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1st SINO-EU 2016
Bio-Natural Gas Summit

Beijing, P.R.China
3 - 5 November 2016

Biogas Monitoring – „Why and How?“
沼气监测 — “为什么和怎么样？”

Jan Talkenberger, Manager International Sales, Binder GmbH
Jan Talkenberger，德国冰得公司国际销售经理

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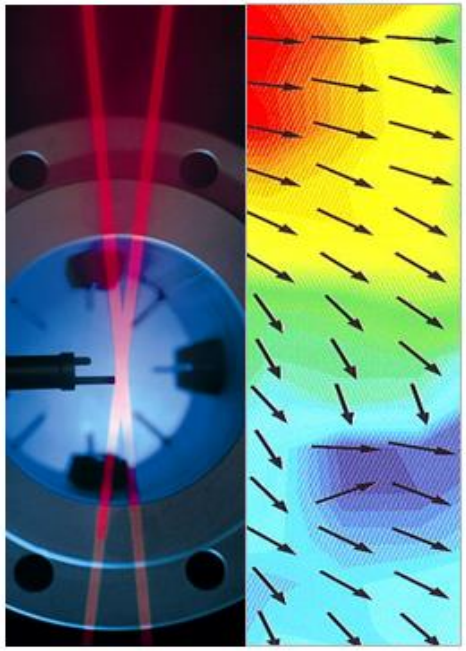
- Introduction
  介绍
  - Binder‘s core business is Gas Flow Metering and Control.

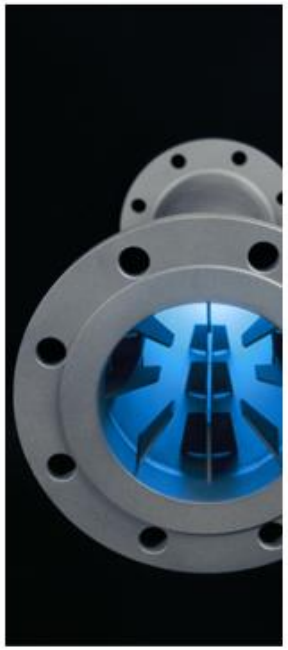
    冰得公司**的核心**业务是气体流量计量和控制。
  - Aeration Control System & Digester Gas Flow Metering & Analysis

    曝气控制系统和消化器气体流量计量和分析

Real Gas Flow Calibration 实际气体流量标定



Gas Flow Conditioning 气体流动调整



Gas Flow Measurement 气体流量测量

Gas Flow Control 气体流量控制

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BINDER @ 1st SINO EU Bio-Natural Gas Summit
Beijing, 04 November 2016
冰得 @第一届中欧生物天然气峰会？北京，2016年11月04日

