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Advanced Biogas Characterization Program

Customer Info:

ALI Track No.:
Received On:
Report Date:
Payment Mode:

Phone:
Attn.:
E-Mail:
Sample ID.: Biogas taken at
Sampled On:
Sample ID.: Received in 4, passivated 300 cc *ALI* cylinders #'s + 40 cc Impinger Soln – IMP-60 Assy + Biostage™ 200 TSA & MEA Agar plates.

Major Biogas Composition (Dry-Gas Basis)	**Result**	**MDL**
Carbon Dioxide (CO_2, % v/v, GC/TCD):		0.001
Methane (CH_4, % v/v, GC/TCD):		0.001
Water Vapor (H_2O, % v/v, Grav):		na

Minor Biogas Composition (Dry-Gas Basis)	**Result**	**MDL**
Hydrogen (H_2 , ppm v/v, GC/PDID):		10
Carbon Monoxide (CO, ppm v/v, GC/PDID):		10
Nitrogen (N_2, ppm v/v, GC/PDID):		10
Oxygen + Argon (O_2 + Ar, ppm v/v, GC/PDID):		10
Ammonia (NH_3, ppm v/v, DT):		0.5
Hydrogen Cyanide (HCN, ppm v/v, GC/FID, DT):		0.2
Nitrogen Oxide (NO, ppm v/v, DT):		0.5
Nitrogen Dioxide (NO_2, ppm v/v, DT):		0.5
Phosphine (PH_3, ppm v/v, DT):		0.25

Comments:

Volatile Sulfur Compous (VSC, ppm v/v, by ISBT 14.0, GC/SCD)

Target Analyte:	**Result**	**MDL**
Hydrogen Sulfide (H_2S):		0.01
Carbonyl Sulfide (COS):		0.01
Sulfur Dioxide (SO_2)*:		0.01
Methyl Mercaptan:		0.01
Ethyl Mercaptan:		0.01
Dimethyl Sulfide:		0.01
Carbon Disulfide** (CS_2):		0.01
Isopropyl Mercaptan:		0.01
Methyl Ethyl Sulfide:		0.01
n-Propyl Mercaptan:		0.01
t-Butyl Mercaptan:		0.01
Diethyl Sulfide:		0.01
Dimethyl Disulfide**:		0.01
sec-Butyl Mercaptan:		0.01
Thiophene:		0.01

Comments: Peak ID based upon t_r match against target analyte standards. Sample taken in a 300 cc Silconert™ passivated Biogas cylinder pressurized to approx. 20 psig.* ISBT TSC definition = ppm v/v as S & excluding SO_2) **TSC contribution = 2X ppm v/v value.

Sample ID: ALI Track No.:

Total Sulfur Content (TSC, ppm v/v, by ISBT 14.0, GC/SCD)	**Result**	**MDL**
TSC* (as S):		0.01

Comments: *ISBT TSC definition = Sum of all detected Target VSC analytes in ppm v/v taking into account #S atoms/molecule a excluding SO_2 level. Report LOQ = 0.01 as S. Sample taken in a 300 cc Silconert™ passivated Biogas cylinder pressurized to approx. 20 psig.

Volatile Hydrocarbons (VHC, C_2 – C_6+, ppm v/v, by ISBT 10.1, GC/FID)

Target Analyte	**Result**	**MDL**
Ethane:		0.1
Ethylene:		0.1
Propylene:		0.1
Propane:		0.1
Isobutane:		0.1
n-Butane:		0.1
Butene:		0.1
Isopentane:		0.1
n-Pentane:		0.1
Hexanes+:		0.1

Comments: Peak ID based upon t_r match against target analyte standards. Sample taken in a 300 cc Silconert™ passivated Biogas cylinder pressurized to approx. 20 psig. C_2-C_6+ measured by GC/FID, see CH_4 on pg 1 measured by GC/TCD.

