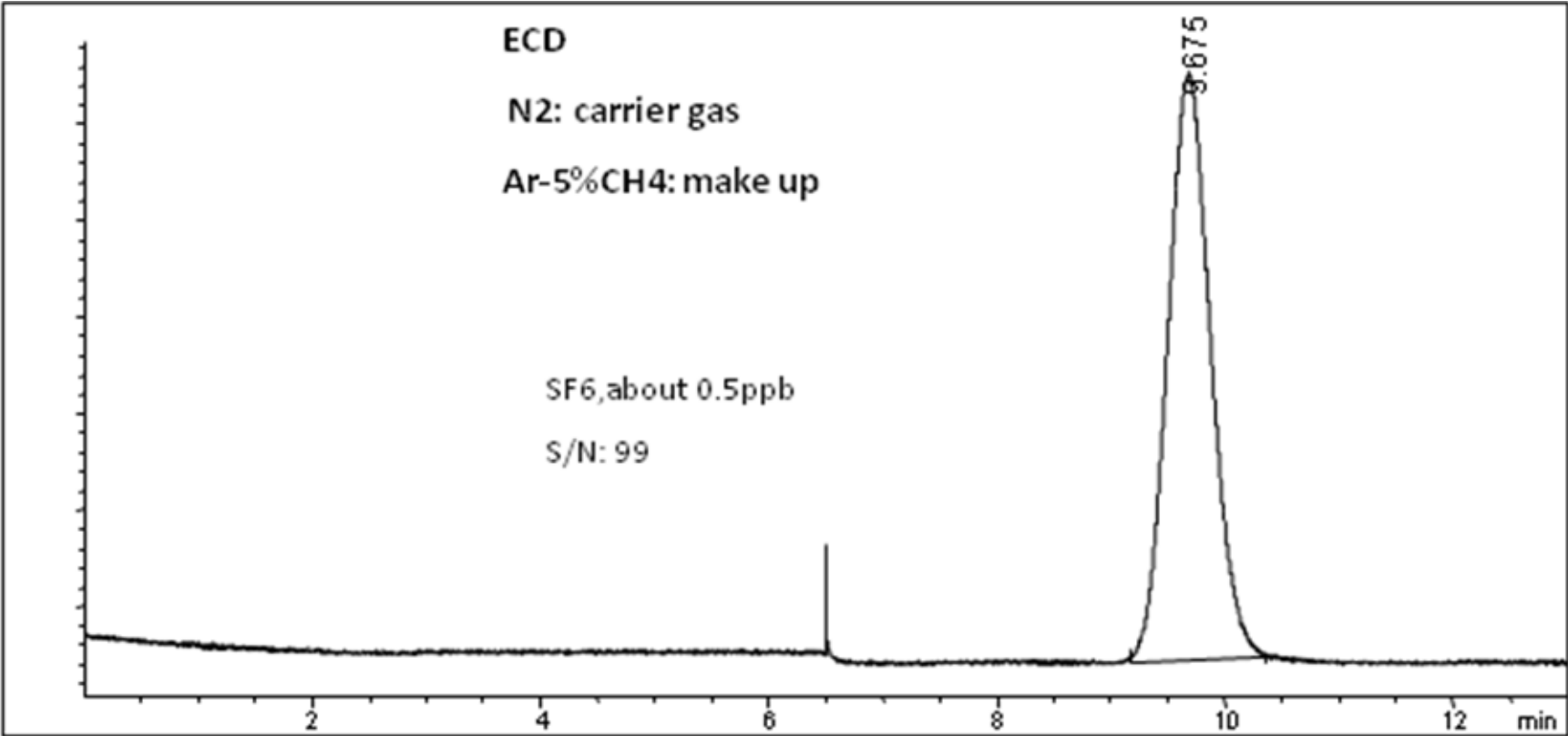


Chromatogram for CH₄, CO₂ and N₂O Standards with a 100-fold Dilution

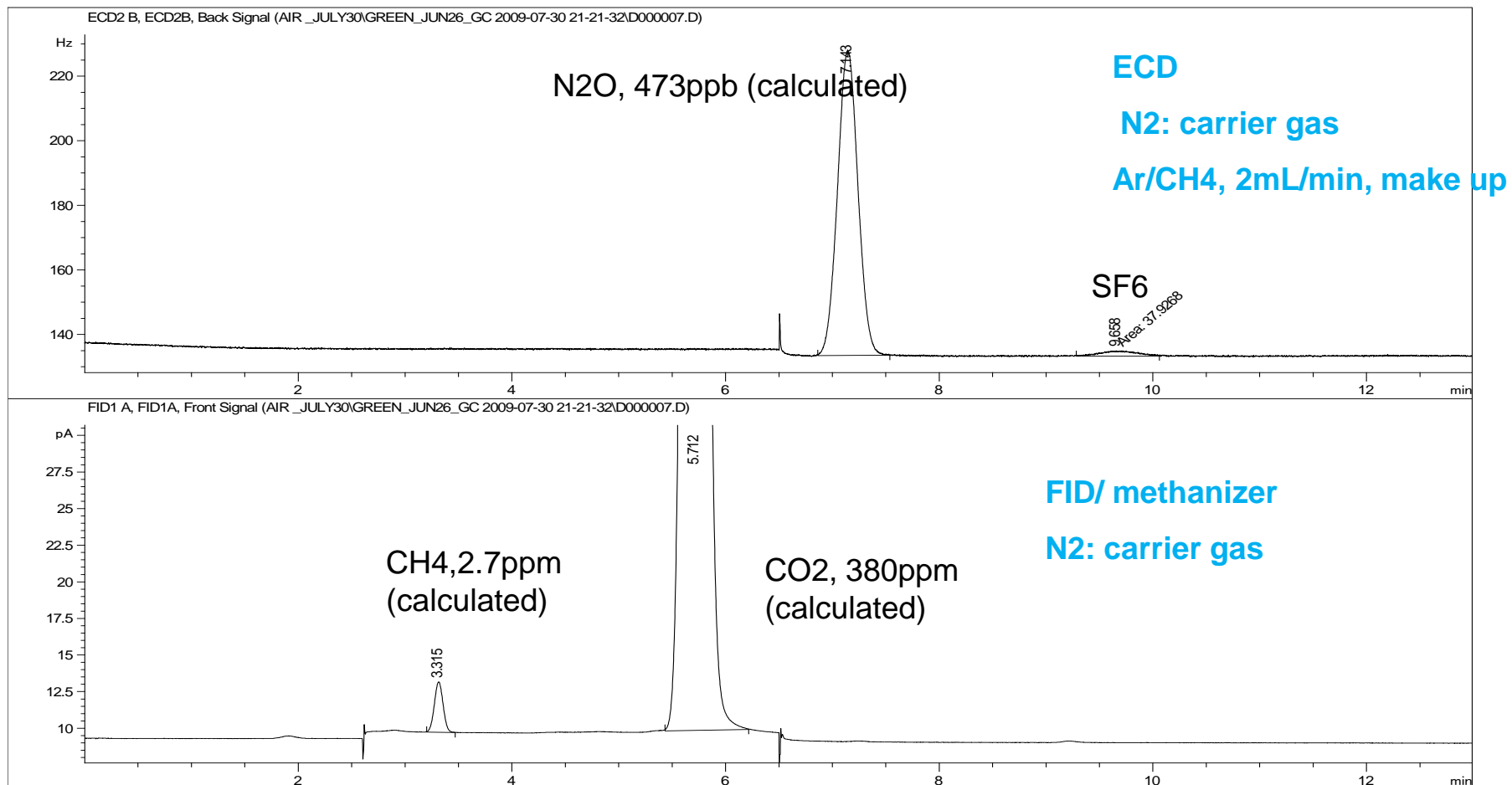


... Excellent Sensitivity

Chromatogram of SF6 Standard at Approximately 0.5 ppb



Chromatogram of Real Sample (Laboratory Air)



Greenhouse Gas Analyzer (G3445B#561/7890-0468)

