

ISBT Beverage Grade Carbon Dioxide (CO₂) Analysis Report

Carbo Gas LTDA – Planta Vitoria de Santo Antao / PE
 Rodovia PE 45 - KM 14 – S/N
 Zona Rural – Engenho Cachoeirinha, Brazil
 Thais Neves
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AAL Number: 59479
 Received On: 12 Feb 21
 Report Date: 23 Feb 21
 P.O. Number: Prepay

Sample ID: Vaporized Liquid CO₂ Sample Final Product – Tank 1
 Received in: Low pressure sampling kit TBK # 4436, SSC # 1133, SBL # 0143

Sample Date: 04 Feb 21
 Final Test Date: 23 Feb 21

<u>RESULT</u>	<u>PARAMETER, CHEMICAL FORMULA (UNITS)</u>	<u>DL</u>	<u>METHOD</u>	<u>ISBT GUIDELINE LIMIT</u>
99.99	Carbon Dioxide Purity CO ₂ (% v/v)	5.	ISBT 2.0	99.90% v/v min
nd	Moisture (Water Vapor) H ₂ O (ppm v/v)	1.0	ISBT 3.0	20.0 ppm v/v max
nd	Oxygen O ₂ (ppm v/v)	4.0	ISBT 4.0	30.0 ppm v/v max
nd	Carbon Monoxide CO (ppm v/v)	0.5	ISBT 5.0	10.0 ppm v/v max
nd	Ammonia NH ₃ (ppm v/v)	0.5	ISBT 6.0	2.50 ppm v/v max
nd	Oxides of Nitrogen NO _x (ppm v/v)	0.5	ISBT 7.0	5.0 ppm v/v max
nd	Nitrogen Dioxide NO ₂ (ppm v/v)	0.5	ISBT 7.1	2.50 ppm v/v max
nd	Nitric Oxide NO (ppm v/v)	0.5	ISBT 7.2	2.50 ppm v/v max
nd	Non-volatile Residue NVR (ppm w/w)	1.0	ISBT 8.0	10.0 ppm w/w max
nd	Non-volatile Organic Residue NVOR (ppm w/w)	1.0	ISBT 8.0	5.0 ppm w/w max
nd	Methanol MeOH (ppm v/v)	0.2	ISBT 9.0	10.0 ppm v/v max
3.1	Total Hydrocarbons as Methane THC (ppm v/v as CH ₄)	0.1	ISBT 10.0	50.0 ppm v/v max
3.1	Total Non-Methane Hydrocarbons TNMHC (ppm v/v as CH ₄)	0.1	ISBT 10.1	20.0 ppm v/v max
0.07	Acetaldehyde AA (ppm v/v)	0.05	ISBT 11.0	0.20 ppm v/v max
nd	Aromatic Hydrocarbon AHC (ppm v/v)	0.002	ISBT 12.0	0.020 ppm v/v max
nd	Total Sulfur TS (ppm v/v as S)	0.02	ISBT 13.0	0.10 ppm v/v max (excl. SO ₂)
nd	Sulfur Dioxide SO ₂ (ppm v/v)	0.02	ISBT 14.0	1.0 ppm v/v max
<u>Sensory Tests</u>				
PASS	Odor in Water	na	ISBT 16.0	No foreign odor
PASS	Taste in Water	na	ISBT 16.0	No foreign taste
PASS	Appearance in Water	na	ISBT 16.0	No color or turbidity

NOTES: ISBT Guideline limits from ISBT Publication “Bulk Carbon Dioxide Quality & Food Safety Guidelines and Analytical Methods And Techniques Reference 2019” – 3rd Revision, October 2019. Parameter results above ISBT Guideline Limits reported in **RED**.

DL = test detection limit. **nd** = less than the test detection limit. **na** = value is non-applicable. **sc** = see comments below.
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 Unit Conversions: 0.0001% = 1 ppm = 1,000 ppb = 1µL/L (v/v) or 1µg/g (w/w)

Comments:

Bruce J. Gollob
 Bruce J. Gollob
 CEO, Analytical Services

Attachments:

