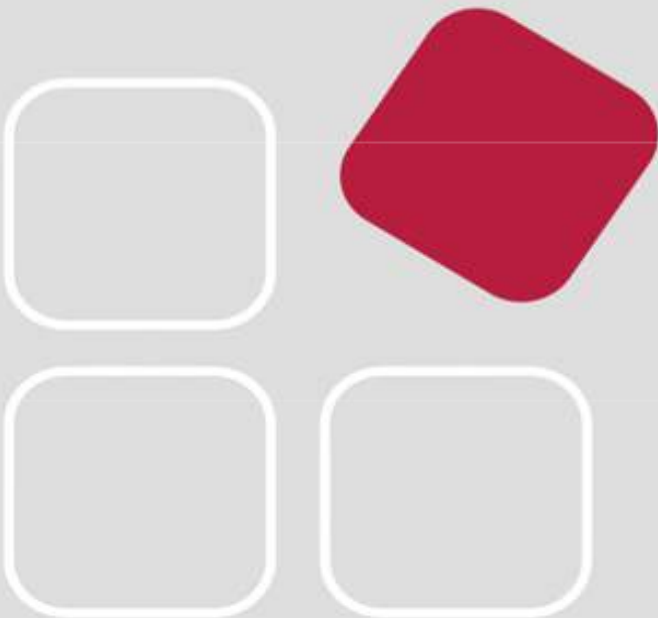


# Dry Fermentation Technologies

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## Dr.-Ing. Hans Friedmann

- Over 30 years of biogas experience in research, planning, consulting, plant construction and plant operation
- **Owner and Manager of the engineering company „Dr.-Ing Friedmann – German Biogas Excellence“**
- Founder member of the German association „Biogasunion e.V.“ and chairman (2000 to 2005)
- Member of Presidium and Vice President of the German biogas association (2005 - 2013)
- Member of the guideline committees 4630 and 4631 (Biogas technique) of the Association of German Engineers (VDI)
- Founder and CEO of Agraferm Technologies AG (2004 – 2010)
- Founder, majority shareholder and managing director of BKW Biokraftwerke Fürstenwalde GmbH (until Feb. 2019)
- Operator of 14 biogas plants with 180 kW up to 5 MW (with BKW GmbH)
- Patents to high viscosity mixer, micro nutrients, stillage digestion process, modular dry fermentation process and more



## The idea to develop a dry fermentation CSTR: Increase of efficiency through high-load biology

**The „market“ said – 3,5 kg VS / cbm / day is enough, but**

- Smaller digester lead to a lower space requirement as well as lower costs for foundation and groundworks
- Lower costs for digester construction
- Reduced internal power requirement (50 % of the internal power requirement results from the necessary agitating power, the expenditure for agitating rises proportional to digester volume)
- Possibility of repowering of existing plants by process optimisation!

**Increase of profitability and efficiency with high load dry fermentation!!**

## Dry fermentation technologies

### ▪ Leaching systems

- comparatively low biogas yield (40 % less than others)
- feedstock must be suitable for leaching
- high uncontrolled methane emissions during post-composting of digestion residues