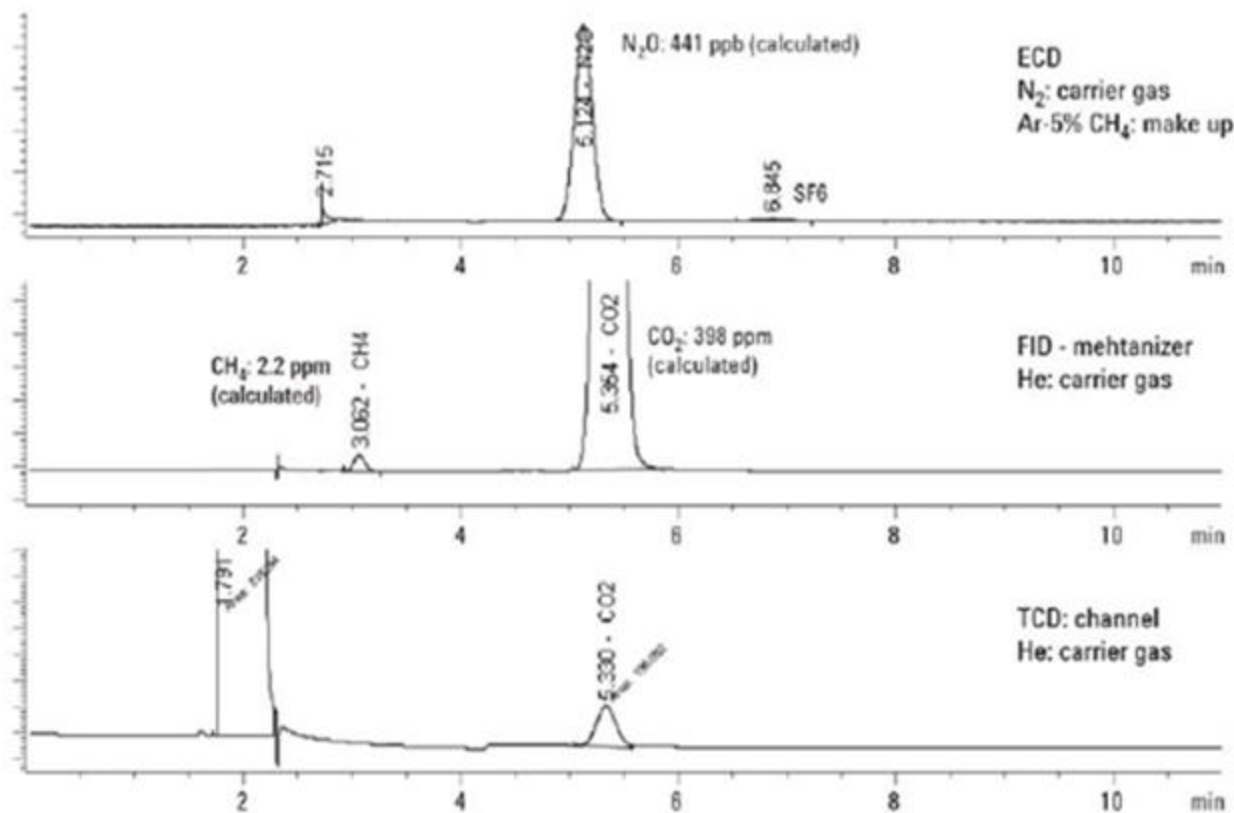


Key Features and Benefits

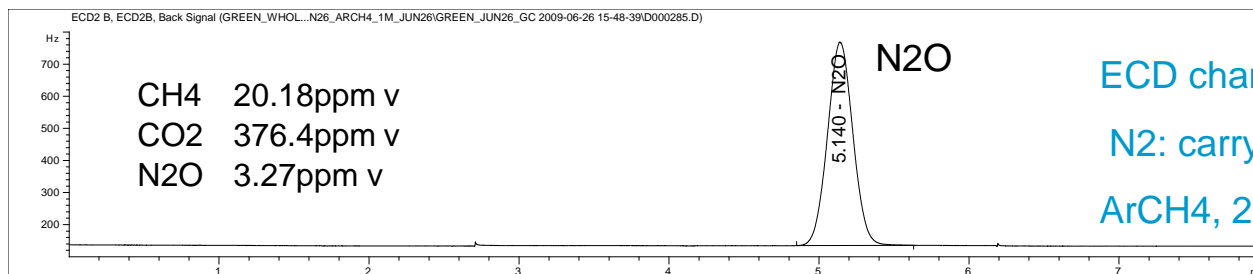
- Simultaneous analysis of greenhouse gas with one injection
- HSS Compatible
- ppb sensitivity for N₂O by ECD
- Expandable to include SF₆
- HSS Compatible
- Easy-to-use union based on CFT connects valves and μ ECD
 - Improves chromatographic performance
 - Better peak shape

