



OPTIONAL
CO₂ ABSORPTION BOTTLES
AVAILABLE, WITH INNOVATIVE
RITTER DIP PIPE DESIGN
FOR GUARANTEED
CO₂ ABSORPTION OF
MORE THAN

99%

The new RITTER Biogas Batch Fermentation System

with Automatic Data Logging in Real Time

Maximum precise measurement results with individually calibrated RITTER MilliGascounters

RITTER Engineering has been successful in the manufacture of measuring instruments as well as in the field of thermoplastic engineering for more than 70 years. In addition to innovative modular Multi-Gas Sensors and Biogas Batch Fermentation Systems, RITTER manufactures Gas Meters made out of various superior thermoplastics and high grade stainless steel, which are used world-wide in research & development laboratories as well as in industry. These meters can be used for volumetric measurement of even highly aggressive gases with laboratory precision.

The MilliGascounter was developed for the volumetric measurement of the smallest amounts of gas with ultra-low flow rates. These small devices are suitable for measurement of inert, and slightly corrosive biogas, as well as most aggressive gases.

Each MilliGascounter is individually calibrated and supplied with an individual calibration certificate.

By PTB calibration of RITTER master meters the traceability to

the national primary standard for each MilliGascounter is given.

As a result, maximum measurement accuracy is guaranteed which provides the necessary basis for any research.

In the field of the biogas research the RITTER MilliGascounter became a central component of a system allowing investigation of fermentation processes with up to 18 PMMA fermentation bottles in a heating oven at the same time.

This RITTER Biogas Batch Fermentation System enables automatic measurement with data acquisition in real time.



National PTB certificates for all RITTER master meters

±1%
Measurement accuracy over the whole measuring range with »RIGAMO« software and with calibration certificate for each MilliGascounter.



»No doubt about precision, but wouldn't it be great to receive multiple results at one time – especially when measuring very small gas volumes in biogas research and development?«

The RITTER Biogas Batch Fermentation System with automatic data logging in real time

The great advantage of the RITTER biogas batch fermentation system is that the fermentation bottles are heated on all sides in the heating oven. In contrast to the heating of the fermentation bottles in a water bath, uncontrolled cooling of the upper part of the bottle by room air and air currents is thus excluded. Furthermore, the fermentation bottles can be easily removed from the heating oven for short visual checks, even while fermentation is in progress.

Features:

- › Batches of up to ...
 - › 18 RITTER PMMA fermentation bottles and 18 RITTER MilliGascounters with heating oven type BBFS-18
 - › 9 RITTER PMMA fermentation bottles and 9 RITTER MilliGascounters with heating oven type BBFS-9
- › **Individual volumetric calibration of each MilliGascounter, traceable to the German National Primary Standard (PTB)**
- › Automated data acquisition of gas volume and flow rate from biogas batch fermentation systems through real time data logging with Windows® software »RIGAMO«. (suitable for up to 18 RITTER MilliGascounters)
- › Graphical and tabular display, printing and storing of measurement data.
- › Export of stored data to Microsoft Excel®.

Standard 18x

- › **1x heating oven type BBFS-18** with integrated control unit **for 18 stirring units**
- › **18x MilliGascounter MGC-1 PMMA**
- › **18x PMMA fermentation bottle 1 ltr** with stirring unit
- › **1x Rack** for placing of MilliGascounters and absorption bottles
- › **1x Data acquisition software »RIGAMO« 18-Channel**
- › **1x Signal Interface Module (»SIM«) 18-channel** for data conversion into USB signal
- › **1x complete set of gas tubes and electrical connection cables**

Compact 9x

- › **1x heating oven type BBFS-9** with integrated control unit **for 9 stirring units**
- › **9x MilliGascounter MGC-1 PMMA**
- › **9x PMMA fermentation bottle 1 ltr** with stirring unit
- › **1x Rack** for placing of MilliGascounters and absorption bottles
- › **1x Data acquisition software »RIGAMO« 9-Channel**
- › **1x Signal Interface Module (»SIM«) 9-channel** for data conversion into USB signal
- › **1x complete set of gas tubes and electrical connection cables**

The RITTER Biogas Batch Fermentation System is available as a standard package for 18 fermentation bottles and in a more compact version for 9 fermentation bottles.