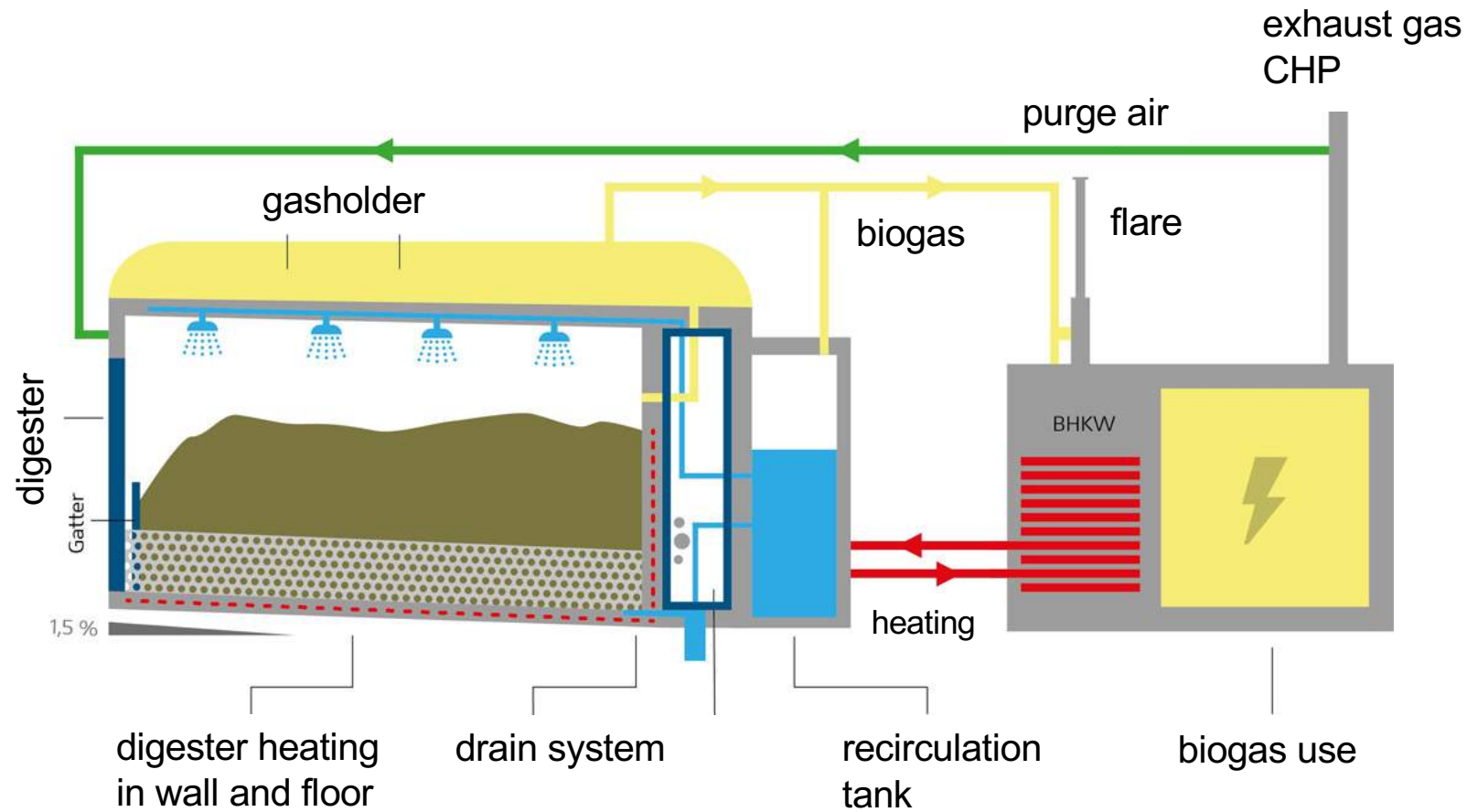
### ▪ Plug flow systems (with mechanical mixer)

- high biogas yield
- high investment costs
- small footprint

### ▪ CSTR digester

- high biogas yield
- comparatively low investment costs
- small footprint
- flexible for different feedstocks

