Bloomenergy

# Bloom Energy Server

## Natural Gas Specification

This gas specification must be used for proper Energy Server contracting and operation

### Specifications

| Hydrocarbon Composition | Limit (mol %) |
|---|---|
| Methane ($CH_4$) | Min 85 |
| Ethylene ($C_2H_4$) | Max 0.5 |
| Ethane ($C_2H_6$) | Max 12 |
| Propylene ($C_3H_6$) | Max 0.125 |
| Propane ($C_3H_8$) | Max 3.4 |
| iButane + nButane ($C_4H_{10}$) | Max 2.0 |
| Sum of $C_{5+}$ | Max 0.2 |

Notes:

1. Note that not all the hydrocarbons can be at the upper limit simultaneously.
2. Composition transients within the above specification ranges shall change at less than 1% per hour.
3. Composition lab data collected shall be per EPA 3C.
4. Customer is expected to provide the hydrocarbon composition during contracting.

| Sulfur Species | Average (ppbV) | Maximum (ppbV)[4] |
|---|---|---|
| $H_2S$ (Hydrogen Sulfide) | 1,000 | 2,000 |
| COS (Carbonyl Sulfide) | 200 | 500 |
| $CS_2$ (Carbon Disulfide) | 50 | 150 |
| Mercaptans[1] | 2,000 | 4,000 |
| Thiophenes[2] | 2,000 | 4,000 |
| Others[3] | 50 | 100 |
| Total Sulfurs (sum of all) | 5,000 | 10,000 |

1. TBM is the primary Mercaptan
2. THT is the primary Thiophene
3. Other sulfides and disulfides
4. Levels above this amount must be approved by Bloom

| Contaminant | Limit |
|---|---|
| Siloxanes | < 0.12 $mg/m^3$ |
| Arsenic ($AsH_3$ &/or As) | < 0.05 ppmV |
| Halogens ($CH_3Cl$, HCl, etc.) | < 2.8 $\mu g/m^3$ |
| Mercury | < 2.0 ppmV |
| Cadmium | < 2.0 ppmV |
| Zinc | < 2.0 ppmV |
| Ammonia | < 40 ppmV |
| Phosphorous/$PH_3$ | < 2.0 ppmV |
| Sodium | < 2.0 ppmV |

- Contaminants and Sulfur species limits shall be measured by Draeger tubes, bag sampling, or online gas analyzers at site.
- The gas composition requirements of this specification were verified by historical data of site gas sampling per: ASTM D8230 Siloxanes, EPS TO-15 Halogens, EPS29 Arsenic, Mercury, Cadmium, Zinc, NIOSH 6015 Ammonia and ASTM D 5504 Sulfur
- The natural gas shall have a moisture content of less than 154 ppmV $H_2O$ (~7 lbs/mmscf)

| Trace component | Limit |
|---|---|
| $N_2$ | < 3.0 mol% |
| $O_2$ | < 0.2 mol% |
| $CO_2$ | < 3.0 mol% |
| $H_2$ | < 1.0 mol% |
| CO | < 100 ppm |

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DOC-1016839 Rev02