„Worldwide -
with the precision
of the original!“

Overview of system components

 Component of »Standard« package /  Component of » Compact« package / Figure inside box: Quantity of article in package

Basic elements



1

Heating Oven Type BBFS-18

- › Suitable for max. 18 x 0.5/1.0/2.0 ltr PMMA Fermentation Bottles
- › Air circulation by 2 powerful fans for homogeneous heat distribution
- › Control panel with LCD display for digital temperature setting, increment 1°C
- › Intergrated mainboard for operation of stirring units
- › RJ12 interface for bus line to the »SIM« signal interface module for controlling the oven temperature and speed/interval operation of the stirring devices (with Rigamo V4.x)

Dimensions	W 750 mm x D 750 mm* x H 300 mm	Weight	39.0 Kg
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* Installation space for rear cable connections: +50 mm



1

Heating Oven Type BBFS-9

- › Suitable for max. 9 x 0.5/1.0/2.0 ltr PMMA Fermentation Bottles
- › Air circulation by 2 powerful fans for homogeneous heat distribution
- › Control panel with LCD display for digital temperature setting, increment 1°C
- › Intergrated mainboard for operation of stirring units
- › RJ12 interface for bus line to the »SIM« signal interface module for controlling the oven temperature and speed/interval operation of the stirring devices (with Rigamo V4.x)

Dimensions	W 480 mm x D 600 mm* x H 300 mm	Weight	26.0 Kg
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* Installation space for rear cable connections: +50 mm



1 1

Rack

- › Suitable for simple and compact installation of max. 18 MilliGascounters and 18 optional CO₂ absorption bottles
- › Frame made of aluminium, shelves made of stainless steel 1.4571

Rack for BBFS-18	Dimensions	W 810 mm x D 370 mm x H 970 mm	Weight	13.5 Kg
Rack for BBFS-9	Dimensions	W 540 mm x D 370 mm x H 970 mm	Weight	9.0 Kg

Roller Table for Heating Oven BBFS-18 (Option) / BBFS-9 (Option)

Features:

- › Wheeled table for setting up the heating oven for fermentation systems BBFS-18 /-9
- › Total height incl. standing heating oven = standard height laboratory tables (920 mm)

Design:

- › Table frame with 4 lockable rolls
- › 1 additional storage compartment below the heating oven
- › Suitable for holding the movable rack for the installation of MilliGascounters and absorption bottles

Material:

- › Frame made of aluminium profiles, table plates made of PE-blue

Table for BBFS-18 Dimensions W 820 mm x D 720 mm x H 620 mm

Table for BBFS-9 Dimensions W 570 mm x D 570 mm x H 620 mm



The illustration shows the tables with the ovens in place as well as with the rack for MilliGascounters and CO₂ absorption bottles. The rack can be moved forward/backward for easy installation and handling of the MilliGascounters and CO₂ absorption bottles.

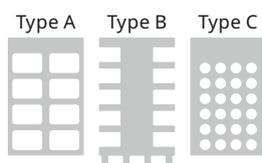
The shown horizontal alu profiles can be used for hanging of gas sampling bags (option).



PMMA Fermentation Bottle with stirring device

Feature highlights:

- > **Absolute gas-tight by magnetic coupling between stirring motor and stirring blade**
- > 1 x Connection for gas outlet port, PVDF screw-type tube connection \varnothing_1 4 mm, \varnothing_0 6 mm
- > 1 x Connection for flushing of headspace or sample extraction, PVDF screw-type tube connection \varnothing 4 mm, \varnothing_0 6 mm
- > Various bottle sizes: 0.5 / 1 / 2 ltr – custom sizes on request
- > High breaking strength by PMMA material (no fragile glass gas outlet nozzle)
- > Incl. stirring blade ...
 - > **Type A** (standard): Suitable for media with medium viscosity and small to medium size solid materials
 - > **Type B** (optional): Suitable for media with high viscosity and fibrous solid materials
 - > **Type C** (optional): Suitable for media with low viscosity and low amounts of solid material
- > Custom stirring blades available
- > Incl. PVC tubing (Rauclair) \varnothing_1 4mm, \varnothing_0 6 mm, 1,5 m