# Dry fermentation leaching digester

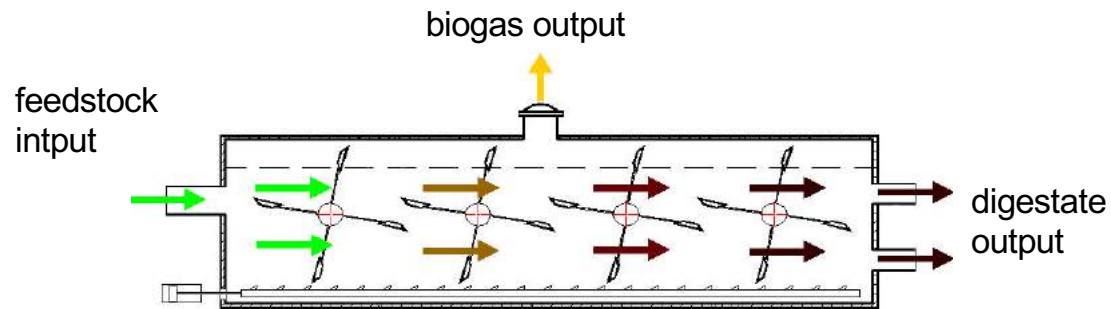


## Dry fermentation leaching digester (Munich)



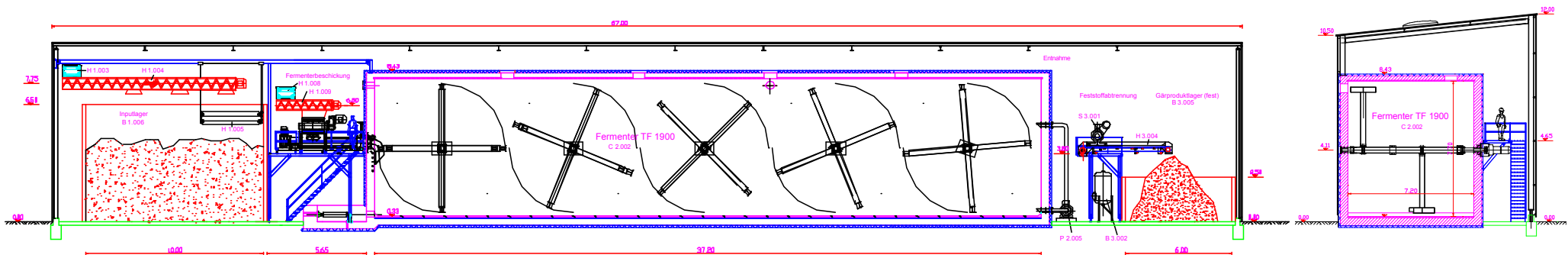
- comparatively simple technology
- waste must be suitable for leaching
- only little preparation of waste before digestion required
- comparatively low biogas yield
- high uncontrolled methane emissions during post-composting of digestion residues

