In-situ gas analysis for fermentation

- or the easy way to control my process!

BlueSens gas sensor GmbH

- Founded in July 2001 by Dr. Udo Schmale and Dr. Holger Mueller
  - up to 11 employees in 2009
  - global network of distributors
  - market leader for gas sensors in bioprocesses in Europe
- Main Focus: Gas analysis to monitor bioprocesses
  - Pharmaceutical industry
  - Research and development
  - Food industry
  - regenerative energy (biogas)
- Philosophy: Measuring where something happens (no sampling)

Main Market: Pharmaceutical Industry

- Process optimization (R&D)
- controlled Scale up
- Quality control (yeast, yogurt etc.)
- Process control
  - Start culture (shake flask) to determine the optimal time for inoculation
  - Fermentation process (e.g. insulin production, cell culture, yeast production)

BlueSens gas sensor GmbH

Biogas Market

Laboratory scale yield tests

- CH4 quality
- Produced gas volume

Biogas plant

- CH4 control just in the near of the engine
- Total analysis of CO2, CH4, O2 and H2S

Laboratory Scale

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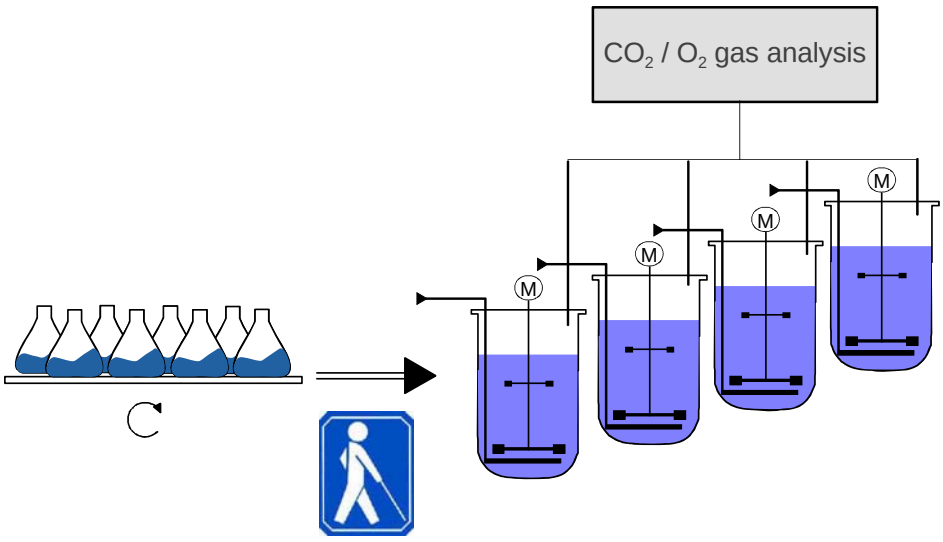
Gas analysis for the Scale up: “normal scale up”



Shake flask

Small size multi-fermenter

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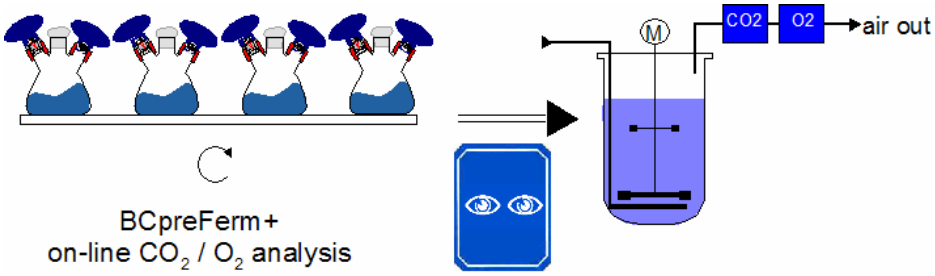
Gas analysis for the Scale up: “modern scale up”



- Online calculation of OUR, CER and RQ
- Increasing reproducibility
- Increasing productivity
- Greater understanding about your process
- Metabolic flux analysis and mass-balance calculations

