

# Monitoring and process control of biogas plants

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# Process monitoring can help to ...



- Identify instabilities during anaerobic digestion
  - React on time before a severe crash happens
  - Re-stabilise crashed plants
  - Give an overall picture of the biogas process
  - Accompany a successful start-up of a plant
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- Reduced gas production (money)
  - Odour (problems with the neighbours)



# Possible reasons for process instabilities

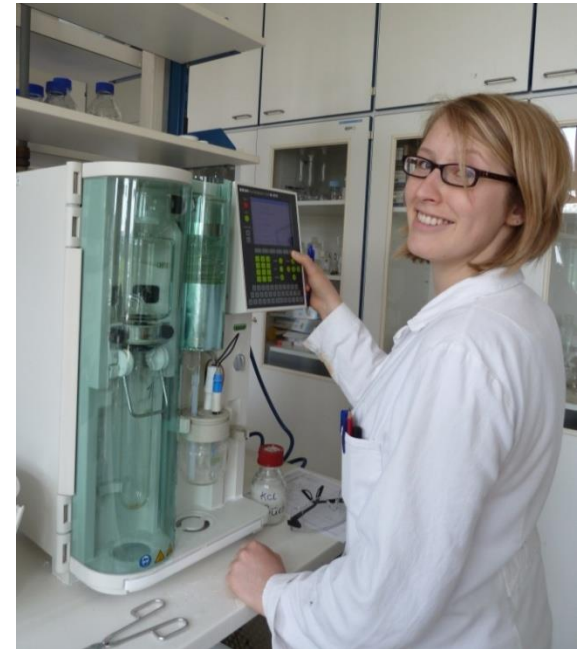


- Feeding problems/changing feedstock
- Temperature changes
- Utilisation of high nitrogen feedstock
- Utilisation of high sulphur feedstock
- Trace element limitation
- Further inhibitory substances in feedstock
  - Heavy metal ions
  - Light metal ions
  - Antibiotics and disinfectants

# Monitoring parameters can be divided into



- Parameters characterising the process
- Early indicators of process imbalance



# Parameters characterising the process



- Quantity and composition of feedstock
- Biogas production and gas composition
- Fermentation temperature
- TS (total solids) / DM (dry matter)
- pH value
- Ammonium nitrogen ( $\text{NH}_4\text{-N}$ )