# Dry fermentation plug flow digester



A - A

D - D



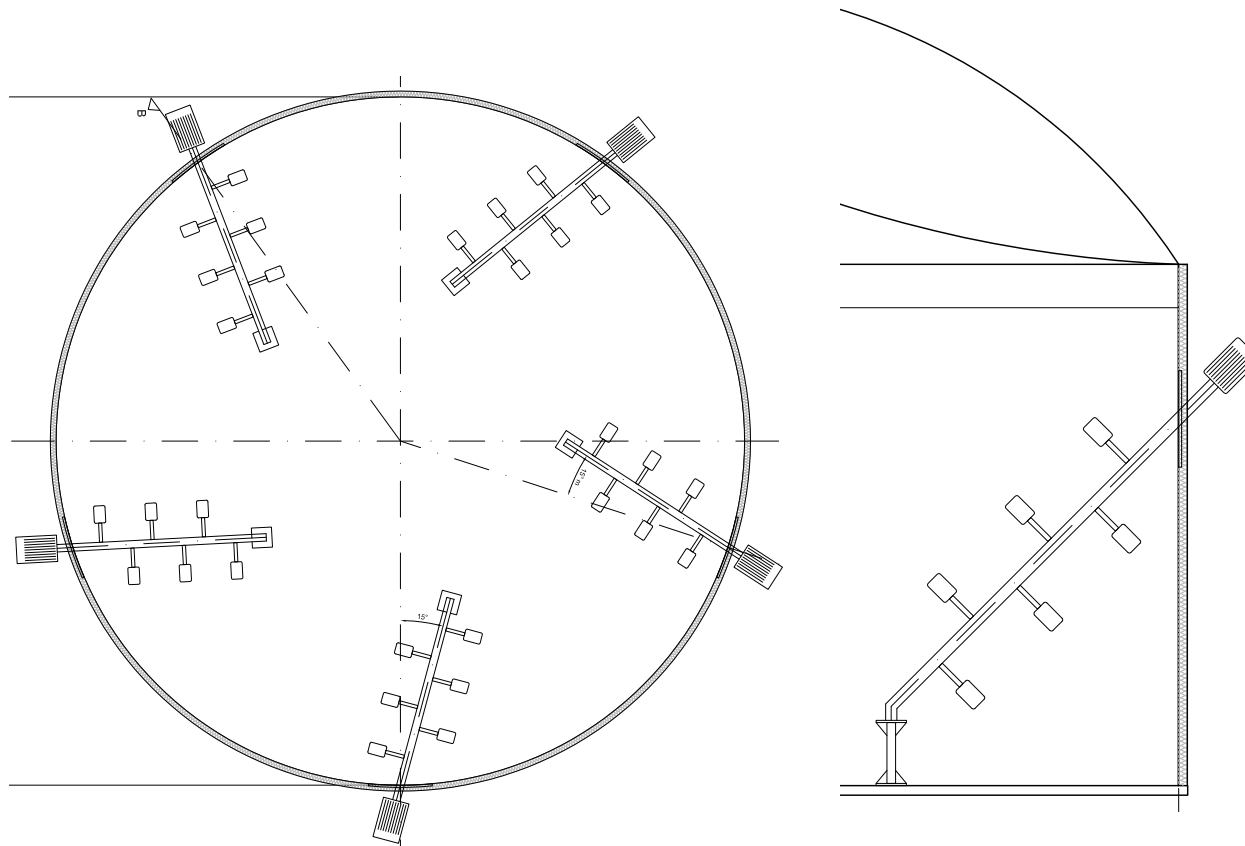
## Dry fermentation plant Malchin



- Monofermentation of corn silage and other silage
- 4.5 MW el. power, steam and heating network
- 2 x 2200 cbm digester volume
- **loading rate up to 18 kg VS/cbm/d**
- **Our services:** conception and design of the plant (2005), since 2011 reconstruction as well as technical and organisational renovation of the plant; operation 2010 to 2015; selling of the plant in 2015



## Dry fermentation CSTR (side entry mixer – Version)



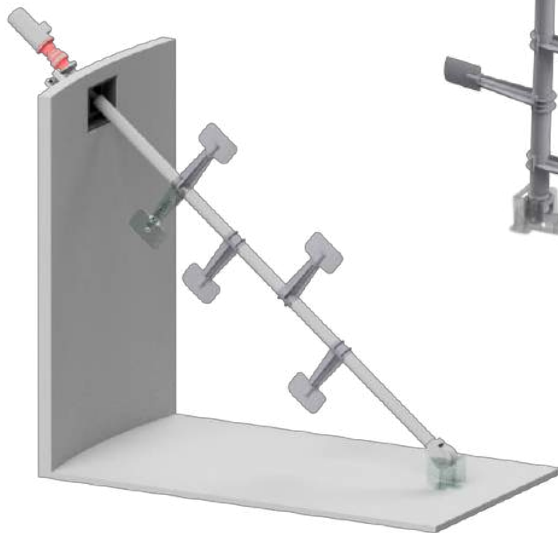
- low cost digester (concrete or steel)
- strong mixer for very high viscosities
- long life mixer (>10 years) with 7 tp 15 rpm
- gasholder on top of digester reduces plant investment and footprint
- **loading rate up to 12 kg VS/cbm/d**

## 5,000 cbm CSTR dry fermentation digester under construction

top entry mixer



side entry mixer



5,000 cbm digester for side entry mixer



Optimization of a steel CSTR  
(7,000 cbm) with side entry  
mixers

## Dry fermentation biogas plant Berg



- CSTR dry fermentation system (**top entry Version 2008**)
- mono-fermentation of whole plant silage (Triticale)
- 625 kW, 41 % el. efficiency
- no slurry, but use of micronutrients
- 870 cbm CSTR digester, loading rate over 10 kg VS/cbm/d
- high viscous digestate (83 % moisture; see picture)
- owned and operated by Dr. Friedmann



## Feedstocks for dry fermentation CSTR

- Industrial feedstocks like
  - press mud from sugar cane processing
  - bagasse from sugar cane processing
  - .....
- Solid agricultural feedstocks like
  - straw from rice, wheat and others
  - napier grass and other energy crops (as silage)
- Municipal waste like
  - source separated organic waste from municipalities
  - food residous
  - vegetable waste