- Biogas Plant Monitoring

  沼气厂监测
- Biogas particularities

  沼气特性
- Technology

  技术

Why is it necessary to monitor Biogas Plants?
为什么需要监测沼气厂？

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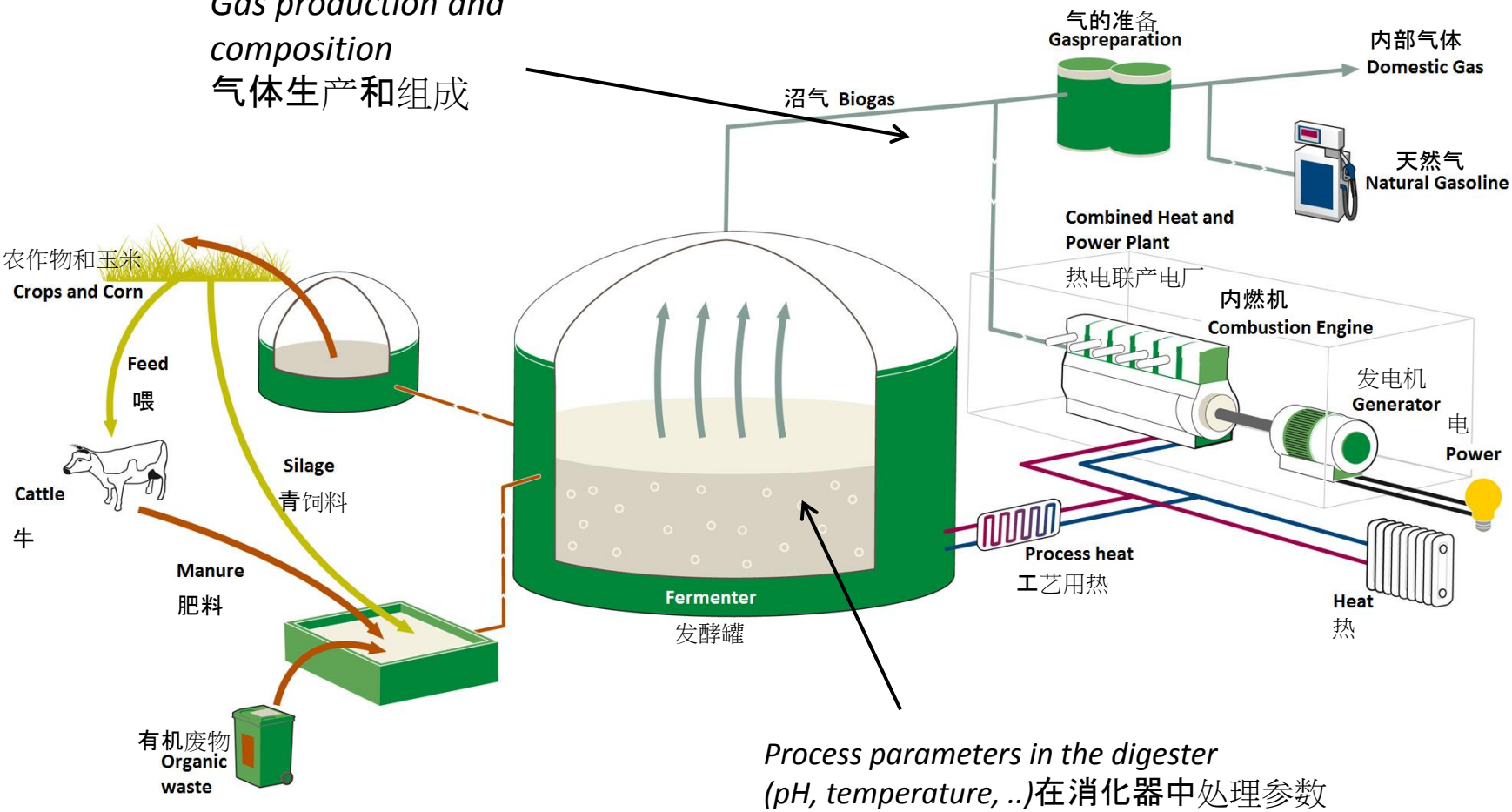
Parameters to be monitored in a biogas plant
沼气厂监测的参数

Gas production and composition
气体生产和组成



Process parameters in the digester (pH, temperature, ..)
在消化器中处理参数
（pH，温度，...）

Equipment used for treatment and utilization of the biogas
用于处理和利用沼气的设备

- H_2S scrubber

  H2S洗涤器

- Blowers or compressors

  鼓风机或压缩机

- Biogas engine (CHP unit)

  沼气发动机（CHP）

- Biogas upgrade technology (Membrane, …)

  生物气提纯技术（膜，…)

Typically this all are sophisticated and rather expensive devices.

通常这一切都是复杂和相当昂贵的设备。

How monitoring of biogas becomes essential
为什么监测沼气变得至关重要

- Performance of H_2S scrubbers:
  H2S洗涤器的性能：
  - Control operation of H2S scrubber according to cleaning performance or oxygen values
    根据清洗性能或氧气值控制H2S洗涤器的操作

- Control and adjusment of CHP units
  热电联产的控制和调整
  - Adjust engine parameters according to changing CH4 concentration
    根据CH4浓度的变化调整发动机参数

- Grid injection or other further use
  网格注入或其他进一步使用
  - Monitor gas quality (composition) and quantitiy
    监测气体质量（组成）和数量

Example: Monitoring of H_2S concentration
示例：监测H2S浓度

- H2S filter shall clean the gas to a suitable concentraction for following equipment

  H2S过滤器应将气体清洁至适合以下设备的浓度

- Performance of the H_2S filter depends on ist principle and handling

  H2S过滤器的性能取决于其原理和处理

- H_2S concentraction at scrubber output must be monitored!

