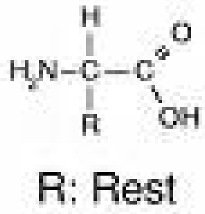
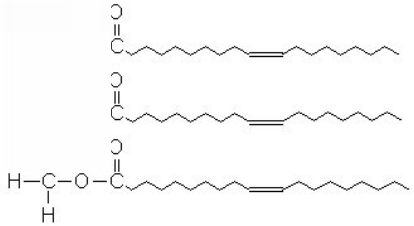
Pre-treatment technologies for biogas production

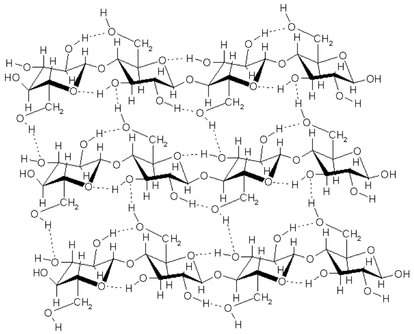
Günther Bochmann

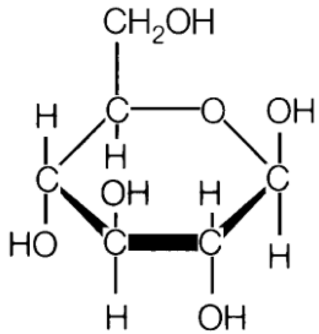
Composition biomass

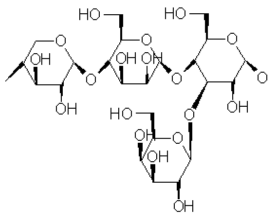
- **Proteins**
- **Fats**
- **Cellulose**
- **Hemicellulose**
- **Lignin**