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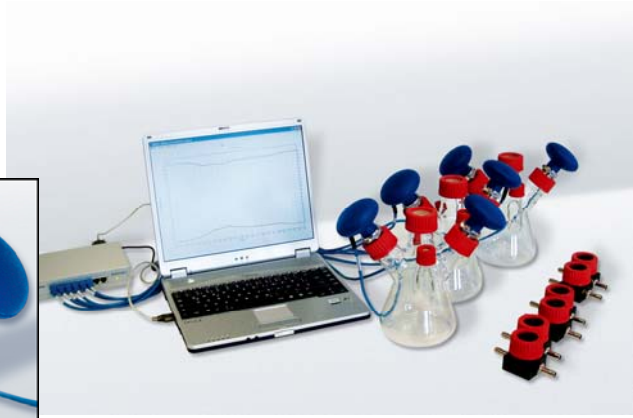
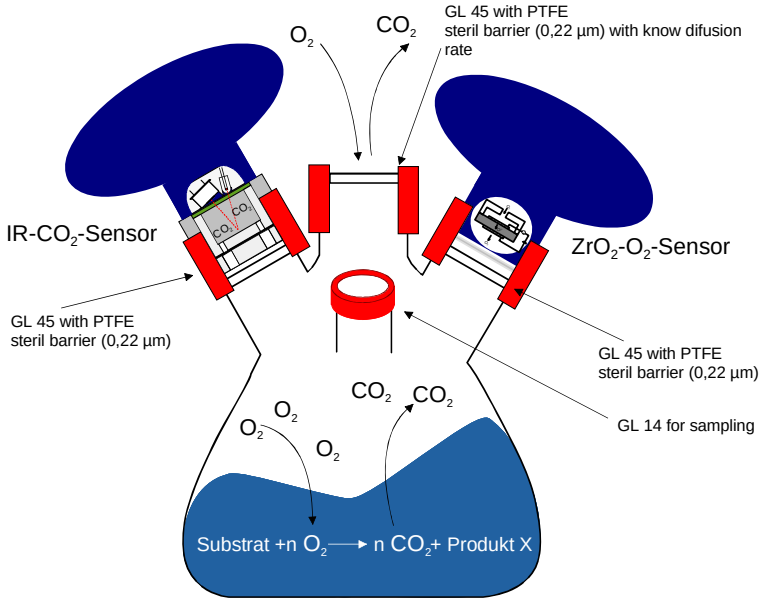
Gas analysis for the Scale up: “modern scale up”



Principal of BCpreFerm



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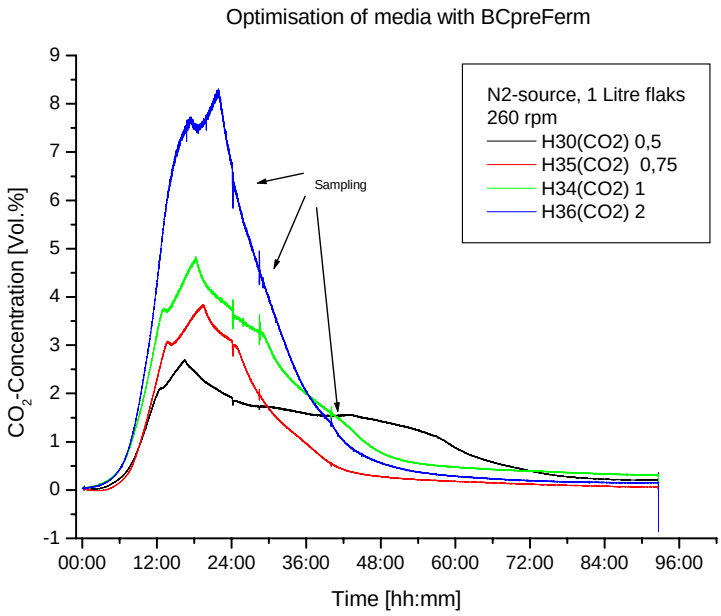
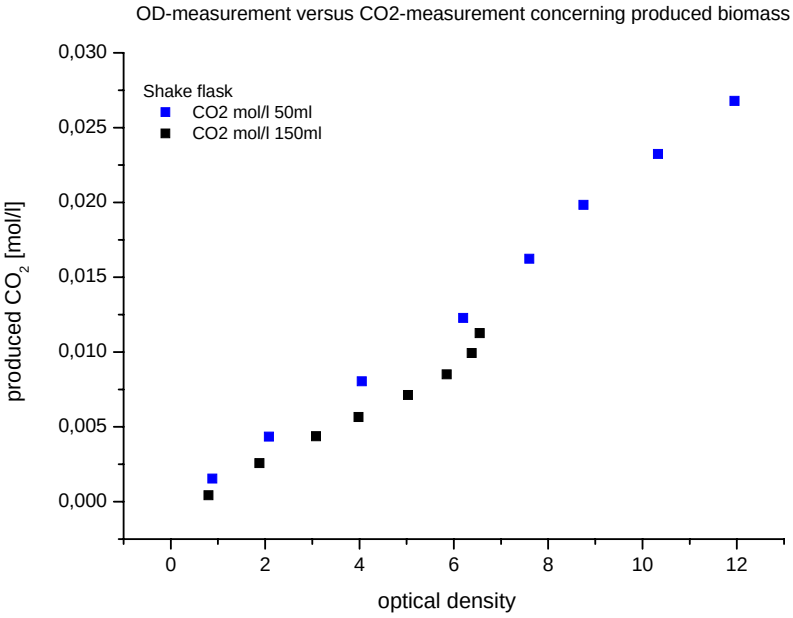
Example 1