0.5 ltr	Dimensions with stiring device	H 183 mm x \varnothing 130 mm	Weight	0.95 kg
1.0 ltr	Dimensions with stiring device	H 249 mm x \varnothing 130 mm	Weight	1.2 kg
2.0 ltr	Dimensions with stiring device	H 399 mm x \varnothing 130 mm	Weight	1.5 kg

Technical Data

- > Stirring speed adjustable from 1 to 30 r/min *
- > Interval stirring with programmable interval times *
- > Suitable for media with low and high viscosity (≤ 450 mm²/sec)
- > Temperature range: 10 – 55°C
- > Step motor 2 Ampere
- > Material fermentation bottle: PMMA crystal clear

* by Software »RIGAMO«



±3%
GUARANTEED

±1%
with »RIGAMO«
software

MilliGascounter MGC-1 PMMA

Type: MGC-1 PMMA / Material: Casing PMMA, measurement cell PVDF

- > Measuring range: 1 ml/h to 1 ltr/h
- > Measuring accuracy: $\pm 3\%$ across the whole flow rate range
(better $\pm 1\%$ with »RIGAMO« software by dynamic correction of measurement errors)
- > **Including individual calibration certificate**
- > Volume measurement cell: 3 ml
- > Equipment: Digital display, 200 ml packing liquid, 1.5 m connection tube, cleaning tool, syringe and bubble level (1 piece each for up to max. 5 pc.)
- > Resolution (= min. measurement increment): 3ml
- > Max. operating temperature 60°C
- > Max. overpressure: 100 mbar

PMMA / PVDF	Dimensions	$\varnothing 96$ mm x H	112 mm	Weight	468 g
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IN PREPARATION



Block-MilliGascounter 9x (Option)

- > Multiple measurement cells in one unit
- > Cells are measuring independently of each other
- > Gas in/outlet for each cell
- > Calibration certificate for each cell
- > Compensation of temperature *
- > Compensation of pressure *
- > Compensation of humidity *

* with Software »RIGAMO«

Components for CO₂ Absorption (Option)



Absorption Bottle

- › CO₂ absorption rate better than 99%
- › CO₂ absorption capacities: See table at the bottom on page 8
- › With unique dip pipe design and PVDF screw-type tube coupling
- › Including tubing to fermentation bottle and to MilliGascounter \varnothing 4 mm / \varnothing 6 mm
- › Volume 250 ml, overall dimensions \varnothing 70 mm x H 200 mm, weight 290 g



Absorption solution

- › Caustic potash solution (KOH 3Mol in aqua dest.)
- › Filling quantity per absorption bottle: 250 ml
- › Delivery in bottles of 1 ltr

Please note: Due to transportation restrictions, the absorption solution might have to be purchased locally. Please contact RITTER!

No false readings with RITTER MilliGascounters due to CO₂ absorption

In contrast to other suppliers, RITTER provides the possibility of measuring the **total** biogas volume from fermentation test consisting of methane **and** carbon dioxide. However, the high solubility of CO₂ (0.8 ltr CO₂ / 1 ltr water) is a problem with all measurements of CO₂. In order to minimize the measurement error with the volumetric measurement by the MilliGascounter, RITTER uses acidulated distilled water (HCl 1.8%) as packing liquid.

The diagram on the right side shows the calibration curve of the MilliGascounter with synthetic biogas (CH₄ 40% / CO₂ 60%) vs. a reference curve with room air containing no significant amount of CO₂.

Discussion of those calibration curves:

