Pre-treatment Technologies for Anaerobic Digestion

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IEA RESEARCH COOPERATION

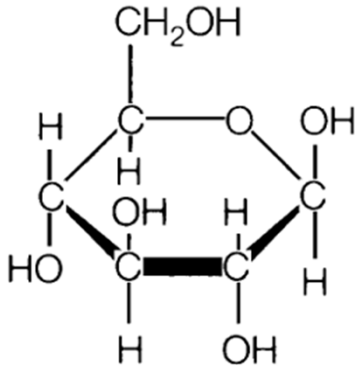
Aim of pretreatment technologies

- Reduction of specific production costs
  - Substrate costs (%)
  - Investment costs (%)
  - Operation costs (%)

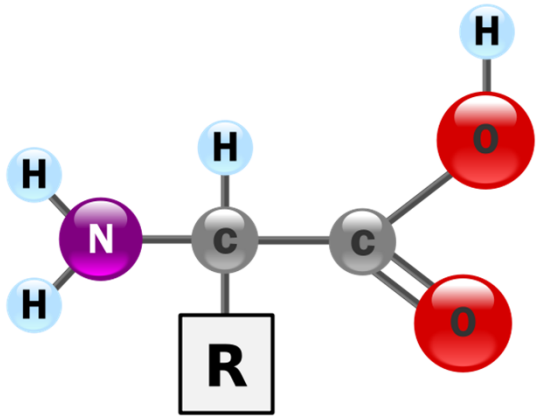
- Realisation by
    - Increasing the biogas yield
    - Inceasing degradation rate
    - Increasing the plant efficiency
    - Reduction of operation costs