TNMHC: (ppm v/v by ISBT Method 10.1): 0.1

Comments: TNMHC ppm v/v = Calculatedd THC analyzer signal equivalency as ppm v/v CH_4 as per ISBT definition.
(TNMHC [ISBT] = sum of each C_2-C_6+ VHC ppm v/v result x $R_{THA\ as\ CH4}$ for that target analyte)

Aromatic Hydrocarbons (AHC, ppb v/v as Benzene, by ISBT 12.0, GC/FID/PID)	**Result**	**MDL**
Benzene (C_6H_6):		2
Toluene:		2
Ethyl Benzene:		2
o,m,p Xylenes:		2

Comments: Peak ID based upon t_r match against target analyte standards. Sample taken in a 300 cc Silconert™ passivated Biogas cylinder pressurized to approx. 20 psig. GC/FID data employed.

Sample ID: ALI Track No.:

Speciated Volatile Oxygenates (VOX, ppm v/v, by ISBT 11.0 GC/PID/FID)

Target Analyte	Result	MDL
Acetaldehyde (AA):		0.1
Dimethyl Ether:		0.1
Diethyl Ether:		0.1
Ethylene Oxide:		0.1
Methanol:		0.1
Acetone:		0.1
Ethanol:		0.1
Ethyl Acetate:		0.1
t-Butanol:		0.1
n-Propanol:		0.1
2-Butanol:		0.1
Isobutanol:		0.1
n-Butanol:		0.1
Isoamyl Acetate:		0.1
Unknown VOX:		0.1

Comments: Peak ID based upon t_r match against target analyte stds. Sample taken in a 300 cc Silconert™ passivated Biogas cylinder pressurized to approx. 20 psig. Note: IPA used for bioagent test hardware sterilization & therefore not reported as a VOX. GC/FID data employed.

Volatile Halogenated Compous (VXC, ppm v/v by GC/ECD)

Target Analyte	Result	MDL
Chloromethane (CH_3Cl):		0.01
Vinyl Chloride (C_2H_3Cl):		0.01
Chloroethane (C_2H_5Cl):		0.01
1,1-Dichloroethene ($C_2H_2Cl_2$):		0.01
Methylene Chloride (CH_3Cl):		0.01
1,1-Dichloroethane ($C_2H_4Cl_2$):		0.01
Cis-1,2-Dichloroethene ($C_2H_4Cl_2$):		0.01
Chloroform ($CHCl_3$):		0.01
1,2-Dichloroethane ($C_2H_4Cl_2$):		0.01
1,1,1-Trichloroethane ($C_2H_3Cl_3$):		0.01
Carbon Tetrachloride (CCl_4):		0.01
1,2-Dichloropropane ($C_3H_6Cl_2$):		0.01
Trichloroethene (C_2HCl_3):		0.01
Cis-1,3-Dichloropropene ($C_3H_4Cl_2$):		0.01
Trans-1,3-Dichloropropene ($C_3H_4Cl_2$):		0.01
1,1,2-Trichloroethane ($C_2H_3Cl_3$):		0.01
Tetrachloroethene (C_2Cl_4):		0.01
1,1,2,2,-Tetrachloroethane ($C_2H_2Cl_4$):		0.01
Hexachloro-1,3-Butadiene (C_4HCl_6):		0.01
Unknown VXC:		0.01

Comments: Peak ID based upon t_r match against target analyte standards. Sample taken in a 300 cc Silconert™ passivated Biogas cylinder pressurized to approx. 20 psig. Industry Standard GC/ECD method.