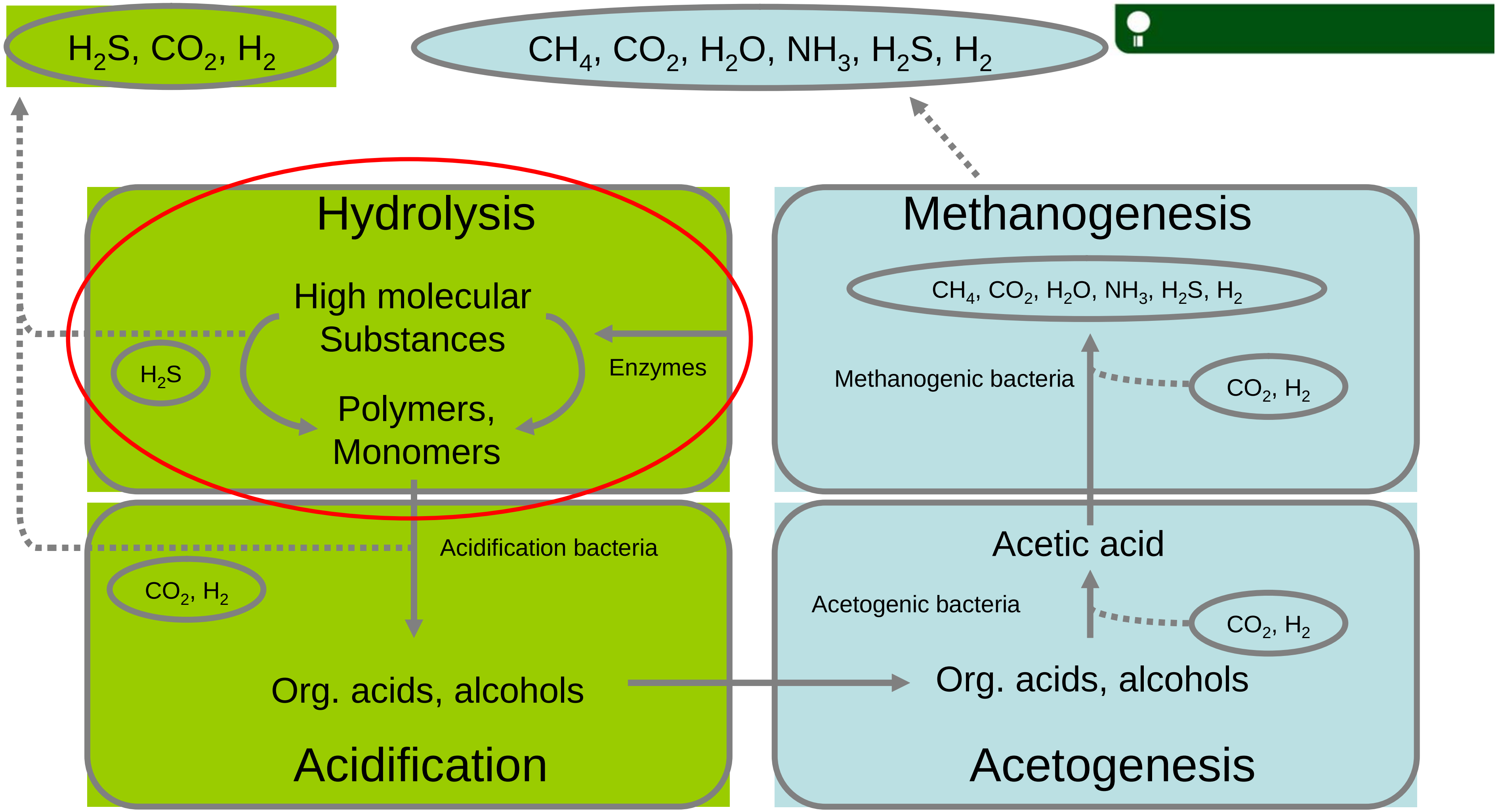




- Xylose - ß(1,4) - Mannose - ß(1,4) - Glucose -
- alpha(1,3) - Galactose

Hemicellulose

Four steps of AD



Aims of pre-treatment technologies

Increasing reactor productivity by

- Degradation rates
- Increasing biogas yields
- Increasing process stability

- Degradation of hard degradable substances

Pre-treatment technologies

Biochemical pre-treatments

- Microbial pre-treatments
- Enzymatic pre-treatments

Chemical pre-treatments

- Caustic pre-treatments
- Acid pre-treatments

Physical pre-treatments

- Mechanical pre-treatments
- Thermal pre-treatments
- Ultrasonic pre-treatments

Combined processes

- Thermal-chemical pre-treatments
- Thermo-mechanical pre-treatments

Pre-treatment technologies I

Microbiological pre-treatment

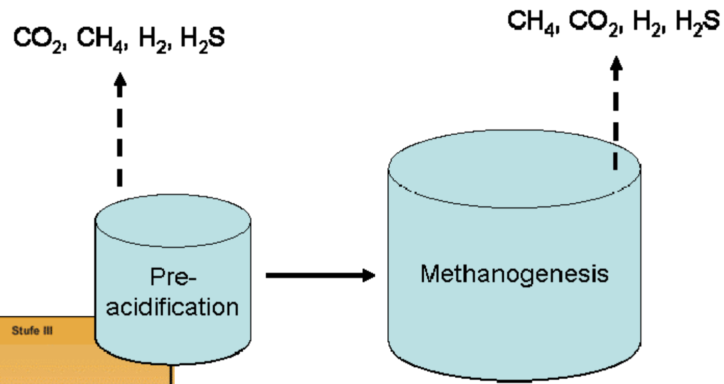
- 2 phase system (“Hydrolysis and methanogenesis”)
- Different pH-values