  必须监控洗涤器输出端的H2S浓度！

  - Scrubber performance check

    洗涤器**性能**检查

  - **Protect the gas-using equipment, e.g. CHP engine**

    保护气体**使用**设备，例如。 **CHP**发动机

Cost - CHP engine repair vs. Gas Analyzer
成本 - CHP发动机修理与气体分析仪

CHP breakdown **CHP故障**	**Gas Analyzer** **气体分析仪**
CHP repair: 20.000 – 50.000 EUR CHP修复：20.000 - 50.000 EUR	Purchase: 8.000 – 10.000 EUR 购买：8.000 - 10.000欧元
Loss of income: 1.000 – 10.000 EUR 收入损失：1.000 - 10.000欧元	Installation: 1.000 EUR 安装：1.000欧元
	Maintenance: 1.000 EUR / year 维护：1.000欧元/年
Total: 21.000 – 60.000 EUR 总计：21.000 - 60.000欧元	***Total: 10.000 – 12.000 EUR*** 总计：10.000 - 12.000欧元
↓ Thread: bankruptcy of plant operator 工厂操作的失败	Additional benefit: use measured parameter to operate the plant more efficient and economic 额外优势： 使用测量的参数来操作工厂更高效和经济
	

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VEREIN DEUTSCHER INGENIEURE	Emissionsminderung Biologische Abfallbehandlungsanlagen – Kompostierung und Vergärung Anlagenkapazität mehr als ca. 6.000 Mg/a Emission control Biological waste treatment facilities Composting and anaerobic digestion Plant capacities more than approx. 6.000 Mg/a	VDI 3475 Blatt 1 / Part 1 Ausg. deutsch/englisch Issue German/English

„.. It is highly advisable to analyze the composition of the biogas in the raw state and before the CHP regarding CH_4, H_2S and O_2. Thus, changes in the biogas and the cleaning measures function can be monitored. The analysis must be made regularly at least daily. In case of unevenly distributed feeding and expected fluctuations in the biogas composition, the analysis frequency needs to be adapted.

"。对于CH4，H2S和O2，在生态和CHP之前分析生物气的组成是高度建议的。 因此，可以监测沼气和清洁措施功能的变化。 分析必须至少每天定期进行。 在进料不均匀和沼气组成预期波动的情况下，需要调整分析频率。

It is advisable to use gas analyzer with set-limits and alarm and opportunity to integrate them into an existing plant control. Methane sensors must be pressure and temperature compensated; hydrogen sulphide sensors also need to be sufficiently resistant with peak concentrations. Regular calibration according to the manufacturer's instructions are generally to follow... "

建议使用具有设定限值和报警的气体分析仪，并将其与现有的工厂控制系统集成。 甲烷传感器必须是压力和温度补偿; 硫化氢传感器还需要具有足够的峰值浓度。 根据制造商的说明进行常规校准一般遵循..."

Why is process monitoring necessary?
为什么**需要**过程监控？

- **Supervision** of individual components, e.g. H_2S scrubber
  监测用于各单独组分**的，例如。** H2S**洗**涤器
- **Protection** of sensitive equipment, e.g. CHP-engine
  保护用于敏感设备，例如 CHP发动机
- **Preventive alarm** settings to react timely on process fluctuations
  预防性报警设置可对过程波动做出及时反应
- **Improve** feeding cycles and reduce raw material usage
  改善进料周期和减少原料使用
- **Comply** to legal requirements, e.g. evidence of biogas production volumes and gas-quality
  遵守法律要求，例如 沼气生产量和气体质量的证据

→ ***Increase of safety, efficiency and profitability***

提高安全性，效率和盈利能力

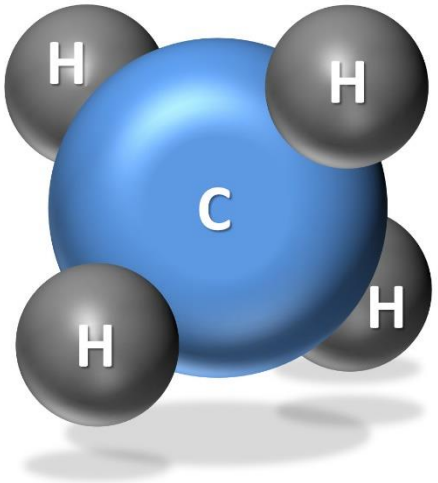
Biogas particularities
沼气特性

CH4

Methane Concentration Measurement – This is the product that we want.