Sample ID: ALI Track No.:

Siloxanes ($C_nH_xO_ySi_z$, ppm v/v, by GC/MS)

Target Analyte:	**Result**	**MDL**
Trimethylsilanol (TMS):		0.1
Hexamethyldisiloxane (L2):		0.1
Octamethyltrisiloxane (L3):		0.1
Decamethyltetrasiloxane (L4):		0.1 semiQ*
Dodecamethylpentasiloxane (L5):		0.1 semiQ*
Hexamethylcyclotrisiloxane (D3):		0.1 semiQ*
Octamethylcyclotetrasiloxane (D4):		0.1
Decamethylcyclopentasiloxane (D5):		0.1
Dodecamethylcyclohexasiloxane (D6):		0.1 semiQ*
Pentamethyldisiloxane:		0.1 semiQ*
1,1,3,3-Tetramethyldisiloxane:		0.1 semiQ*

Comments: *Semi-quantitative result based on use of a surrogate siloxane std (D5). Sample taken in a 300 cc Silconert™ passivated Biogas cylinder pressurized to approx. 20 psig. Industry Std GC/MS method employed

Trace Metals & Elements ($\mu g/L_{gas}$ = ppm w/v in Biogas by Acid Impingment / ICPES)

Target Element	**Result**	**MDL**
Arsenic (As, ppm /v):		0.3
Comments: Field Blank result =		
Barium (Ba, ppm w/v):		0.3
Comments: Field Blank result =		
Cadmium (Cd, ppm w/v):		0.3
Comments: Field Blank result =		
Calcium (Ca, ppm w/v):		0.3
Comments: Field Blank result =		
Chromium (Cr, ppm w/v):		0.3
Comments: Field Blank result =		
Copper (Cu, ppm w/v):		0.3
Comments: Field Blank result =		
Iron (Fe, ppm w/v):		0.3
Comments: Field Blank result =		
Lead (Pb, ppm w/v):		0.3
Comments: Field Blank result =		
Magnesium (Mg, ppm w/v):		0.3
Comments: Field Blank result =		
Manganese (Mn, ppm w/v):		0.3
Comments: Field Blank result =		
Mercury (Hg, ppm w/v):		0.3
Comments: Field Blank result =		
Nickel (Ni, ppm w/v):		0.3
Comments: Field Blank result =		
Phosphorus (P, ppb w/v):		0.3
Comments: Field Blank result =		
Selenium (Se, ppm w/v):		0.3
Comments: Field Blank result =		
Silicon (Si, ppm w/v):		0.3
Comments: Field Blank result =		
Silver (Ag, ppm w/v):		0.3
Comments: Field Blank result =		
Tin (Sn, ppm w/v):		0.3
Comments: Field Blank result =		
Zinc (Zn, ppm w/v):		0.3
Comments: Field Blank result =		

Comments: Sample taken by 60 cc PTFE impingement using 40.0 mL reagent H_2O – acidified with metal-free HNO_3. Flow conditions (750 sccm target) for 60 min = (45L target). MDL LT 0.3 ppm w/v. EPA 200.7 adapted method

Sample ID: ALI Track No.:

Bioagent Testing

1) Biostage 200™ (for Viable Bacteria & Fungi Sample + Field Blank, Results = CFU/m^3 vapor phase)

Prominent (5) Viable Bacteria (Media: TSA, Inc. Temp 35ºC, CFU/m^3, by light microscope) **Result**

TSA #1
None: ----------
Total: ----------
Comments: Field Blank (TSA 5B) CFU/m^3) = none.

TSA #2
None: ----------
Total: ----------
Comments: Field Blank (TSA 5B) CFU/m^3) = none.

Comments: TSA Samples 1 & 2 taken @ (15 LPM target for 20 min = 300L target) Sample Volume (Note: CO_2 Cal Chart used for flowmeter ball settings). Most Prominent 5 Bacteria types ID'd from a library list of TSA culturable Bacteria. Sensitivity = 4 CFU/m^3. (ex. Total Colonies x 4 = CFU/m^3 reported). All gas wetted hardware sterilized with 70% IPA before sampling.

