



ThermoFisher
S C I E N T I F I C

Air Liquide and Thermo Fisher Scientific Collaboration

Stable isotope ratio certified N₂, H₂ and CO₂ gases for IRMS

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Offer Deployment Manager
Air Liquide

The world leader in serving science

Air Liquide and Thermo Fisher Scientific Collaboration

- Air Liquide in partnership with Thermo Fisher Scientific has established stable isotope certified N₂, H₂ and CO₂ gases
- The aim of this collaboration is to bring to your lab:



Convenience



Confidence



Certainty



Stable Isotope Ratio Gases
for Thermo Fisher Scientific IRMS



Product Description

Non refillable cylinders

- Gas volume CO₂: 55 liters
- Gas volumes N₂ and H₂: 60 liters
- Nominal pressure: 30-37 bar (420-550 psig)
- Water volume: 1.6 Liters
- Outlet Swagelok connection: C10-5/8"-18 UNF standard
- Weight: 0.4 kg (0.8 lbs)
Other cylinder sizes and packages are available upon request



Low internal volume regulator

- Model: 206BB.single-stage brass regulator
- Compact and light weight
- Low internal dead volumes minimizes purging time
- Delivery Pressure Range: 0.1 – 5 bar Regulator
- Regulator outlet: Swagelok connection: ¼" NPT Outlet to 1/16"
- Weight: 0.6 kg (1.3 lbs)



Airgas

an Air Liquide company

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CERTIFICATE OF ACCURACY:

Product Information

Part No.: CD ISO20013CN3
Laboratory No.: 124-Plumsteadville - PA
Cylinder Size: 200
Cylinder No.: A31964
Expiration Date: 016OCT2021
Cylinder Pressure: 835 psig
CGA Outlet: 320
Net Weight: 23 kg
Gross Weight: 85.80 kg
Fill Temperature: 20°C

CERTIFIED VALUE:

Component Name	Concentration	Isotopic Ratio (‰) δ ¹³ C (vs. VPDB)*
Carbon Dioxide	99.99 %mol/mol	(-2.7 ± 0.5) ‰

*CO₂ isotopic characterization is traceable to the NBS18-NBS19 carbonate standards analyzed as CO₂ extracted by 100% orthophosphoric acid digestion.

APPROVED BY:


James L. McHale

DATE:

4/2/19

Isotope Characterized Gases

- Available as Start Up Kits (gas bottle + regulator) or as individual gas bottles
- All δ -values are traceable to primary reference material
 - $\delta^{13}\text{C}$ in CO_2 : Traceable to NBS-18 / NBS-19 - McCrea (1950) or Epstein, et al. (1964)
 - $\delta^{15}\text{N}$ in N_2 : Traceable to NSVEC nitrogen gas standard
 - $\delta^2\text{H}$ in H_2 : Traceable to VSMOW-SLAP scale - normalized to GISP - Coplen (1988)

ALPHAGAZ™ Pure Gases		Element	Data value	Uncertainty (‰)	Source Variation (‰)
Carbon Dioxide	CO_2	$\delta^{13}\text{C}$ (‰ VPDB)	-25	$\pm 0,5$	± 3
	CO_2	$\delta^{13}\text{C}$ (‰ VPDB)	-3	$\pm 0,5$	± 3
Nitrogen	N_2	$\delta^{15}\text{N}$ (‰ Air)	0	$\pm 0,5$	± 15
Hydrogen	H_2	$\delta^2\text{H}$ (‰ VSMOW)	-250	± 10	± 30

Technical Note – Cylinder Preparation And Calibration

Air Liquide has rigorously validated gas filling, processing, and storage protocols used in the manufacture of these products to directly address and eliminate associated isotopic fractionation that commonly accompanies those processes.

Technical note reports:

- Vaporization of liquefied gas
- Gas transfilling
- Gas Pressurization/depressurization—regulation
- Isotopic characterization of CO₂

thermo scientific
TECHNICAL NOTE 00734

δ¹³C of Air Liquide carbon dioxide: cylinder preparation and calibration

Authors: Rick Socki, Matt Matthew².

1. Vaporization of liquefied gas
In this note, we will address the following parameters, with examples shown for CO₂ in a gas cylinder:
1. Vaporization of liquefied gas
2. Gas transfilling
3. Gas Pressurization/depressurization—regulation
4. Isotopic characterization of CO₂

2. Gas transfilling
The equipment used to transfill gas from a source cylinder to the product cylinders is referred to as a transfill manifold. The source cylinder is connected to the feed side of the manifold; the product cylinders are on the receiving side. Typically, a source cylinder can fill many product cylinders at a time. Gases flowing through the transfill manifold are then subjected to gas expansion, pressurization and flow direction changes, all of which are possible sources of isotope fractionation. By judicious design of the gas transfill manifold system and controlled gas transfer operations, it is shown that isotopic fractionation during the transfill process is negligible. The δ¹³C value of CO₂ as measured and calibrated was -3.2‰ (VPDB). The same gas that was analyzed at Air Liquide was further analyzed at the United States Geological Survey (USGS), Reston, VA USA also on a dual inlet mass spectrometer. The δ¹³C value of that CO₂ as measured and calibrated at the USGS was -3.27±0.03‰ (VPDB).

Summary
Air Liquide has established isotopically characterized N₂, H₂ and CO₂ gases that can be used as reference material for isotope ratio mass spectrometers. By controlling several aspects of cylinder preparation, proper source to product cylinder transfilling techniques, and careful pressure regulation, Air Liquide can assure IRMS end users with isotopic uniformity and reliability in gas standards, not only in the Thermo Scientific[®] Start-Up Kit, but also for subsequent use when re-ordered.

Acknowledgment
We would like to acknowledge Tyler Coplan, USGS, for stable isotope analysis associated with this work.

