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Analytical Products and Solutions

Gas analysis in biogas plants with the "Set BGA" complete measuring system from Siemens

Set BGA (Bio Gas Analyzer) is a fully configured and ready-to-run gas analysis system for use in biogas plants. The integrated ULTRAMAT 23 industrial gas analyzer has four measuring channels for simultaneous determination of the relevant gas components methane, carbon dioxide, hydrogen sulfide, and oxygen. The Set BGA is especially economical for the operator thanks to standardization. The ULTRAMAT 23, proven in decades of harsh industrial use, features maximum performance and operational reliability.

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Biogas – production and use

Biogas is a flammable gas used for generating energy; it is produced by fermentation of biomass under exclusion of oxygen. Such plants can be found in agricultural companies and also in municipal or industrial sewage treatment plants. The materials used include organic municipal waste, renewable raw materials, and liquid manure. The crude biogas produced in a first reactor (fermenter) consists of methane and carbon dioxide as the main components as well as hydrogen sulfide, ammonia and water vapor (see table "Biogas composition"). The flammable methane is the supplier of energy. Following further treatment, the biogas is used in combined heat and power (CHP) plants with gas engines to generate electricity and heat or is fed into a natural gas network.

Gas analysis in biogas plants

A biogas plant must be continuously monitored with respect to gas composition, temperature, dwell time in the fermenter and the addition of substrate to ensure optimum operation of the biological process and to achieve as high a methane yield as possible. It is particularly important to check the concentration of hydrogen sulfide as this residual gas is toxic and corrosive and can also disrupt the biological process above a specific concentration level.

Plant monitoring is carried out by analyzing the composition of the raw biogas downstream of the fermenter with the following significance for the process:

- The methane concentration is used to control the addition of material. A fluctuating methane content in the fermenter would considerably disrupt the fermentation process.
- The oxygen concentration is extremely important to ensure an optimum fermentation process since the formation of explosive gas mixtures can then be detected early and prevented.

- Measuring hydrogen sulfide levels makes it possible to keep the concentration of this toxic and corrosive gas as low as possible by taking appropriate action. Besides the risk to people resulting from its toxicity, this gas can adversely affect both the generation of biogas and downstream processes.
- Under the effects of humidity and warmth, hydrogen sulfide reacts with metal components such as pipelines or connections. When hydrogen sulfide is converted to sulfur dioxide in combustion engines, this endangers their operational safety and makes more frequent oil changes necessary. The metallic heat exchanger installed downstream can also be damaged.

If biogas is to be used in combined heat and power (CHP) plants or particularly for feeding into a natural gas network, certain gas qualities (the methane content, remaining content of carbon dioxide and contamination) have to be achieved and maintained by means of a downstream gas preparation system. The Siemens gas chromatograph SITRANS CV (Calorific Value) or the complete system "Set CV" is ideally suited to such monitoring.

Gas component	Concentration range	Mean value
Methane (CH ₄)	45 ... 70 %	60 %
Carbon dioxide (CO ₂)	25 ... 55 %	35 %
Water vapor	0 ... 10 %	3 ... 10 %
Nitrogen (N ₂)	0.01 ... 5 %	1 %
Oxygen (O ₂)	0.01 ... 2 %	0.3 %
Hydrogen (H ₂)	0 ... 1 %	< 1 %
Ammonia (NH ₃)	0.01 ... 2.5 mg/m ³	0.7 %
Hydrogen sulfide (H ₂ S)	10 ... 30 000 mg/m ³	< 500 mg/m ³

Biogas composition

Set BGA standard measuring system

Set BGA (biogas analysis, see title picture) is one of a series of standardized complete systems for gas analysis which Siemens Analytical Products and Solutions has developed for certain fields of application. The sets contain all the required components for the relevant application, from gas sampling to operator control and display units in a compact design. Sets are easy to configure and provide considerable user benefits thanks to reduced requirements for planning, engineering, installation, training, and maintenance.

The Set BGA comprises a measuring system and an optional sample preparation device (see title picture). The Set BGA measuring system (see Fig. "Set BGA measuring system") consists of the four-component ULTRAMAT 23 gas analyzer with selectable equipment and I/O components (basic equipment) as well as additive modules (see Table "Configuration scheme of the Set BGA").

Efficient sample preparation (see Fig. "Two-stream sample preparation") for fast, reliable and reproducible analytical results is an essential prerequisite for analyzing raw biogas. Up to four sample streams can be chosen for continuous analysis. The sample preparation device is fitted in a rugged enclosure in which a cabinet heater can be accommodated (to avoid condensation moisture when installed outdoors) in addition to a suction pump.