→ These parameters are necessary for finding reasons of a process imbalance



# Early indicators of process imbalance



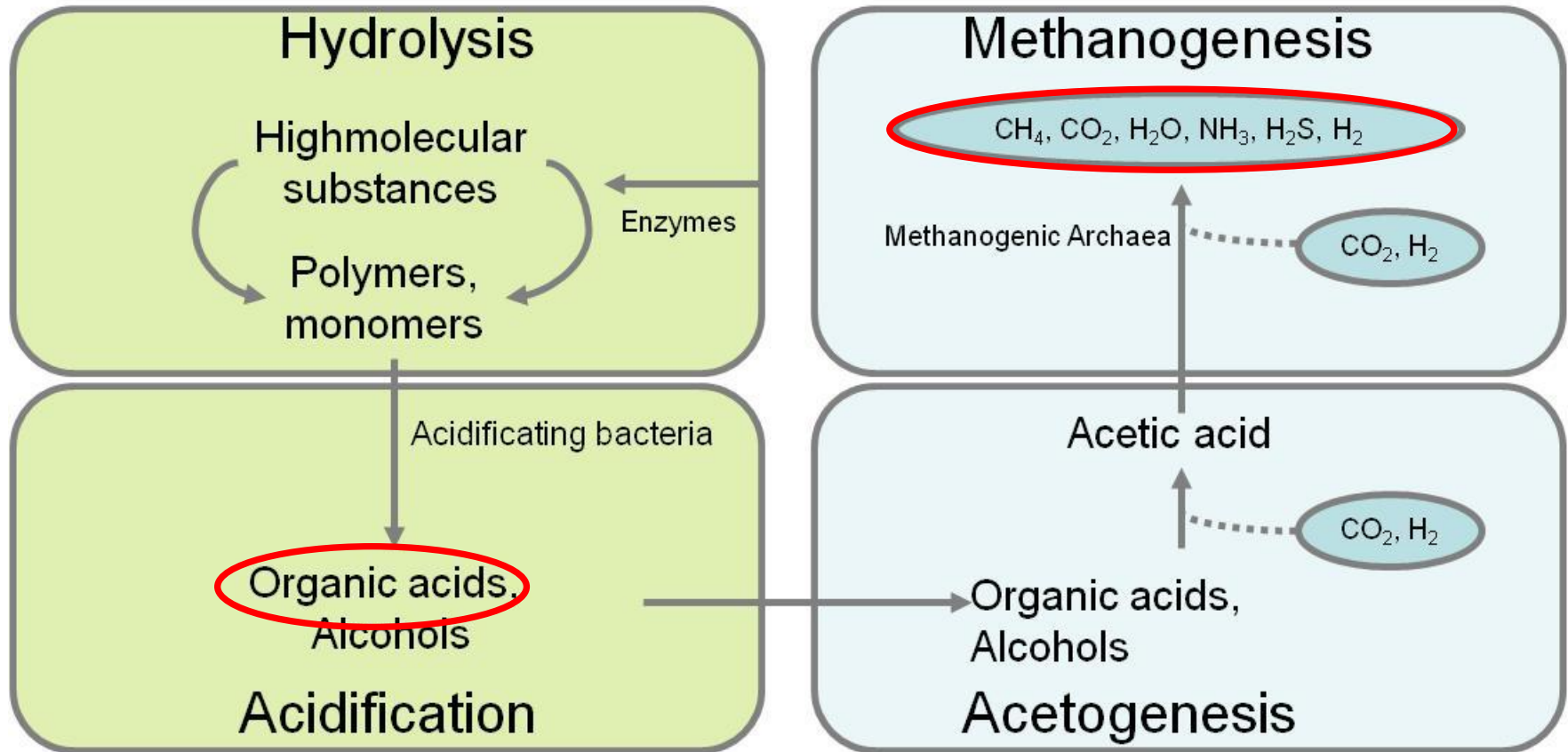
- Gas measurement ( $\text{CH}_4$ ,  $\text{CO}_2$ ,  $\text{H}_2$ )
- Volatile fatty acids (VFA)
- Alkalinity ratio (German: FOS / TAC) - titration
- Redox potential
- Complex monitoring of mixed parameters (online!)
  - NIRS (Near infra-red spectrometry)
  - Electronic nose
  - ...



→ These parameters give information on current process stability, but often not the reason why!



# 4 steps of anaerobic digestion



# Limits - parameters characterising the process



	Range of parameter
<b>NH<sub>4</sub>-N</b>	< 5,000 mg L <sup>-1</sup>
	> 5,000 mg L <sup>-1</sup>
<b>pH</b>	7 - 8
	< 7
	> 8
<b>TS</b>	< 10
	> 10



# Reasons for instability



- Process engineering/digester type
- Retention time
- Lack of nutrients
- Inhibiting feedstock (bacteriostatic, archaeostatic, -toxic)
- Bottle neck of the process

# General recommendations for avoiding process imbalances



- Continuous feeding
- Continuous feedstock mix (e.g. manure and biowaste)
- Careful change of feedstock mixes
- Avoid temperature changes
- Constant intervals and intensity of agitating
- Continuous process control

# Conclusions



- The anaerobic process is a complex chain of subsequent and interacting degradation steps
  - biological monitoring of a biogas plant is highly important
- Some monitoring parameters are essential for indicating an upcoming process imbalance, whereas others help to find the reason for it
- Various challenges exist: available infrastructure, influence of sampling, online vs. offline data, skills of the operators
- No clear stability limits can be defined, rather recommended ranges
- Avoiding GHG emissions

# Training of biogas plant operators



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# IEA Bioenergy Task 37 – Technical brochure on process monitoring of biogas plants



**Available at: <http://www.iea-biogas.net/technical-brochures.html>**

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