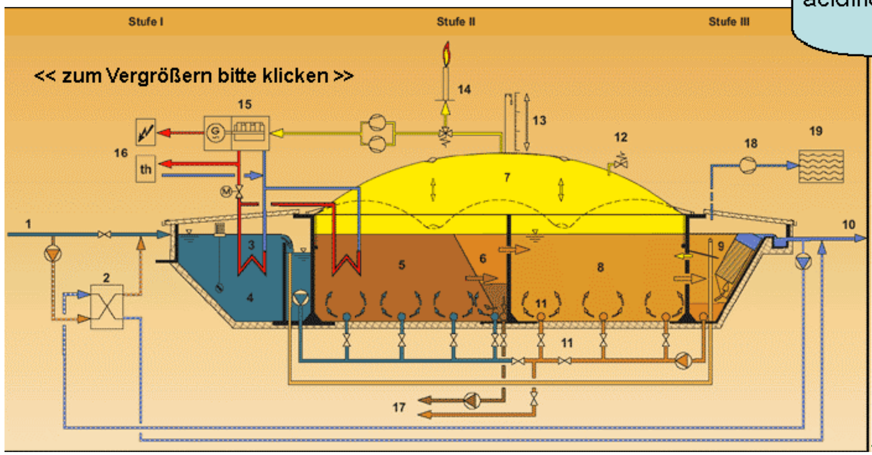
Advantages/disadvantages

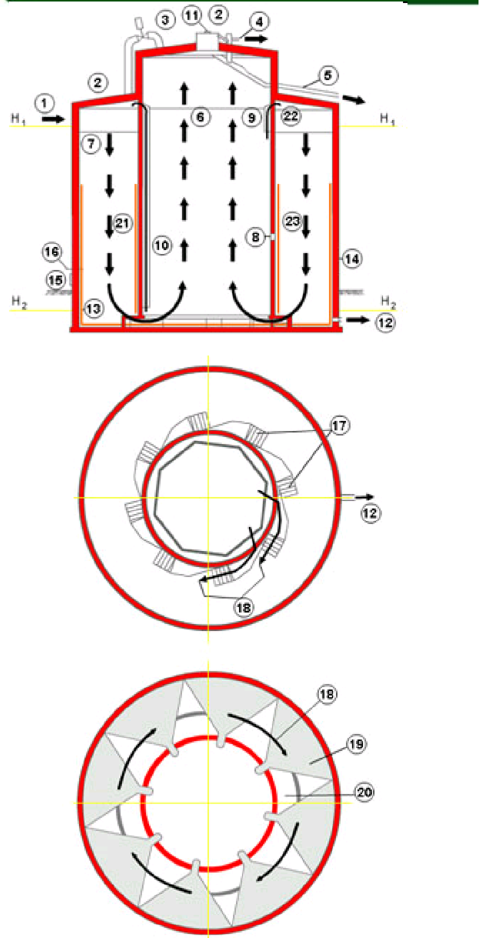
- H_2 and CO_2 production
- Increasing methane concentration
- Higher process stability

Applications I (Microbiological)

- Multi stage fermentation systems







Pre-treatment technologies II

Mechanical pre-treatment

- Cutting
- Milling

Advantages/disadvantages

- Electrical energy demand
- Increased biogas yield (depends on the particle size)
- Reduction of swim layers

Pre-treatment technologies III

Thermal pre-treatment

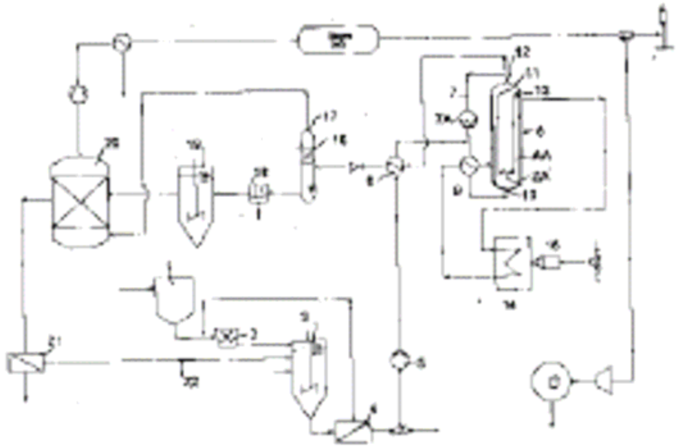
- External reactor
- Temperatures 100 – 230 °C
- Different pH-values

Advantages/disadvantages

- Process engineering/energy demand
- Increased biogas yield
- Production of bacteriostatic components

Applications II (Thermal)

- Thermal pre-treatment (e.g. TDH)
- Substrates
  - Energy Crops
  - Brewers spent grains
  - Slaughter house wastes
  - Canteen/kitchen wastes
  - Sewage sludge



Pre-treatment technologies IV

Combined technologies

- Steam-explosion
- Extruder

Advantages/disadvantages

- High thermal energy demand
- Increased biogas yield or degradation rate
- Reduction of swim layers

Applications III (Thermo-mechanical)

- Steam-explosion
- High energy demand
- Heating from 100 °C → 180 °C
  - E.g. 20 % DS → 83,55 kWh / Mg FM energy demand
- Spontaneous decompression
  - Evaporation of water
  - Destroyed cell structure

Applications IV (Thermo-mechanical)

- Extruder technology
- Electrical energy demand
- Compression → Energy conversion into heat
    - E.g. 65 kW → ~0.8 t / h
- Influence to degradation rate
    - Retention time of < 40 d → higher gas yield of ~5-15 %
    - Retention time of > 50 d → no additional gas yield was measured

Overview

Pre-treatment technology	Increasing specific surface	Degradation lignocellulose complex	Influence to AD process	Energy demand / specific costs
Microbiological	+	~	+	+ + / + +
Thermal	+	+ +	+ +	- / - - -
Mechanical	+	+ / -	+	- / +
Steam-Explosion	+ + +	+ + +	+ *	- - - / - - -

Conclusions

- Advantage of pre-treatment technology depends on substrates
- Pre-treatment technology specific for chemical composition
- Effect of pre-treatment varies (positive/negative effect possible)
- Additional investment costs
- Energy balance

Thank you for your attention

Günther Bochmann

Institute of Environmental Biotechnology
Department of Agrobiotechnology IFA-Tulln
University of Natural Ressources and
Life Sciences Vienna
A-3430 Tulln
Konrad Lorenzstrasse 20

guenther.bochmann@boku.ac.at
http://www.ifa-tulln.ac.at

International Symposium on Anaerobic Digestion of Solid Wastes and Energy Crop
August 28th – September 01st, 2011

www.adswec2011.org