User benefits and performance features

Reduced operating and maintenance costs

- Monitoring of several fermenters using one device via measuring point switchover function
- Can be ordered from catalog, supplied ready-to-run, minimum installation efforts
- Reduced calibration gas requirements thanks to AUTOCAL function with ambient air
- NDIR measuring cells can be cleaned by the user and are therefore reusable
- Excellent accessibility thanks to arrangement in hinged bays

Particularly high operational reliability, long-term stability and availability

- Industry-compatible, extremely rugged mechanical and electrical design
- High service life of the H₂S- sensor; no dilution or backflushing required
- Compensation of pressure and temperature influences
- Self-explanatory operating text, large display, protection against unauthorized access
- Diagnostics functions, logbook

Particularly high measuring accuracy and safety

- No dilution of sample gas required
- Suitable for connection of flammable gases at high concentration (as is the case with biogas) in accordance with TÜV (German Technical Inspection Association) report
- Highly selective multi-layer detector measurement of CH₄ in addition to CO₂ in an NDIR measuring cell

Simple integration into process systems

- Open interface architecture including fieldbus (optional)

		Basic configuration	Optional additional modules
1	Basic equipment for wall or rack mounting including flame arrester	X	
2	Gas connections: 6 mm or 1/4 inch	X	
3	Gas cooling: without, Peltier cooler	X	
4	Enclosure design: not heated or electrically heated	X	
5	Pump version: without, internal in analyzer, or external	X	
6	Power supply: 100 V ... 120 V or 200 ... 240 V AC, in each case 47 ... 63 Hz	X	
7	Measuring components and measuring ranges: see text	X	
8	Oxygen measurement: with or without O ₂ sensor	X	
9	H ₂ S measurement: with or without H ₂ S sensor	X	
10	Documentation: German, English or French	X	
11	Heated sample gas line, self-regulating, Ex-proof, 5 ... 35 m		X
12	Sample stream switchover for up to 4 streams		X
13	LEL sensor for leak monitoring in the measuring system (alarm threshold methane)		X

Configuration scheme of the Set BGA

Simultaneous determination of concentration. of up to four gas components (without dilution)

Component	Minimum measuring range	Maximum measuring range	Sensors
CO ₂	0 ... 20 %	0 ... 100 %	NDIR measuring cell
CH ₄	0 ... 20 %	0 ... 100 %	NDIR measuring cell
O ₂	0 ... 5 %	0 ... 25 %	Electrochemical sensor or paramagnetic
H ₂ S	0 ... 5 ppm	0 ... 50 ppm	Electrochemical sensor



Set BGA measuring system



Two-stream sample preparation

Technical Specifications

Ambient temperature	+ 5 ... +38 °C
Dimensions of Set BGA measuring system (W x H x D)	600 x 781 x 600 mm
Dimensions of sample preparation (W x H x D)	600 x 600 x 220 mm
Weight of Set BGA measuring system	50 kg
Weight of sample preparation	22 kg
Degree of protection	IP54
Installation site	Indoor /outdoor (configurable)
Cabinet conditioning	Ventilator
Measured components / measuring ranges	
• CH ₄	0 ... 100 vol% to 0 ... 20 vol% (NDIR)
• CO ₂	0 ... 100 vol% to 0 ... 20 vol% (NDIR)
• O ₂	0 ... 25 vol% to 0 ... 5 vol% (electrochemical); optional
• H ₂ S	0 ... 5 vpm to 0 ... 50 vpm (electrochemical); optional
Safety switching devices	<ul style="list-style-type: none"> • Detonation protection F501 • Flow measurement with limit monitoring at the output • Stainless steel screwed glands (outdoor installation) • LEL monitoring (optional)
Power supply	110 V AC ± 10%, 47 ... 63 Hz 230 V AC ± 10%, 47 ... 63 Hz
Power consumption	Approx. 180 VA (without cooler and sample preparation)
Analog outputs	Per component 0/2/4 ... 20 mA; NAMUR, floating, max. load 750 Ohm
Sample preparation	Max. 4 sample streams can be controlled using Logo module with fast loop pump in separate enclosure
Permissible pressure fluctuations	<ul style="list-style-type: none"> • Without pump, not pressurized (< 1 200 mbar absolute); pressure reduction must be provided for higher input pressures • With pump, suction mode with flow by gravity
Pump performance	Adjustable to 60 ... 80 NL/h

For more information, please contact:

Siemens Industry, Inc.
5980 West Sam Houston Parkway North
Ste 500
Houston, TX 77041
Phone: 713-939-7400
Email: ProcessAnalyticsSales.industry@siemens.com

Siemens Industry, Inc.
100 Technology Drive,
Alpharetta, GA 30005

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