It is therefore essential that your plant maximises the percentage of CH4 produced. It is a good practice to document and record the quantity, quality and composition of the Biogas being generated. A clear indication of the yield of your plant per tonne of feedstock.

甲烷浓度测量 - 这是我们想要的产品。
因此，您的工厂必须最大化生产的CH4的百分比。 记录和记录生成的沼气的数量，质量和组成是一个很好的做法。 清楚表明您的工厂每吨原料的产量。

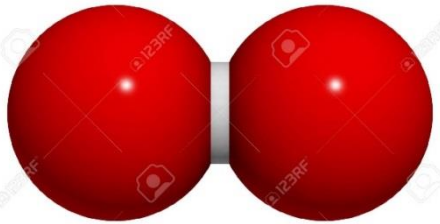


O2

Oxygen Concentration Measurement - this is a critical process indicator.

You have to ensure that we are not producing an inefficient or explosive mixture of Methane and Oxygen gases. Increasing Oxygen levels could indicate performance issues leading to a decrease in microbial activity (poisoning) in the anaerobic digester or inward leaks into the system, both affecting productivity of the plant.

氧浓度测量 - 这是一个关键的过程指示器。
您必须确保我们不会产生甲烷和氧气的低效或爆炸性混合物。 **增加氧气水平可以指示**导致厌氧**消化器中的微生物活性（中毒）减少或向内泄漏到系**统中的性能问题，这两者都影响植物的生产力。



H2S

Hydrogen Sulphide Concentration Measurement - this is a highly toxic and corrosive gas.

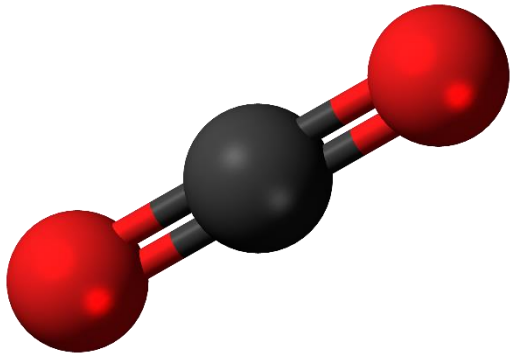
It is essential its concentration be monitored. High levels of H2S must be prevented as it is corrosive to engines and can condense and form Sulphuric Acid within the process resulting in large operational and maintenance costs. Most engines typically require less than 200ppm H2S, but as the concentration can often rise well above this it is important to know when this is occurring so appropriate steps can be taken. Feeding of gas into a network grid has more stringent requirements

硫化氢浓度测量 - 这是一种高毒性和腐蚀性气体。
必须监测其浓度。 **必**须防止高水平的H 2 S， **因**为它对发动机具有腐蚀性，并且在该过程中可**冷凝并形成硫酸**，导致大的操作和维护成本。 **大多数**发动机通常需要小于200ppm**的**H 2 S， **但是由于**浓度通常可以高得多地上升，所以重要的是知道何时发生这种情况，因此可以采取适当**的步**骤。 **将气体供**给到网格中具有更严格的要求

CO2

Carbon Dioxide Measurement - In a similar way to the measurement of the Oxygen levels present, the Carbon Dioxide composition is a good indicator of the performance of the plant, ensuring that the anaerobic digester is operating efficiently. Rising CO2 levels would indicate a drop in quality of the fuel being supplied to the Combined Heat and Power (CHP) generator.