Greenhouse Gas Analyzer (7890-0467)

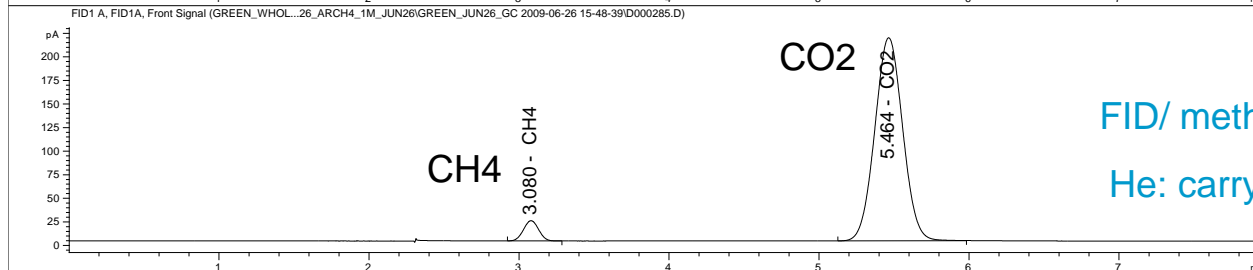
Typical Chromatogram



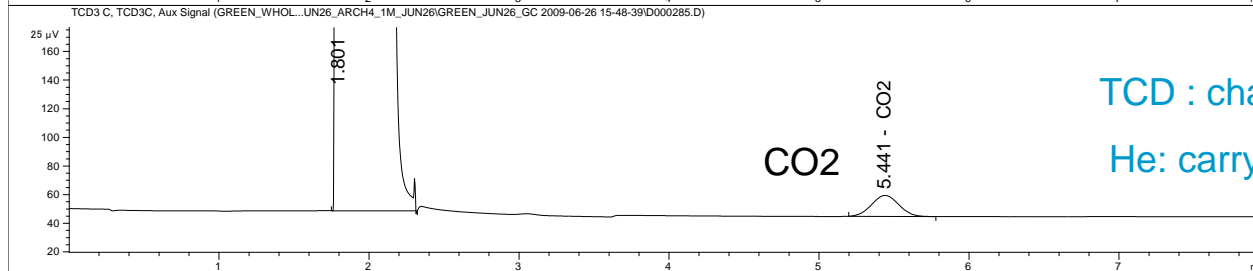
Chromatogram for Greenhouse Gases Standards Sample



ECD channel
N2: carry gas
ArCH4, 2ml/min, make up



FID/ methanizer channel
He: carry gas



TCD : channel
He: carry gas

Quantitative precision for Greenhouse Gases Standards (n=20)

Name	Average (Area)	STDVE	RSD%
CH4	151.61	0.64	0.42
CO2(FID)	2788.51	14.72	0.53
N2O	7467.92	13.91	0.19
CO2(TCD)	186.00	0.80	0.43