Substrates

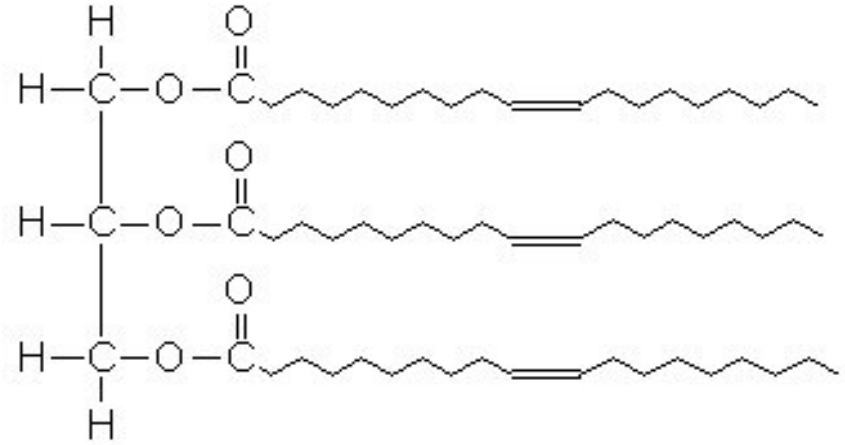
- Carbohydrate



- Protein

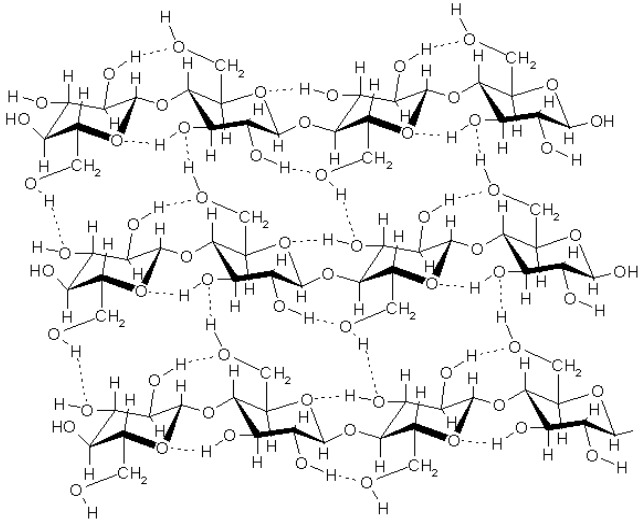


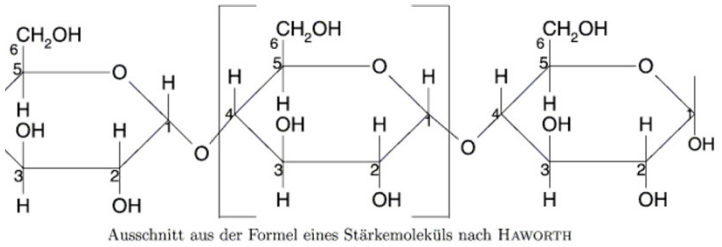
- Fat



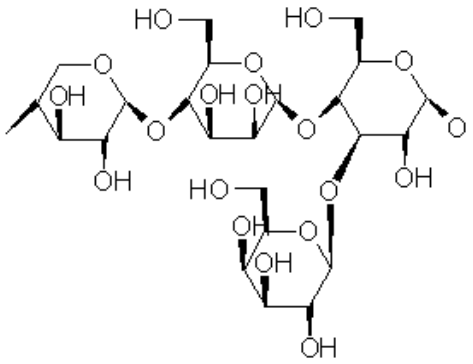
Carbon hydrates

- Starch
- Cellulose
- Hemicellulose
- Lignin



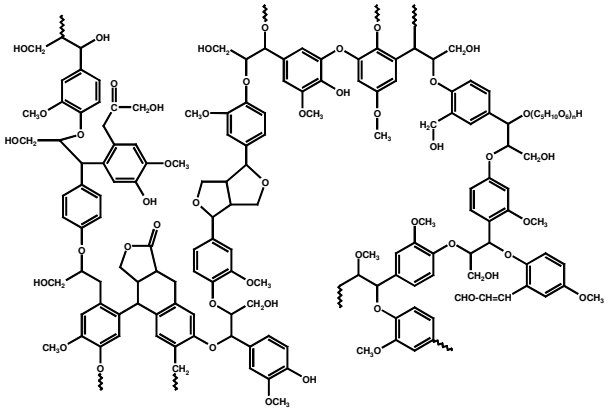


Ausschnitt aus der Formel eines Stärkemoleküls nach HAWORTH

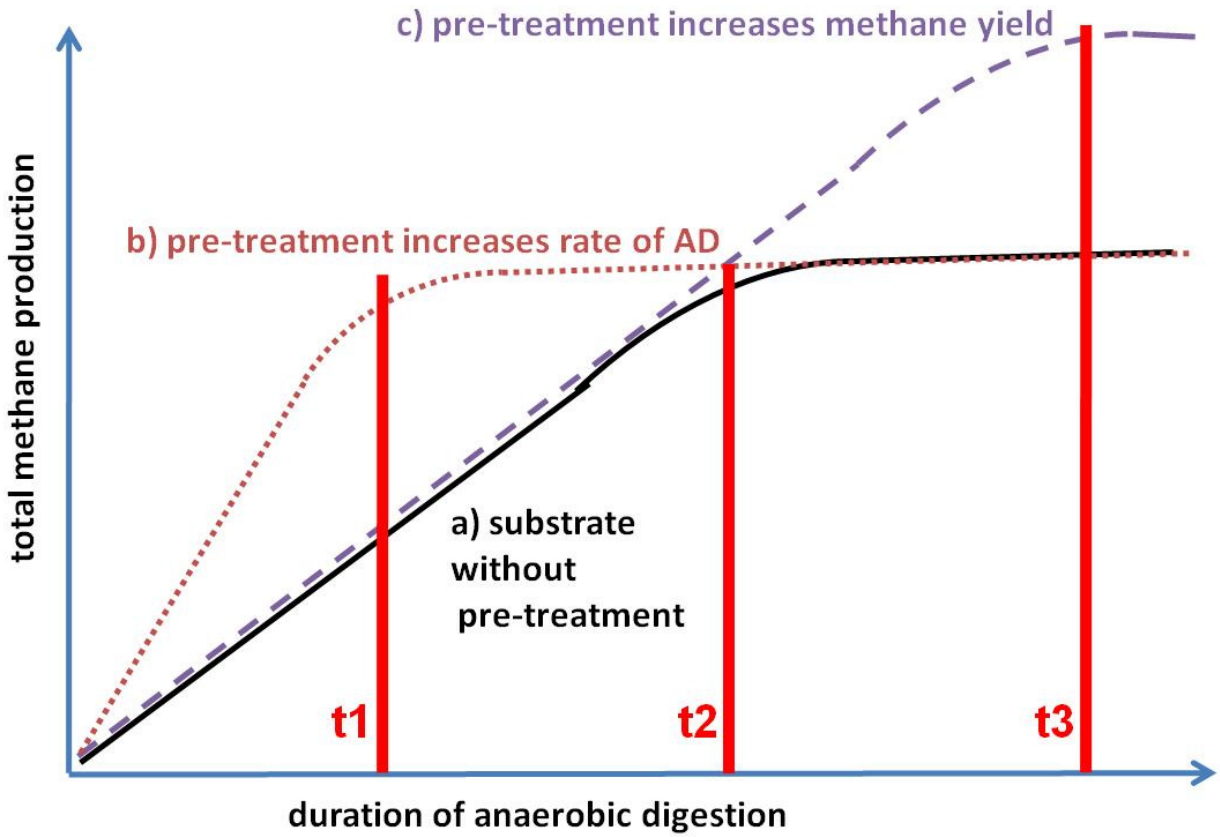


- Xylose - ß(1,4) - Mannose - ß(1,4) - Glucose -
- alpha(1,3) - Galactose

Hemicellulose



Impact pre-treatment



Pre-treatment technologies

Physical	Mechanical	Thermal	Ultra sound	Electrokinetic Disintegration
Chemical	Alkaline	Acidic		
Biological	Microbiological	Enzymatic		
Combined processes	Steam Explosion	Extrusion	Thermochemical	