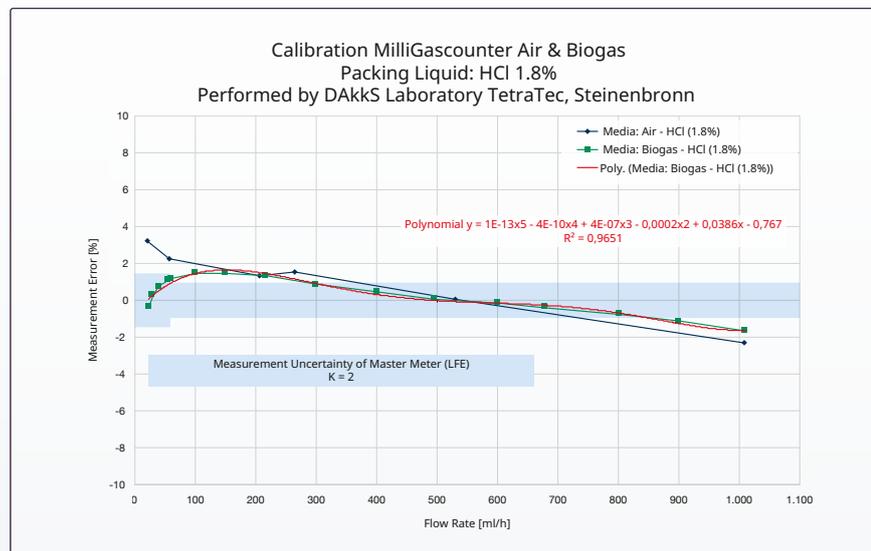
Above a flow rate of approx. 100 ml/h the curves of room air and biogas can be seen as more or less equal taking the measurement uncertainty into account.

Below that flow rate (which is a flow rate range many fermentation tests are operating in, at least during the last 2/3 of the tests) the biogas curve shows smaller values than that one of room air. In this area the remaining CO₂ absorption results in this deviation. However, the measured and indicated values tend to zero values thus reducing the measurement error. Furthermore, values unequal to zero are corrected by the optional »RIGAMO« software. Rigamo uses a polynomial regression algorithm(*) basing on the very calibration data of the respective MilliGascounter. This algorithm corrects the measurement results dynamically, that means as a function of the flow rate. The remaining error is smaller than $\pm 1\%$ across the full flow rate range.

By the way:

When comparing our MilliGascounters with other systems, please ask for the calibration data or calibration curve.

(*) The actual software version uses a second-order polynomial regression algorithm; a future version will use a polynomial of higher order.



Introducing the unique RITTER dip pipe



**NOW WITH
INNOVATIVE
RITTER DIP-PIPE
DESIGN FOR
CO₂-ABSORPTION
OF MORE THAN
99% !**

Ordinary systems for CO₂ absorption lead the biogas into the inside upper part of the absorption bottle, the gas thus wetting the absorption liquid surface. The real CO₂ absorption ranges between roughly 75% and 95%. Advanced systems are working with a dip pipe leading the gas into the absorption liquid. By bubbling the gas through the liquid, higher absorption rates can be obtained by the larger surface of the gas bubbles in contact with the liquid.

The ultimate advancement of the dip pipe system results in the unique RITTER dip pipe system: The lower end of the dip pipe is designed like a bell, holding the gas within the liquid. Both the large surface of the gas bubble inside of the bell as well as the long duration the gas bubble is kept in the bell result in the extraordinary absorption rate of better than 99%.

Another outstanding effect is the fact that the RITTER absorption system can operate without any absorption liquid indicator showing the limit of the absorption capacity. It is a general problem of such indicators that the colour doesn't change abruptly but continuously. Therefore, it is difficult for the user to recognize the true limit of the absorption capacity. In contrast to indicator systems the RITTER system guarantees a specific amount of CO₂ being absorbed at an absorption rate better than 99%.



For example: The absorption capacity is approx. 9 ltr of CO₂ per 250 ml absorption bottle for biogas CH₄ 60% / CO₂ 40% and a flow rate of 200 ml/h. This corresponds to a biogas input of approx. 22 ltr.

More than 99% CO₂-Absorption guaranteed with RITTER unique dip pipe design

Features

- › Absorption solution: 3-molar caustic potash solution (KOH 3mol)
- › Absorption bottle (»bubbler«): Gas inlet via a dip pipe with a unique design, allowing an absorption of more than 99%
- › Volume of bubbler: 250 ml
- › Filling quantity of absorption solution: 250 ml per bubbler
- › CO₂ absorption capacities per bubbler: Please see the table on the bottom of this page
- › Absorption limit indicator: With the RITTER absorption system an absorption limit indicator is obsolete
- › Easy-connect PVDF screw-type tube nozzles allow quick connection to RITTER PMMA fermentation bottles (on the gas production side) and to RITTER MilliGascounters (on the measurement side)

Application

The CO₂ Absorption System was developed by RITTER to absorb CO₂ from biogas reliably and with **guaranteed(!) more than 99%**.