Greenhouse gases standards concentration, ppm V
CH4: 20.18, CO2: 376.4, N2O:3.27

... Excellent Quantitative precision

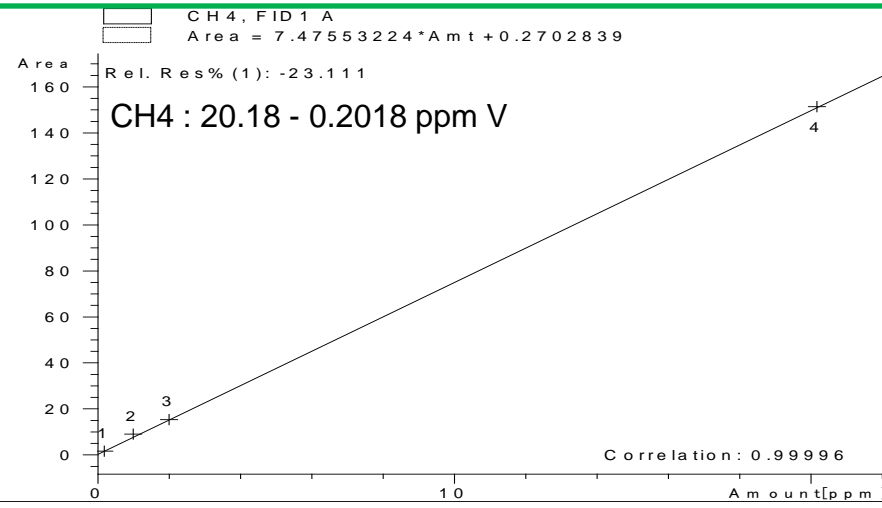
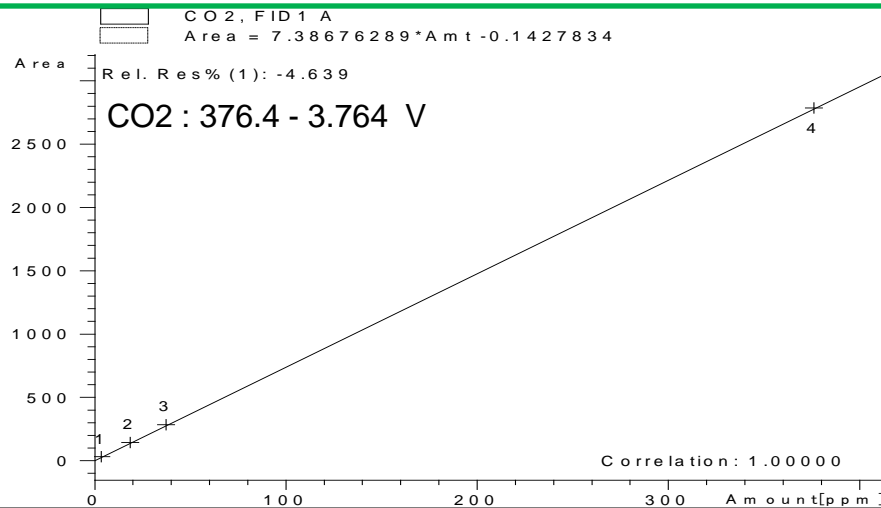
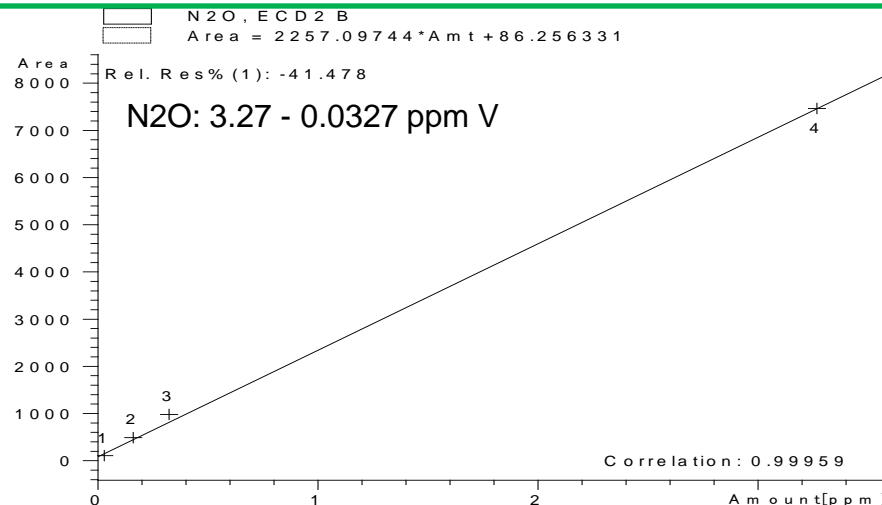
Multi-level Calibration for Greenhouse Gases Standards Using Dynamic Blending System

Standards sample information

Greenhouse gases standards are diluted for multi-level calibration by dynamic blending