Mechanical

Principle

Mechanical crushing

e.g. cutterbars

Quelle: IKTS Frauenhofer

Mode of action

Increasing the specific surface

- **Advantage**
  - Relatively low investment costs
  - Relatively low energy demand

- **Disadvantage**
  - Foreign materials reduce life time of unit significantly

Thermal

Principle

Thermal pretreatment leads to disintegration of hard degradable substances

Mode of action

Solving of hemicellulose and swelling of biomass

Quelle: Dr. Franke ATZ/D

- Advantage
  - Higher gas yield
  - Exclusively heat demand

- Disadvantage
  - High investment costs
  - Production of inhibiting substances

Thermo-mechanical

Principle

Extruders crush biomass

Mode of action

Increasing the specific surface

Quelle: IFA Tulln

- Advantage
  - Degradation rate
  - Relatively low investment costs
  - Low energy demand

- Disadvantage
  - Foreign materials reduce life time of unit significantly

Chemical

Principle

Addition of lye or acid in an additional pre-treatment step

Mode of action

Solving of lignocellulose complex

Quelle: enbasys

- Advantage
  - Higher gas yield
  - Faster degradation

- Disadvantage
  - Operation costs
  - Production of inhibiting products

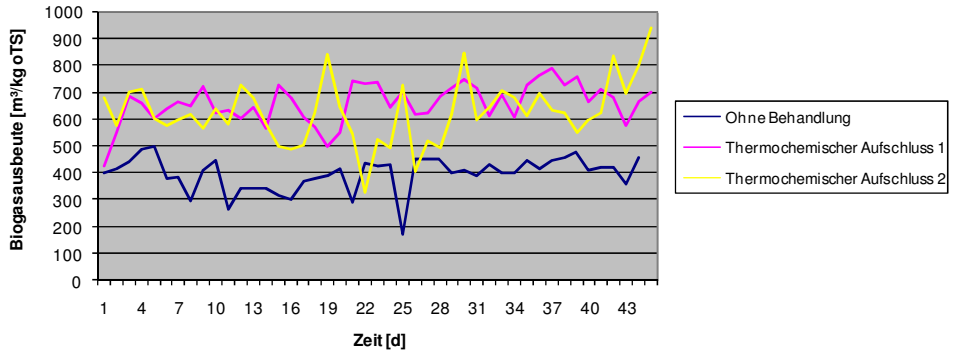
Thermochemical

Principle

Support of chemicals through heat

Mode of action

Solving of lignocellulose complex



- Advantage
  - Higher gas yield
  - Faster degradation

- Disadvantage
  - Operation costs
  - Production of inhibiting products

Steam explosion

Principle

Heating and abrupt decompression

Mode of action

Rupture cell structures

Quelle: Boku

- Advantage
  - Higher gas yield
  - Only thermal energy

- Disadvantage
  - High investment costs
  - Formation of inhibiting substances

Microbiological

Principle

Additional digester

Mode of action

Reduced pH enables enzymes
to work at their optimum

Quelle: AAT

- Advantage
  - Faster degradation
  - Higher methane concentration

- Disadvantage
  - No higher gas yields to be expected

Ultra sound

Principle

Ultra sound (US) into digester

Quelle: ULTRWAVES /D

Mode of action

US frequences lead to cavities or formation of gas bubbles and their subsequent implosion

- Advantage
  - Low energy demand
  - Low investment costs

- Disadvantage
  - No direct degradation of biomass

Electrocinetical disintegration

Principle

Addition of high voltage impulses

Quelle: ATRES Group/D

Mode of action

Electrical field destroys ionic bonding of cell walls by changing the charge

- Advantage
  - Low energy demand
  - Low investment costs

- Disadvantage
  - No direct degradation of biomass

Summary/conclusion

- Pre-treatment technologies specific to substrate
- Pre-treatment technologies specific to plant
- Awareness of investment and operation costs
- Energy balance
- Awareness of higher gas yield
- Additional effects of pre-treatment technologies

BiogasScience 2014

Vienna | Austria

International Conference on Anaerobic Digestion

26th - 30th October 2014

www.biogas2014.boku.ac.at

Thank you

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