二氧化碳测量 - **以与存在的氧气水平的**测量类似的方式，二氧化碳组成是植物性能的良好指示，**确保**厌氧消化器有效地操作。 **二氧化碳水平的上升将表明供**应给热电联产发电机的燃料质量下降。



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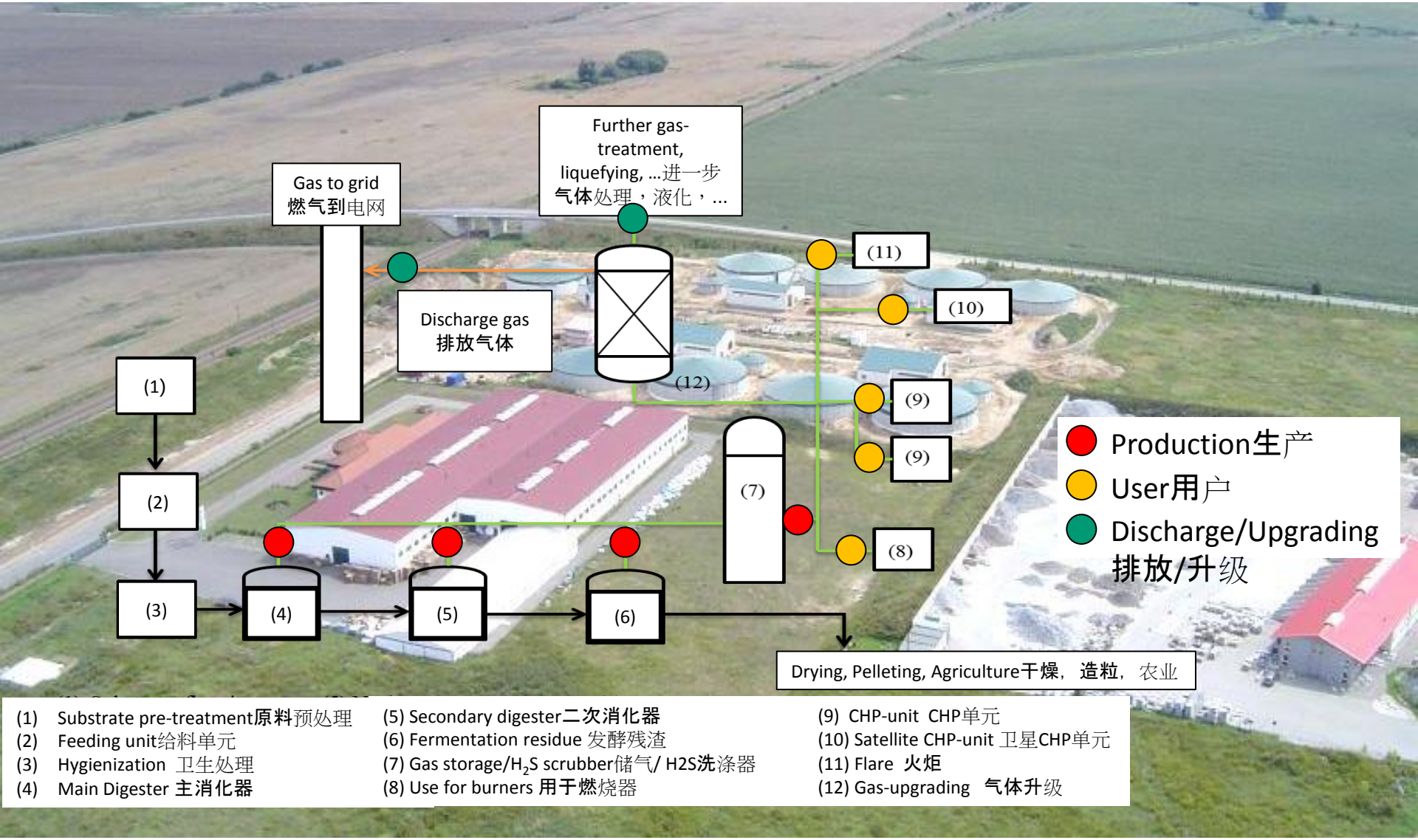
Typical measurement locations
典型测量位置



(1) Substrate pre-treatment原料预处理
(2) Feeding unit给料单元
(3) Hygienization 卫生处理
(4) Main Digester 主消化器
(5) Secondary digester二次消化器
(6) Fermentation residue 发酵残渣
(7) Gas storage/H_2S scrubber储气/ H2S洗涤器
(8) Use for burners 用于燃烧器
(9) CHP-unit CHP单元
(10) Satellite CHP-unit 卫星CHP单元
(11) Flare 火炬
(12) Gas-upgrading 气体升级