Concentration, ppm V

	Original	10 X diluting	20 X diluting	100X diluting
CH4	20.18	2.018	1.009	0.2018
CO2	376.4	37.64	18.82	3.764
N2O	3.27	0.327	0.1635	0.0327



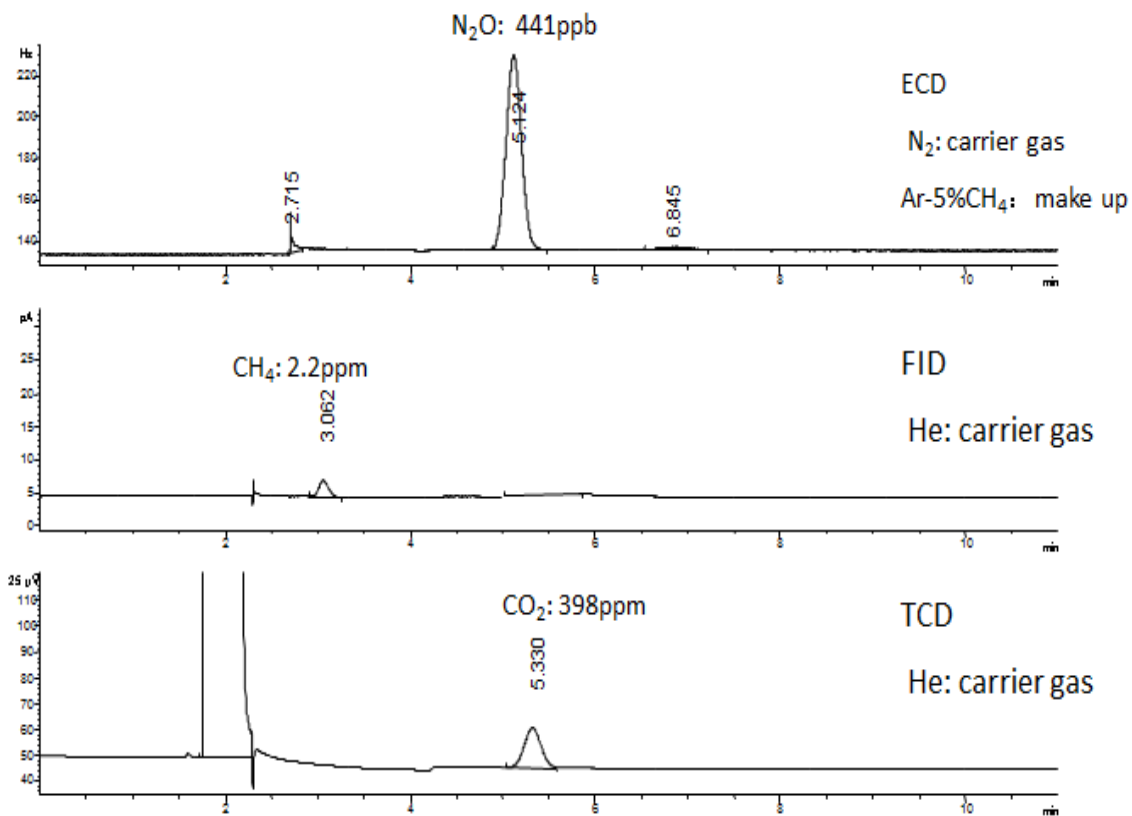
Greenhouse Gases Analyzer (7890-0467)

Key Features and Benefits

- Simultaneous analysis of greenhouse gas with one injection uses 2 separate channels with three detectors
 - Achieve faster results
 - Uses third TCD to expand concentration range for CO₂ determinations
- ppb sensitivity for N₂O by ECD
- Expandable to include SF₆
- Not HSS compatible
- Easy-to-use union based on CFT connects valves and μ ECD
 - Improves chromatographic performance
 - Better peak shape

Greenhouse Gas Analyzer (7890-0542)