Source: Bayer Healtcare AG, Wuppertal

Example 2



Source: Hexal Forschungs GmbH

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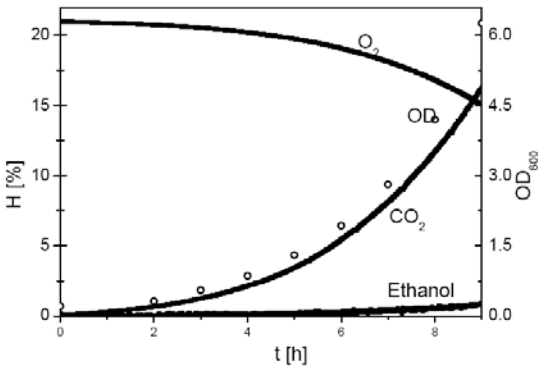
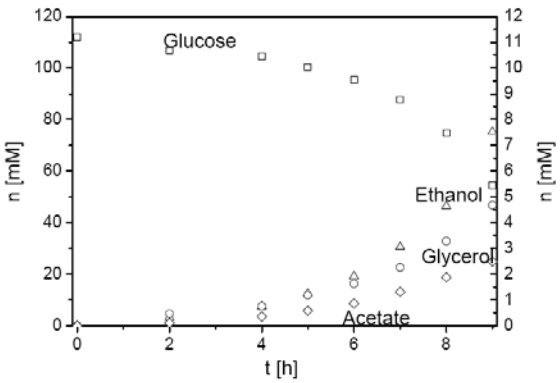
Example 3

Carbon balance in S. cerevisiae by online and offline analysis

Online data – BlueSens gas sensors



Offline data - HPLC



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Fakultät Bio- und Chemieingenieurwesen
Lehrstuhl Biotechnik

Example 3

Physiological growth parameter and carbon balance

Spec. rates [mmol /gh]			Spec. yield coefficient [Cmol /Cmol]		
$r_{glucose}$	20.21	± 0.61	$Y_{glucose}$	7.55	± 0.16
$r_{glycerol}$	2.04	± 0.34	$Y_{glycerol}$	0.38	± 0.06
$r_{acetate}$	0.98	± 0.09	$Y_{acetate}$	0.12	± 0.01
$r_{ethanol}$	29.95	± 0.66	$Y_{ethanol}$	3.73	± 0.09
r_{CO2}	34.37	± 0.70	Y_{CO2}	2.14	± 0.03
			$\sum C$	-0.18	± 0.06
			$\sum C/Y_{gluc}$ [%]	-2.36	± 0.81

Carbon balance could be exactly closed and is reproducible

⇒ good method for quantitative physiological studies

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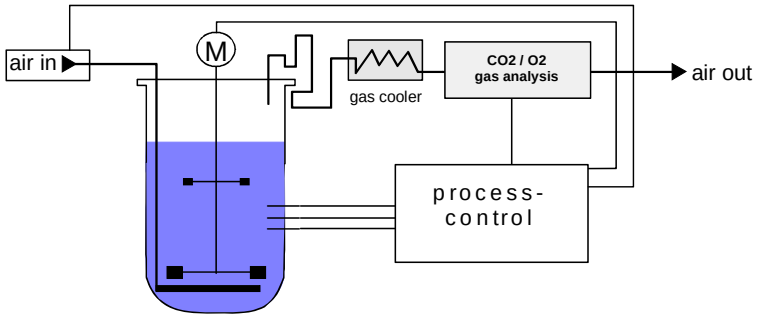
Production scale

Control of fermentation processes

"normal" gas analysis



- a lot of maintenance
- delay of data
- difficult to control the process

Transport of the gas to the analyzer!

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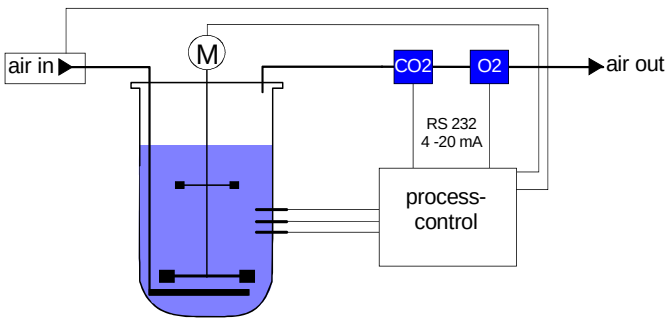
Process control with in-situ gas sensors

"modern" gas analysis conform to PAT (process analytical technology)



- low maintenance
- online data
- easy to control the process

Measuring where something happens!