Prominent (5) Viable Fungi (Media: MEA, Inc. Temp 25ºC, CFU/m^3, by light microscope) **Result**

MEA #1P
Sterile (Dark): ----------
Total: ----------

MEA #2P
Alternaria alternarta: ----------
Sterile (Dark): ----------
Total: ----------
Comments: Field Blank (MEA 5B) CFU/m^3) = none. "Sterile (Dark) indicates it was a dark colony with no sporulation (spores produced) making definite identification not possible.

Comments: MEA Agar Petri Dish. Sample taken @ (15 LPM target for 20 min = 300L target) Sample Volume.
Most Prominent 5 Fungi types ID'd from a library list of MEA culturable Fungi. Sensitivity = 4 CFU/m^3. (Ex. Total Colonies x 4 = CFU/m^3 reported). All gas wetted hardware sterilized with 70% IPA before sampling.

Report Legend: LOQ = Limit of Quantitation (lowest amount of analyte quantitatively determined with suitable precision a accuracy). **MDL** = method detection limit (lowest amount of analyte detected). **trace** = unquantified amount observed between MDL a LOQ. = impurity was not detected (below MDL). **--** = test not performed. **na** = not available. **LT** = less than the amount specified. **GT** = greater than the amount specified. **%** = percent. ppm = parts per million. **ppb** = parts per billion. v/v = volume analyte/volume sample. **w/w** = weight analyte/weight sample. **[result]** indicates the result was obtained by the method listed within brackets. **DT** = Detector Tube (Colorimetry). **Unit Conversions:** 1ppm v/v = 1µL/L = 1000 ppb = 0.0001% v/v. **NTP** = 760 mm Hg, 25ºC, [75ºF]. CFU = colony forming units,1 m^3 = 1,000L. **Date format:** MM/DD/YY

Report Summary:

Customer requested a specialized Biogas analytical test program including Bioagent screening.

Reviewed by / Date:

Laboratory Manager *mm/dd/yy*

Attachments: See Sampling Protocol + Analytical Method References / Overview
Addendum: Signatures, Instrument & Notebook data on-file
Instrument Data: Results on file @ *ALI* & subcontractors:

Addendum I
Biogas Sampling Protocol

1) Bioagent (BioStage™) Sampling Performed 1st Stage

- Use of sterilized Transfer line, Ice-Water chilled KOA H_2O Trap, Bio-Stage Assembly components assembled as per supplied instructions.

- Calipump-1S 12VDC with high flow 605 flowmeter operated according to instructions for preliminary line flushing & set up for Bioagent (Biostage) Sampling including installation a use of TSA then MEA culture plate installation, use of 20 LPM gas flow for x min. = y L followed by immediate secure plate lidding & labeling of all culture disks back into their insulated & chilled shipping box. Open then immediately close, seal & label the appropriate “Feld Blank” culture plate.

2) Biogas Cylinder Sampling 2 Stage (for majority of Target Impurity Analysis)

- Purge sample lines as described in the instructions. Connect, flush a fill to pressure (25+ psig) all submitted 300 sccm passivated Biogas sample cylinders using the time periods suggested including use of outlet H_2O bubbling trap. Make sure no visibly water saturates the KOA trap system, gets into the Calipump or flowmeter system during this sampling process.

3) PTFE Impinger Sampling 3rd Stage (for Trace Metals)

- Install a 602 Low-Medium flowmeter onto the Calipump. Purge sample lines as described in the instructions. Next, attach 2-stage PTFE Impinger assembly + ball and valve inlet assembly as outlined in the instructions. Fill the primary impinger unit with 40 cc of supplied impinger solution. During collection, ensure that the required flow rate of 750 sccm is maintained for the desired sampling time (x min). Make sure no visibly water saturates the KOA trap system during this period or gets into the Calipump or flowmeter system during this sampling process.

-At the end of the desired sampling period, shut off the impinger inlet ball valve, then disconnect the 60 cc PTFE impinger body a quantitatively transfer all of the impinger solution back into its original 60 cc PP vial a properly label this sample vial with sampling ID information. Open then immediately close the supplied “Field Blank” vial.