Typical Chromatogram



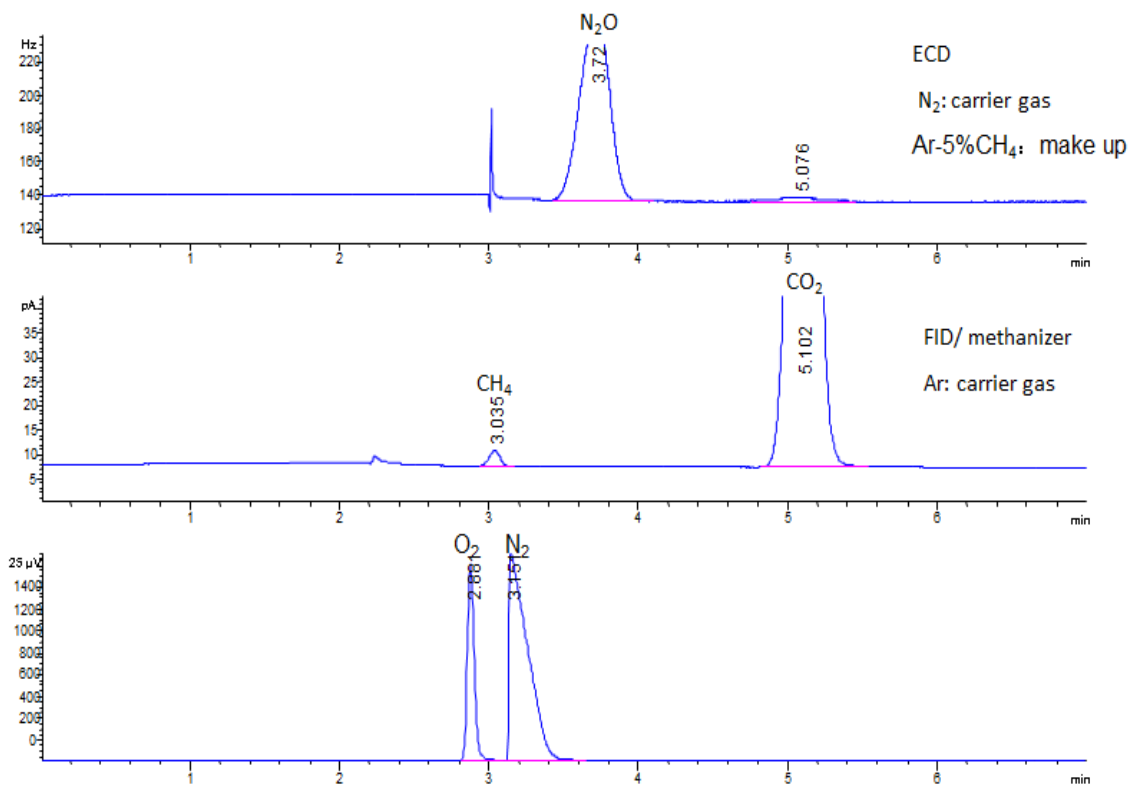
Greenhouse Gas Analyzer (7890-0542)

Key Features and Benefits

- Simultaneous analysis of greenhouse gas with one injection
 - TCD and FID connected in series to measure CH₄ by FID and CO₂ by TCD
 - Simplified configuration (no Methanizer) for analysis of CO₂ at concentrations > 50ppm
- Sensitivity of μ ECD ensures the detection of N₂O at ppb level
- Not HSS Compatible
- Easy-to-use union based on CFT connects valves and μ ECD
 - Improves chromatographic performance
 - Better peak shape

Greenhouse Gas Analyzer (7890-0504)

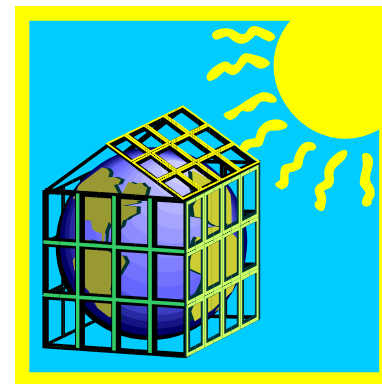
Typical Chromatogram



Greenhouse Gases Analyzer (7890-0504)