Without indicator liquid for absorption limit! (Please see diagrams on page 7.) This absorption system combined with the »RITTER Biogas Batch Fermentation System«, provides the ideal solution for professional biogas research.

Operating Principle

The biogas generated in the fermentation bottles flows through a dip pipe into the bubbler containing the absorption solution. More than 99% CO₂ absorption will be achieved as a result of the large wetting surface of the biogas within the absorption liquid. This is made possible by the unique RITTER dip pipe design.

Standard Equipment

- › Absorption bottle (»bubbler«) 250 ml with PVDF dip pipe unit, 2 PVDF screw-type tube nozzles for gas inlet and outlet
- › Check valve⁽¹⁾ with tube connection adapters for tubing $\varnothing_1 = 4$ mm
- › Connection tubes made of special PVC

Accessories / Options

- › 3-molar caustic potash solution, 1 ltr

⁽¹⁾ Please note: After gas production has stopped, some biogas including CO₂ will remain in the headspace of the fermentation bottles. Even without gas flow, this CO₂ fraction will continue to be absorbed by the bubblers. This can lead to under-pressure within the fermentation bottles, which may cause the absorption solution to flow back into the fermentation bottles. To prevent this, a check valve is delivered as standard with the system. It should be located in the tube between the fermentation and absorption bottles.

Technical Specifications

Absorption bottle (»bubbler«)	Volume 250 ml Material: Borosilicate glass, Screw cap, wide mouth GL80, \varnothing 95 mm x H 106 mm
Absorption solution	3-molar caustic potash solution (KOH 3mol in aqua dest.) Filling quantity per bubbler: 250 ml, delivered in 1-liter bottles

Absorption capacities

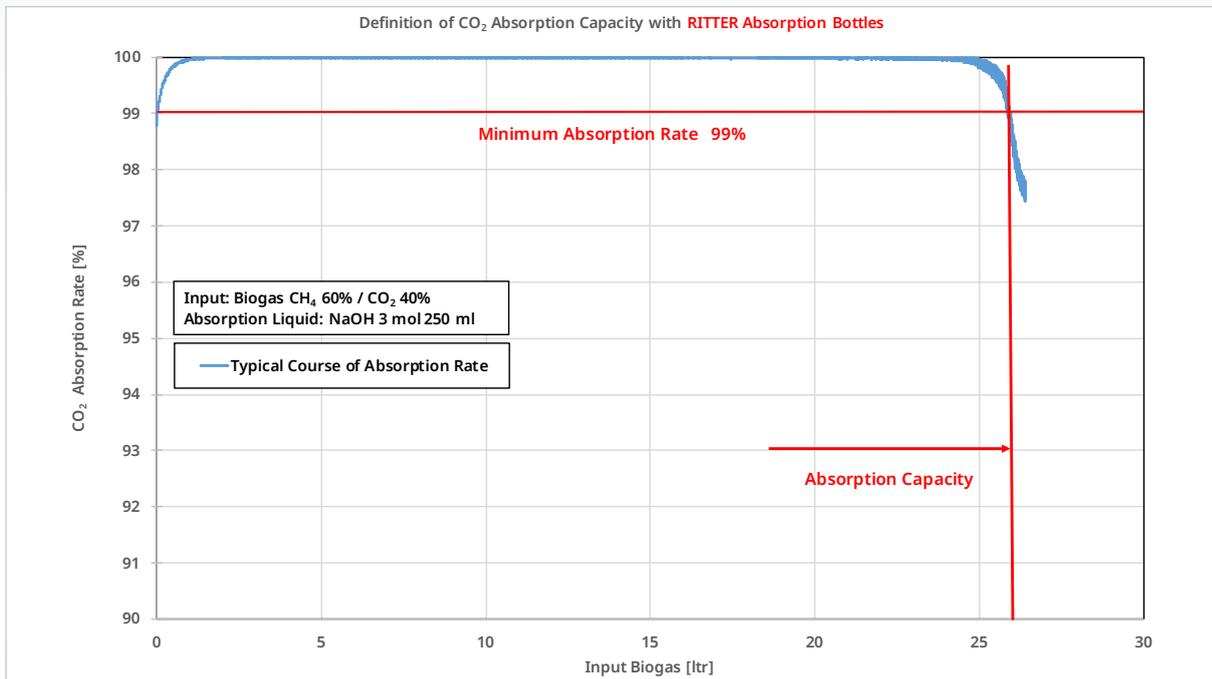
	Biogas Input	Flow Rate (ml/h)						
		50	100	200	300	500	750	1000
CO ₂ -absorption capacity, approx (ltr)*	60% CH ₄ / 40% CO ₂	13.4	12.1	8.8	7.9	7.8	7.7	7.6
	40% CH ₄ / 60% CO ₂	13.5	11.8	8.9	8.5	8.3	8.0	8.1
Absorption limit (ltr)**	60% CH ₄ / 40% CO ₂	20.1	18.2	13.2	11.9	11.7	11.6	11.4
	40% CH ₄ / 60% CO ₂	9.0	7.9	5.9	5.7	5.5	5.3	5.4