References
1. Socki, R.A., Matthew, M., Morais, J., Sorensen, J., Megumi, T., Ehrhard, M., and Sorensen, J., "Stable Isotope Gas Analysis: ACO Group," submitted.
2. Socki, R.A., Wehring, A., and Jackson, T., "Carbon and Oxygen Isotope Fractionation of Pressurized CO₂ in Dual and Single Phase Cylinders," Presented at the 2019 Fall Meeting of the AGU, San Francisco, CA, December 2019.
3. Coplan, T. B., Kiehl, C., and Rappig, J., (1983), Comparison of stable isotope reference samples, Nature, v. 302, p. 216-218.
4. Brand, M.A., Coplen, T.B., Vogl, J., Brenner, M., and Froehner, T., (2014), Assessment of international reference materials for isotope-ratio analysis (IRMS), Technical Report, Pure Appl. Chem., 86 (3), p. 420-429.

Product cylinders in 10% (‰ VPDB) δ¹³C in CO₂

Product cylinders in 10% (‰ VPDB) δ ¹³ C in CO ₂	Product cylinders in 10% (‰ VPDB) δ ¹³ C in CO ₂	Product cylinders in 10% (‰ VPDB) δ ¹³ C in CO ₂	
10	-24.92	6	-24.98
2	-24.97	7	-24.98
3	-24.98	8	-24.98
4	-24.97	9	-24.96
5	-24.97	10	-24.97
Avg. -24.97			

End user and product cylinders

When a compressed gas is used, it is important to ensure that the gas is isotopically uniform. To ensure this, compressed gas cylinders are filled with gas that has been isotopically characterized. This ensures that the gas composition is uniform throughout the cylinder.

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Find out more at thermofisher.com/IRMS

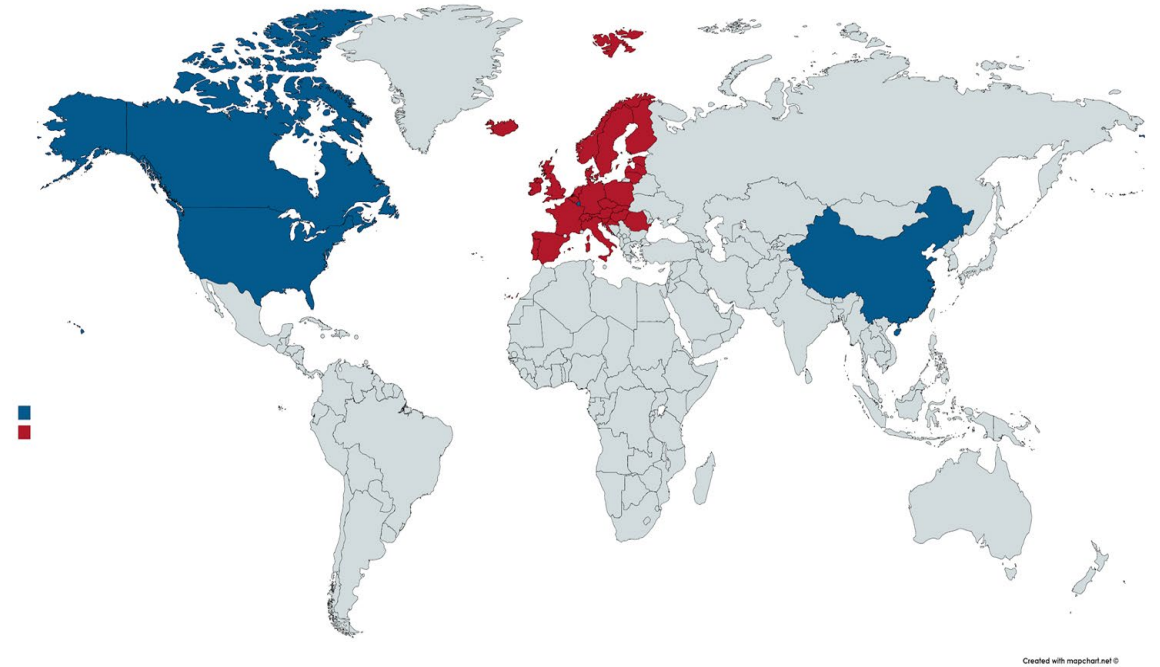
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Evaluation - Air Liquide / USGS Reston Lab, USA (Tyler Coplen)

- Proof-of-concept evaluation – the same gas that was analyzed at Air Liquide was further analyzed at the United States Geological Survey (USGS)

Component	Nominal value	Air Liquide - value on CoA	USGS Value
CO ₂	-25 (VPDB)	$\delta^{13}\text{C}$ $-24.9 \pm 0.5\text{‰}$ (VPDB)	$-24.90 \pm 0.05 \text{‰}$ (VPDB)
CO ₂	-3 (VPDB)	$\delta^{13}\text{C}$ $-3.3 \pm 0.5\text{‰}$ (VPDB)	$-3.27 \pm 0.03\text{‰}$ (VPDB)
N ₂	~0 (air)	$\delta^{15}\text{N}$ $-1.9 \pm 0.5\text{‰}$ (air)	$-1.90 \pm 0.04\text{‰}$ (air)
H ₂	-250 (VSMOW)	$\delta^2\text{H}$ $-253 \pm 5\text{‰}$ (VMSOW)	$-250.0 \pm 3.3\text{‰}$ (VSMOW)

- **Air Liquide Germany**
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UK, Norway, Switzerland
- **Airgas (Air Liquide Company)**
USA, Canada, China
(+ ROW through local Air Liquide affiliates)



Local Air Liquide personnel trained to support customers on site.
Reach out to your regional Thermo Fisher representative for more information on isotopically characterized gases.

Q&A

Thank you for your attention.