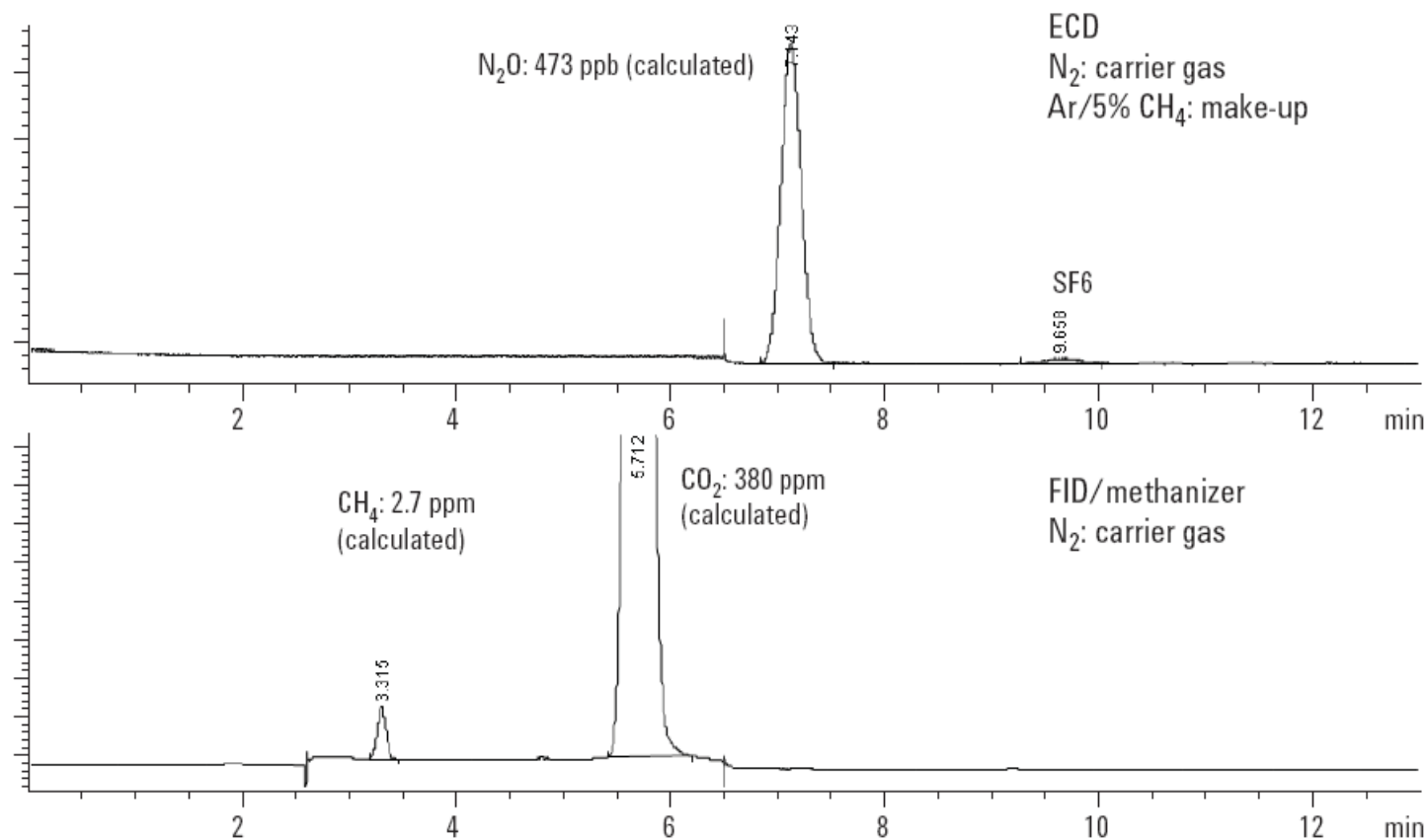
Key Features and Benefits

- Simultaneous analysis of greenhouse gas with one injection
 - Includes additional packed column to separate O₂ and N₂ in air
- Sensitivity of μ ECD ensures the detection of N₂O at ppb level
- Not HSS compatible
- Easy-to-use union based on CFT connects valves and μ ECD
 - Improves chromatographic performance
 - Better peak shape



Greenhouse Gas Analyzer (7890-0505)

Typical Chromatogram



Selected Resources: Application Notes

Publication	Title
5990-5129EN	Simultaneous Analysis of Greenhouse Gases by Gas Chromatography

Application Note inventory under review for revision and development.



Thank
You!