* per absorption bottle 250 ml, absorption solution KOH 3 mol

** After the CO₂ was absorbed from the biogas, the MilliGascounter displays the volume of the pure methane. The CO₂ absorption capacity limit is reached when the MilliGascounter indicates the values the stated in the table above.

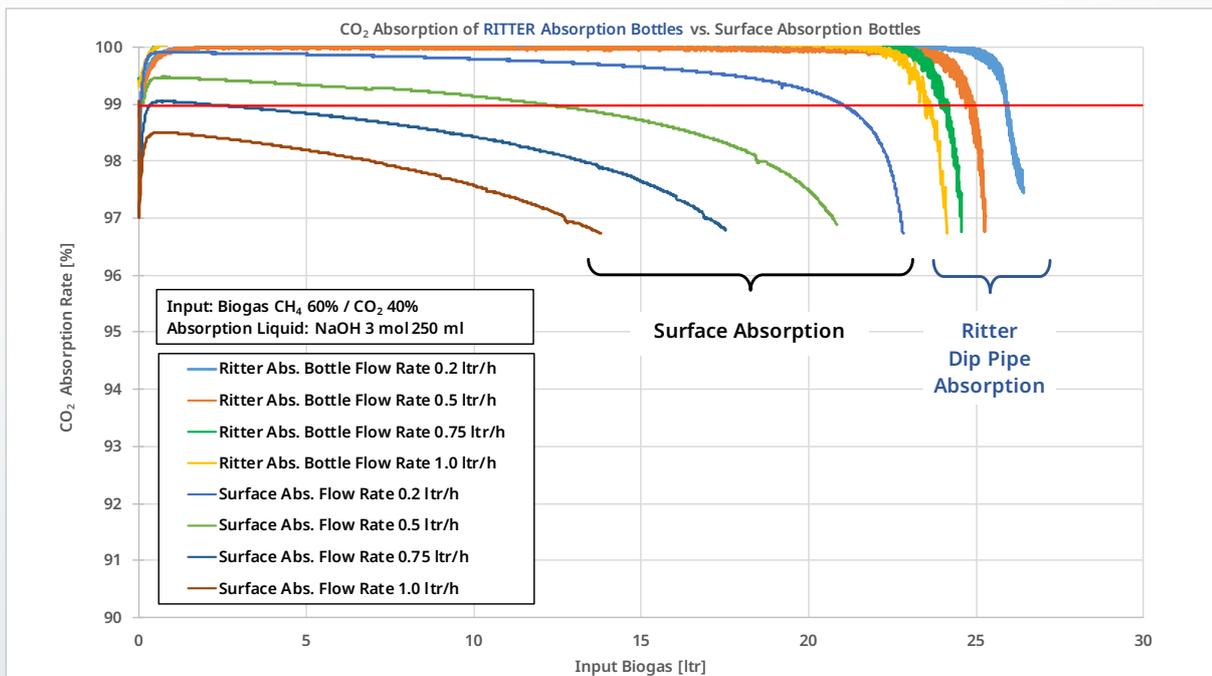
Gas connections	PVDF screw-type tube nozzles for \varnothing_1 4 mm / \varnothing_0 6 mm tubes
Connection tubes	Low diffusion special PVC, \varnothing_1 4 mm / \varnothing_0 6 mm
Pressure loss per bubbler	approx. 4 mbar

A new dimension of CO₂ absorption



Definition of CO₂ Absorption Capacity with RITTER Absorption Bottles:

The above diagram shows the definition of the CO₂ absorption capacity with the RITTER Absorption Bottle. The capacity limit is reached when the CO₂ absorption rate is reduced from 100% at start to 99%. That means: The CO₂ fraction of the biogas at the exit of the absorption bottle ranges between 0% and max. 1%. The remaining CH₄ fraction is measured and indicated by the MilliGascounter. The table of the measured and indicated CH₄ volume when reaching the absorption capacity is shown for various flow rates on page 8. Below of those stated volume values the user can be sure that the indicated CH₄ volume contains a maximum of 1% of CO₂.