Gas qualities on the different measuring points
不同测量点的气体质量

Gas Production:
气体生产

At the digester, after gas-cooler, after gas-storage, in front of the H_2S-scrubber/filter
dirty, wet, corrosive, low pressure (-3…+3 mbar), low velocities (0,5…3m/s)
CH_4 48-54 Vol.-%, CO_2 38-42 Vol.-%, O_2 0-1 Vol.-%, N_2 0-5 Vol.-%, H_2S up to 1000 ppm, $H_2$0-vapour up to 15 Vol.-% (thermophilic)
在消化器处，在气体冷却器之后，在气体存储之后，在H2S-涤气器/过滤器前面
脏污，潮湿，腐蚀性，低压（-3 ... + 3 mbar），低速度（0.5 ... 3m / s）
CH 4 48-54体积%，CO 2 38-42体积%，O 2 0-1体积%，N 2 0-5体积%，H 2 S高达1000ppm，H 2 O蒸汽高达15Vol。 - %（嗜热）

Gas-Use:
气体使用

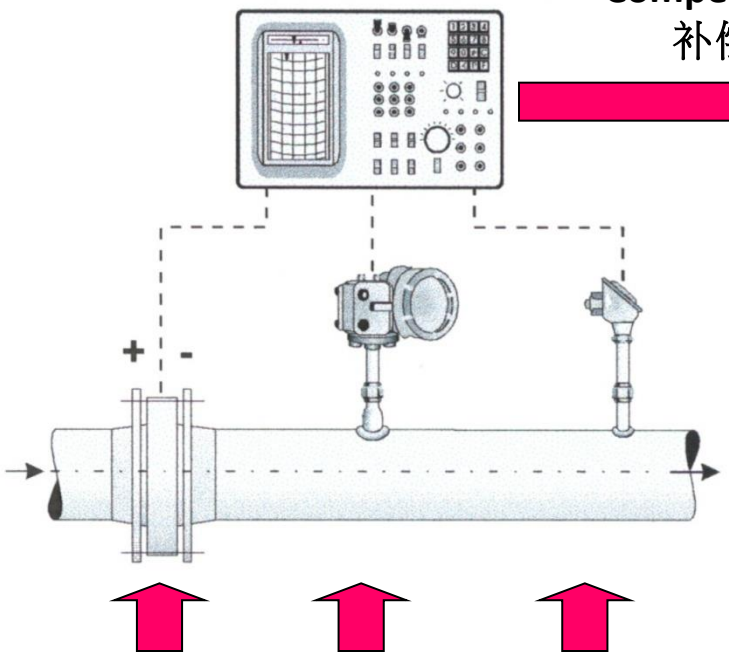
After H_2S-scrubber/filter, in front of the CHP-unit, in front of the flare, in front of the burner/boiler
Less dirty, partly dry, still corrosive, higher pressure (40…80 mbar), higher velocity (8…15 m/s)
CH_4 48-54 Vol.-%, CO_2 38-42 Vol.-%, O_2 0-1 Vol.-%, N_2 0-5 Vol.-%, H_2S < 100 ppm, $H_2$0-vapour < 1 Vol.-%
在H2S洗涤器/过滤器之后，在CHP单元前面，在火炬前面，在燃烧器/锅炉前面
较少脏，部分干燥，仍腐蚀性，较高压力（40 ... 80 mbar），较高速度（8 ... 15 m / s）
CH4 48-54体积%，CO 2 38-42体积%，O 2 0-1体积%，N 2 0-5体积%，H 2 S <100ppm，H 2 O蒸气<1体积%

Upgrade and discharge:
升级和排放

After bio-methanization plant, in front of the feed-in point to the gas grid
Clean, dry, high pressure (bar ranges), high velocity
CH_4 95-98 Vol.-%, CO_2 2-5 Vol.-%, H_2S < 2 ppm
在生物甲烷化工厂之后，在进气点前进入气体网格
清洁，干燥，高压（bar范围），高速度
CH4 95-98体积%，CO 2 2-5体积%，H 2 S <2ppm

Definition Standard-Cubic-Meter
定义标准 - 立方米

Measuring volumetric flow
测量体积流量



Volume**体积** Pressure压力 Temperature**温度**

Biogas沼气: ***+ Humidity湿度 + Gas-Composition 气体组分***

Compensation
补偿

Standard Volume V_0
标准体积V0

Gas Mass m
气体质量m

p & T compensation necessary for:

必要的压力**&温度**补偿：

- Orifice plates DP**孔板差**压
- Vortex flow meter涡流流量计
- Turbine meters/ mechanical counters涡轮流量计/**机械**计数器
- Ultrasonic flow meter**超声波流量**计
- Pitot tubes **皮托管**
- ...