Full Final Product Carbon Dioxide (CO₂) Analysis Report

Carbo Gas LTDA
Sample ID: Vaporized Liquid CO₂ Sample Final Product – Tank 1

AAL Number: 59479
Sample Date: 04 Feb 21

RESULT	PARAMETER, CHEMICAL FORMULA (UNITS)	DL	METHOD	ISBT GUIDELINE LIMIT
99.99	Carbon Dioxide Purity (% v/v)	5.	ISBT 2.0	99.90% v/v min
nd	Non-volatile Residue NVR (ppm w/w)	1.0	ISBT 8.0	10.0 ppm w/w max
nd	Non-volatile Organic Residue NVOR (ppm w/w)	1.0	ISBT 8.0	5.0 ppm w/w max
3.1	Total Hydrocarbons as Methane THC (ppm v/v as CH ₄)	0.1	ISBT 10.0	50.0 ppm v/v max
3.1	Total Non-Methane Hydrocarbons TMHCH (ppm v/v as CH ₄)	0.1	ISBT 10.1	20.0 ppm v/v max
nd	Moisture (Water Vapor) H ₂ O (ppm v/v)	1.0	ISBT 3.0	20.0 ppm v/v max
nd	Carbon Monoxide CO (ppm v/v)	0.5	ISBT 5.0	10.0 ppm v/v max
nd	Ammonia NH ₃ (ppm v/v)	0.5	ISBT 6.0	2.50 ppm v/v max
nd	Oxides of Nitrogen NO _x (ppm v/v)	0.5	ISBT 7.0	5.0 ppm v/v max
nd	Nitrogen Dioxide NO ₂ (ppm v/v)	0.5	ISBT 7.1	2.50 ppm v/v max
nd	Nitric Oxide NO (ppm v/v)	0.5	ISBT 7.2	2.50 ppm v/v max
Source Specific Parameters (ppm v/v)				
nd	Hydrogen Cyanide HCN	0.5	ISBT 17.0	Not detectable by method
nd	Vinyl Chloride C ₂ H ₃ Cl	0.1	ISBT 18.0	Not detectable by method
nd	Phosphine PH ₃	0.1	ISBT 19.0	0.30 ppm v/v max
nd	Ethylene Oxide C ₂ H ₄ O	0.1	ISBT 20.0	0.20 ppm v/v max
Non-Condensable Gases (NCG. ppm v/v)				
nd	Nitrogen N ₂	4.0	ISBT 4.0	na
nd	Oxygen O ₂	4.0	ISBT 4.0	30.0 ppm v/v max
nd	Argon Ar	4.0	ISBT 4.0	na
nd	Hydrogen H ₂	10.0	ISBT 4.0	na
nd	Helium He	10.0	ISBT 4.0	na
Volatile Hydrocarbons (VHC. ppm v/v)				
nd	Methane	0.5	ISBT 10.1	na
nd	Ethylene	0.5	ISBT 10.1	na
nd	Ethane	0.5	ISBT 10.1	na
nd	Propylene	0.5	ISBT 10.1	na
nd	Propane	0.5	ISBT 10.1	na
nd	Isobutane	0.5	ISBT 10.1	na
nd	n-Butane	0.5	ISBT 10.1	na
nd	Butenes	0.5	ISBT 10.1	na
nd	Isopentane	0.5	ISBT 10.1	na
nd	n-Pentane	0.5	ISBT 10.1	na
nd	Pentenes	0.5	ISBT 10.1	na
nd	C ₆ +	0.5	ISBT 10.1	na
Aromatic Hydrocarbons (BTEX. ppm v/v)				
nd	Benzene AHC	0.002	ISBT 12.0	0.020 ppm v/v max
nd	Toluene	0.002	ISBT 12.0	na
nd	Ethyl Benzene	0.002	ISBT 12.0	na
nd	m+p Xylene	0.002	ISBT 12.0	na
nd	o-Xylene	0.002	ISBT 12.0	na

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Comments:



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RESULT	Volatiles (VSC, ppm v/v)	DL	METHOD	ISBT GUIDELINE LIMIT
nd	Hydrogen Sulfide H ₂ S	0.02	ISBT 14.0	na
nd	Carbonyl Sulfide COS	0.02	ISBT 14.0	na
nd	Sulfur Dioxide SO ₂	0.02	ISBT 14.0	1.0 ppm v/v max
nd	Methyl Mercaptan	0.02	ISBT 14.0	na
nd	Ethyl Mercaptan	0.02	ISBT 14.0	na
nd	Dimethyl Sulfide	0.02	ISBT 14.0	na
nd	Carbon Disulfide	0.02	ISBT 14.0	na
nd	i-Propyl Mercaptan	0.02	ISBT 14.0	na
nd	t-Butyl Mercaptan	0.02	ISBT 14.0	na
nd	n-Propyl Mercaptan	0.02	ISBT 14.0	na
nd	Methyl Ethyl Sulfide	0.02	ISBT 14.0	na
nd	sec-Butyl Mercaptan	0.02	ISBT 14.0	na
nd	i-Butyl Mercaptan	0.02	ISBT 14.0	na
nd	Diethyl Sulfide	0.02	ISBT 14.0	na
nd	n-Butyl Mercaptan	0.02	ISBT 14.0	na
nd	Dimethyl Disulfide	0.02	ISBT 14.0	na
nd	Diethyl Disulfide	0.02	ISBT 14.0	na
nd	Other Sulfurs	0.02	ISBT 14.0	na
nd	Total Sulfur Content TSC as S	0.02	ISBT 13.0	0.10 ppm v/v max (excl. SO ₂)
<u>Volatiles (VOX, ppm v/v)</u>				
0.07	Acetaldehyde AA	0.05	ISBT 11.0	0.20 ppm v/v max
nd	Ethylene Oxide	0.1	ISBT 20.0	0.20 ppm v/v max
nd	Dimethyl Ether	0.1	ISBT 11.0	na
nd	Methyl Ethyl Ether	0.2	ISBT 11.0	na
nd	Methanol MeOH	0.2	ISBT 9.0	10.0 ppm v/v max
nd	Propionaldehyde	0.2	ISBT 11.0	na
nd	Acetone	0.2	ISBT 11.0	na
1.9	Ethanol	0.2	ISBT 11.0	na
nd	Isopropanol	0.2	ISBT 11.0	na
nd	Ethyl Acetate	0.2	ISBT 11.0	na
nd	t-Butanol	0.2	ISBT 11.0	na
nd	n-Propanol	0.2	ISBT 11.0	na
nd	2-Butanol	0.2	ISBT 11.0	na
nd	Isobutanol	0.2	ISBT 11.0	na
nd	n-Butanol	0.2	ISBT 11.0	na
nd	Isoamyl Alcohol	0.2	ISBT 11.0	na
nd	Isoamyl Acetate	0.2	ISBT 11.0	na
<u>Sensory Tests</u>				
PASS	Odor in Water	na	ISBT 16.0	No foreign odor
PASS	Taste in Water	na	ISBT 16.0	No foreign taste
PASS	Appearance in Water	na	ISBT 16.0	No color or turbidity

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