CO₂ Absorption of RITTER Absorption Bottles vs. Surface Absorption Bottles:

The above diagram shows the CO₂ absorption rates of RITTER Absorption Bottles at various flow rates in comparison to those ones of common surface absorption bottles.

Components for Data Acquisition in Real Time

1 1



»RIGAMO« Software for data acquisition

Type: RIGAMO-V4.x

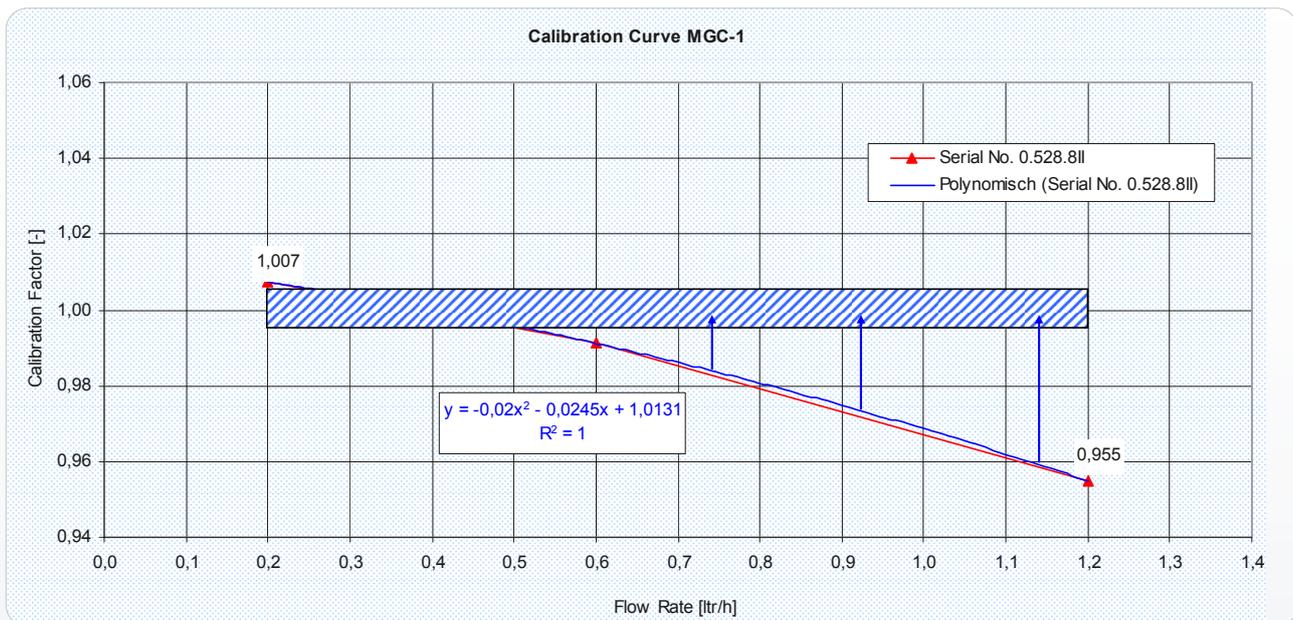
Improves the measurement accuracy of MilliGascounter from $\pm 3\%$ to better than $\pm 1\%$ across the whole flow rate range by algorithm using individual calibration data

Software features:

- › Windows software (7/8/10) for data acquisition of gas volume and flow rate from up to 18 Ritter gas meters to a PC USB port. Attention: RIGAMO can only be started once at a time on a single PC
- › Graphical and tabular real-time display of acquired data
- › Storing of data
- › Export of stored data to Microsoft Excel
- › Automatic correction of the dynamic (flow rate dependent) measurement error (with MilliGascounters only).
- › No support of bi-directional recognition of measuring drum rotation with Pulse Generator V4.01
- › Requires Signal Interface Module »SIM«.