Overview (according ATV-DWA M 264)
概述（根据ATV-DWA M 264）

	Orifice plate 孔板	Mechanical counter 机械计数器	Thermal meter 热式流量计	Vortex meter 涡街流量计	Ultrasonic meter 超声波流量计
Measured value 测量值	volumetric flow 体积流量	volumetric flow 体积流量	mass flow at standard temperature and pressure 标准温度和压力下的质量流量	volumetric flow 体积流量	volumetric flow 体积流量
Compensation to standard Conditions 补偿到标准条件	pressure, temperature, humidity 压力，温度，湿度	pressure, temperature, humidity 压力，温度，湿度	Humitidy 湿度	pressure, temperature, humidity 压力，温度，湿度	pressure, temperature, humidity 压力，温度，湿度
Maintenance efforts 维护工作	Significantly high efforts 工作量很大	Significantly high efforts 工作量很大	Low efforts 低工作量	Low efforts 低工作量	Low efforts 低工作量
Typical accuracies 典型精度	±1 % of measured value ±1 % 测量值	±2 % of measured value ±2 % 测量值	±1 % to ±2,5 % of measured value + const. Part ±1%至±2.5%测量值+常数部分	±1 % of measured value + const. Part ±1%测量值+常数部分	Up to ±1,5 % of measured value 高达测量值的±1.5%

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Technologies for Flow &
Analyze of Biogas
沼气流量测量与成分分析
技术

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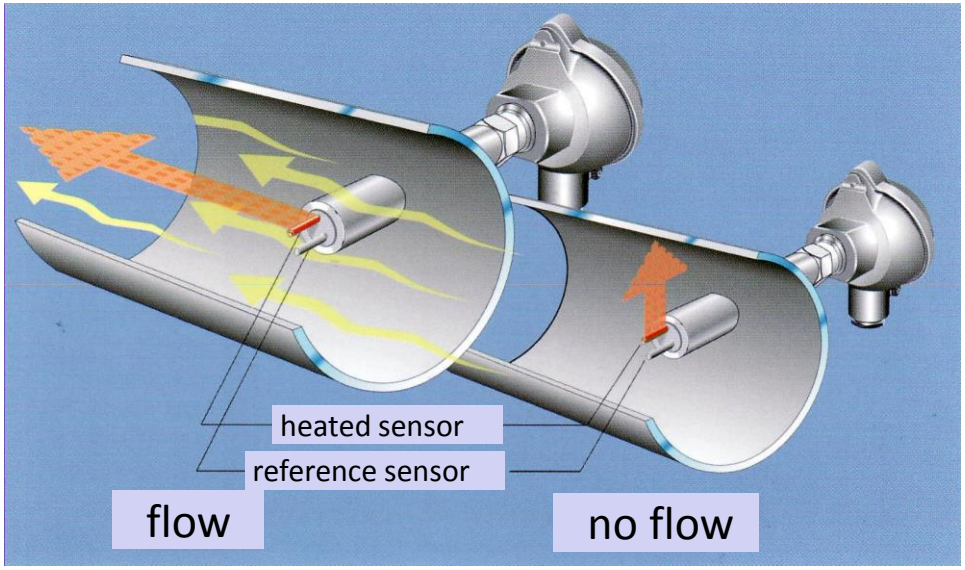
COMBIMASS® - thermal gas flow measurement
COMBIMASS® - 热式气体流量测量

COMBIMASS® Thermal dispersion mass flow measurement
COMBIMASS®热分散质量流量测量



Temperature:

温度

Sensors measure resistance (by use of Pt100 sensors) – second sensor provides as reference

传感器测量电阻（通过使用Pt100传感器） - **第二**传感器提供**参考**

Principle:

原理

Dispersed heat provides as reference for the amount of gas-molecules passing by → direct mass-flow measurement**分散的**热**量作**为气体分子通过直接质量流量测量的量的**参考**

Advantages:

优点

Unaffected by pressure and temperature changes, very low pressure drop, precise even at low flow rates, reference sensor can be used to provide the gas temperature.