Process control with in-situ gas sensors

for smale pipes...

...for hugh pipes...

...or for tubes

The size doesn't matter!

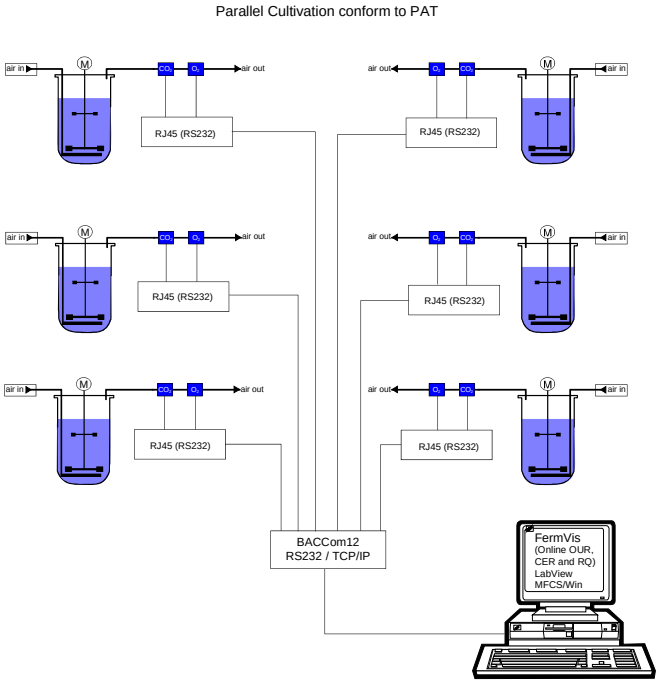
BlueSens gas sensor GmbH

Advantages of BlueSens' sensors

- small investment cost
- no sampling
- no gas treatment
- very stable and reliable measurements
- usable with every fermenter brand
- high redundancy through multiple sensors
- easy installation
- fits to every tube or pipe

Process control with multiple sensors

- easy communication via Ethernet
- complete control loops
- different drivers available



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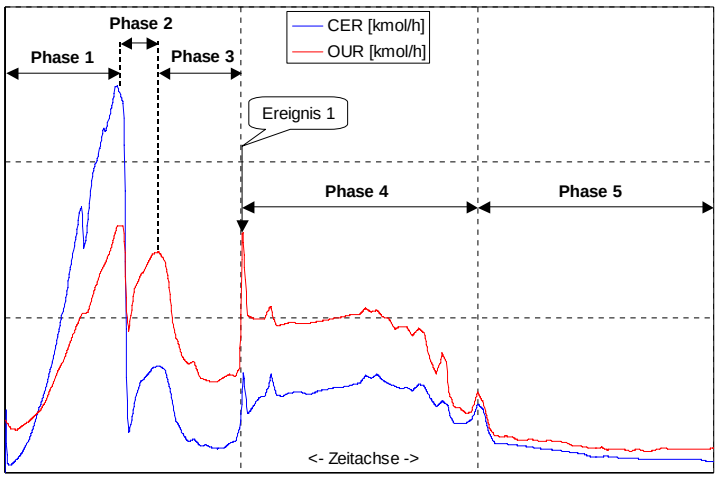
Example 4

Measurement of the Oxygen uptake rate (OUR) and Carbon dioxide emission rate (CER) of a yeast fermentation



Source: Schering AG, Engineo GmbH, BlueSens gas sensor GmbH

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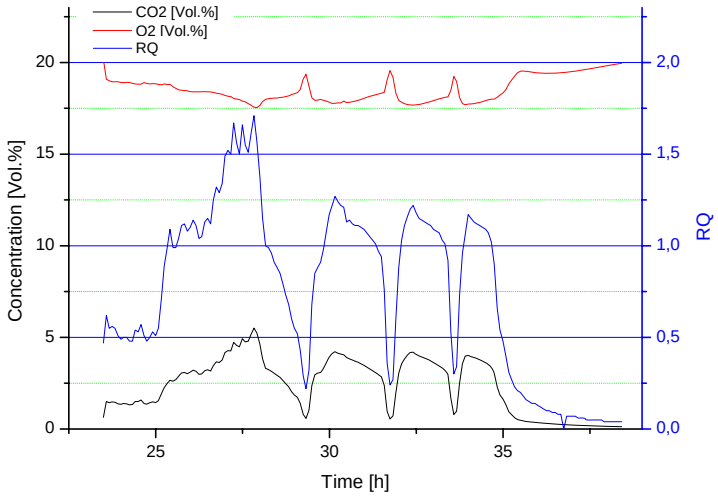
Example 6

Discontinuous feeding of molasses based on an ethanol control



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