Please note the system specifications listed below ***

Effect of the automatic correction of the dynamic (= flow rate dependent) measurement error with MilliGascounters: The real measurement data across the whole flow rate range are corrected by the algorithm of »RIGAMO« (polynomial regression). Thus, the remaining error of the corrected values is $\pm 1\%$ across the whole flow rate range.



*** System requirements for the »RIGAMO« Software for data acquisition

- › Gas meter with built-in pulse generator (MilliGascounter standard)
- › Signal Interface Module »SIM«
- › Operation system Windows 7/8/10
- › Microsoft Excel® 2003 or higher for data export to Microsoft Excel
- › Recommended processor performance: ≥ 1.5 GHz
- › Random access memory (RAM): ≥ 500 MB
- › 1 free USB port
- › Monitor 17" (optimised for resolution of 1280x1024 pixel)





Signal Interface Module (»SIM«)

Types: 1-/3-/9-/18-Channel

Central interface module for RITTER biogas batch fermentation system BBFS V4.x

Functions:

- › Data transmission of gas volume and temperature of a RITTER gas meter
- › Normalisation (temperature and pressure compensation) of gas volume and volume flow *
- › Data transmission for temperature control of the heating oven *
- › Data transmission for stirrer control of the fermentation bottles *
- › Conversion of data into USB signals for connection to PC

Specifications:

- › Number of recordable data channels: max. 18
- › incl. data acquisition software »RIGAMO« V4.x
- › incl. SD card for permanent storage of previously recorded measurement data
- › incl. temperature sensor PT 1000, 0 to 80°C
- › incl. pressure sensor for atmospheric pressure, 300 - 1.100 mbar abs.
- › incl. rechargeable battery NiMH (nickel-metal hydride)
- › incl. USB cable 5 m
- › incl. power supply 230 V AC - 12 V DC
- › Temperature range: 0 - 55°C
- › Aluminium casing W x H x D 103 x 30 x 220 mm, 400 g

Interfaces:

- › Signal inputs of RITTER gas meters (TG, MGC, BG)
- › 1 x bus RS485 heating oven
- › 1 x bus RS485 for additional SIM units for other RITTER products
- › 1 x USB interface for data exchange with PC *
- › 1 x temperature sensor

* by software »RIGAMO« V4.x

100% data security through data recovery! Guaranteed!

The »Signal Interface Module« (SIM) stores the measured values of all connected gas meters after the data recording has been started by the software »RIGAMO«. If the computer on which »RIGAMO« is executed fails for whatever reason, data recording and storage by the »SIM« will continue regardless of the computer function.

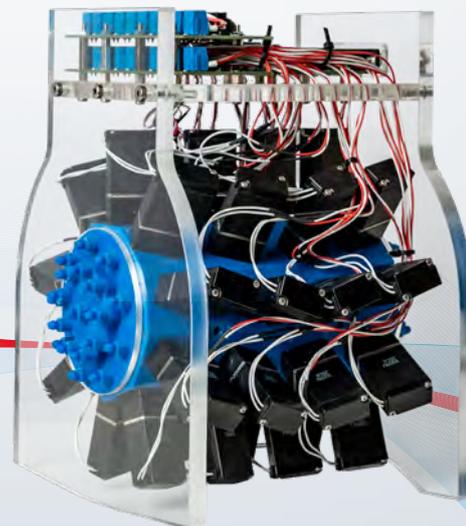
The only precondition: An uninterrupted power supply to the »SIM«, which can be achieved, for example, by an »UPS battery« (Uninterruptible Power Supply).

The 100% data security of the storage is completed by the fact that in case of a restart of the computer resp. RIGAMO" software, the measurement data since the failure of the computer can be read in by "RIGAMO", while the current real-time measurement can be continued at the same time.

IN PREPARATION

Multiplexer for Gas Analysis

The »Multiplexer for Gas Analysis« allows the measurement of gas concentrations from up to 18 gas sources (fermenters) with one gas sensor only.



Subject to alterations.

Please check our website for latest product updates at:

www.ritter.de/en/products/biogas-batch-fermentation-system

Most components can be customized to match individual requirements.

Do not hesitate to contact us directly!

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