不受压力和温度变化的影响，非常低的压降，甚至在低流速时**精确**，**参考**传感器可用于提供气体温度。

Challenge:

挑战：

A CH_4-molecule disperse a different amount of heat than a CO_2-molecule etc. Also water damp molecules disperse heat.

CH4**分子分散的**热量不同于CO2**分子等。水分子**还分散热量。

BINDER Gas analysis
冰得气体分析

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Analyzer station ***COMBIMASS® GA-s Hybrid***
分析仪站COMBIMASS®GA-s Hybrid

The New flexible analyzer system:
新的灵活的分析仪系统

- flexibility in cabinet sizes & material
  机柜尺寸和材料的灵活性
- flexibility in size of graphic display
  图形显示尺寸的灵活性
- flexibility in gas cells
  在气体传感器的灵活性
- flexible for indoors/outdoors
  室内/室外的灵活性
- flexible in sampling frequency and sequence (continuously/ frequently)
  灵活的采样频率和序列（连续/频繁）
- Easy assembly and maintenance
  易于组装和维护

Modular System for specific customer's requirement
模块化系统，满足特定客户的要求

Maintenance is work that is carried out to preserve an asset, in order to enable its continued use and function above a minimum acceptable level of performance over its design service life, without unforeseen renewal or major repair activities.

维护**是指**为了保持资产的持续使用和功能，在其设计使用寿命内达到最低可接受的性能水平而进行**的工作，而没有不可**预见的更新或主要维修活动。

- Support the business continuity in the most efficient manner.
  以最有效的方式支持业务连续性
  - Ensuring the asset is design and operated correctly to it intended purpose
    确保资产的设计和操作正确达到其预期目的
  - Prolonging the assets life
    延长资产寿命
  - Maximising equipment capability from the original design
    最大限度地提高原始设计的设备能力
  - Improving the asset performance
    提高资产绩效
- Ensuring quality of production/service delivered in timely manner
  确保及时提供生产**/服**务的质量
- Responsible care in Safety health and environment
  安全健康和环境的责任关怀
- Compliance to regulatory requirements and accreditation needs
  符合监管要求和认证需求

Maintenance Made Easier
维护更容易

As Gas Analysers are essential for monitoring the process in your Biogas Plant, it is imperative that you must maintain this equipment. Any downtime will put your plant at risks.

由于气体分析仪对于监测生物气工厂的过程至关重要，因此您必须维护此设备。 任何停机时间将使您的工厂面临风险。

- Eliminate the tedious task of exchanging cells by using modular cells. (No need skill technicians to exchange a Hybrid Module)

  消除使用模块化单元格交换细胞的乏味任务。 （无需技术人员更换混合模块）

- Providing optional auto calibration to dispense with the need for on-site or off-site calibration

  提供可选的自动校准，以省去现场或非现场校准的需要

- Ethernet/Internet remote control, trouble-shoots and diagnostic assessment

  以太网/互联网远程控制，故障排除和诊断评估

- Calibration and maintenance with local service back-up and on site recalibration possibility

  校准和维护，具有本地服务备份和现场重新校准的可能性

Conclusions
结论

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- Importance of Plant Monitoring

  工厂监控的重要性

- Suitable solution for particular requirements

  适合特殊要求的解决方案

- Maintenance made easy

  维护变得容易

→ ***stable***, ***safe*** and ***profitable*** operations

  稳定，**安全和盈利的操作**

We are happy to receive your feedback, questions and remarks.
我们很高兴收到您的反馈，问题和意见

Jan Talkenberger
Manager International Sales
国际销售经理
jan.talkenberger@bindergroup.info
+49 1733069903
Binder GmbH
德国冰得公司
Buchbrunnenweg 18
89081 Ulm, Germany

Alex Zhaoming Tan
Sales Manager Instrumentation China
中国区销售经理
alex.tan@binder-instrumentation.cn
+86 13816271680
Binder Instrumentation Trading (Shanghai)
冰得仪器仪表贸易（上海）有限公司
Room 106A, Xingyuan Tech Building,
Guiping Road 418
Shanghai 200233, China
中国上海市桂平路418号兴园科技广场106A 室，200233