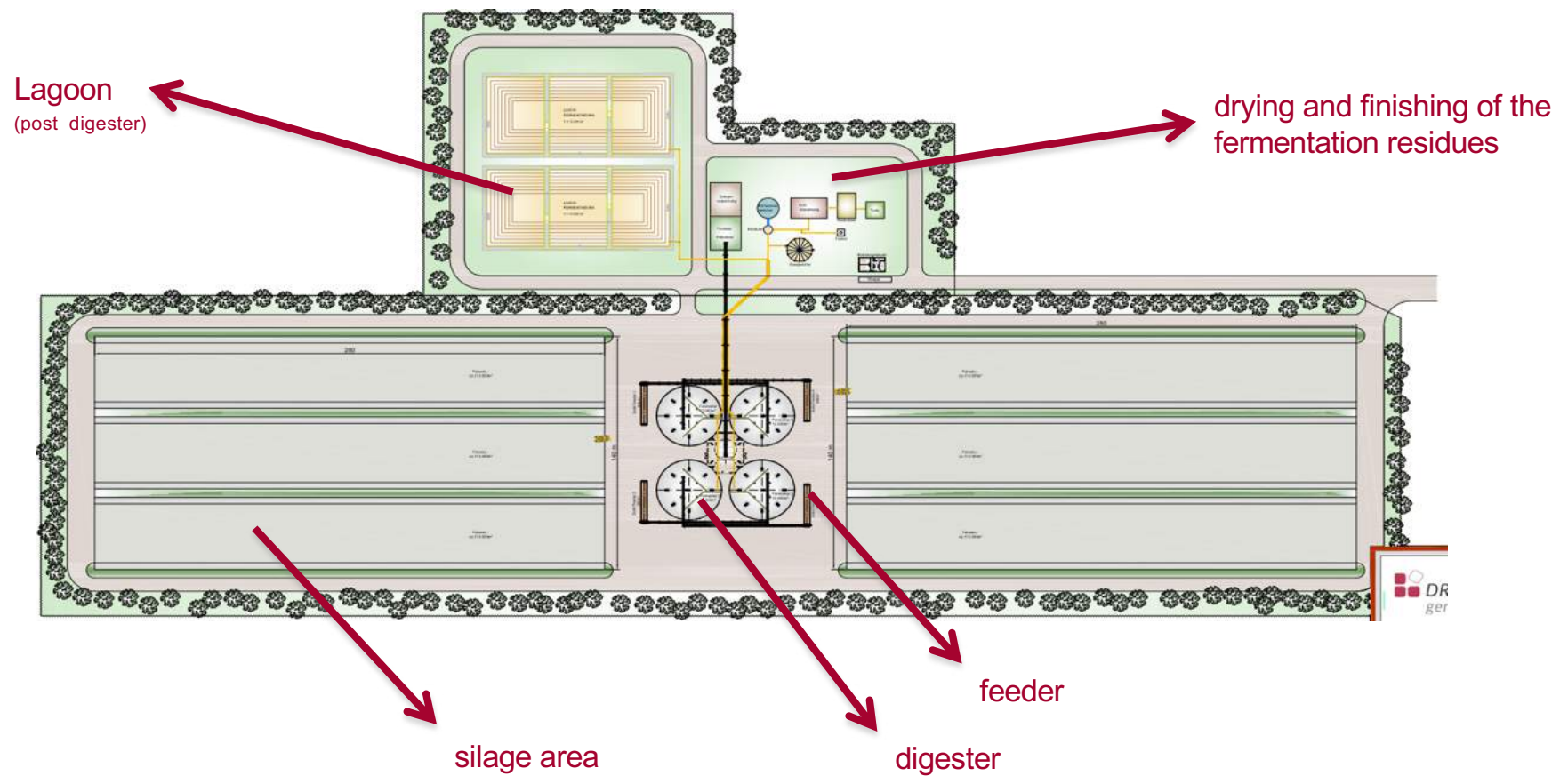
## International biogas business - Brazil



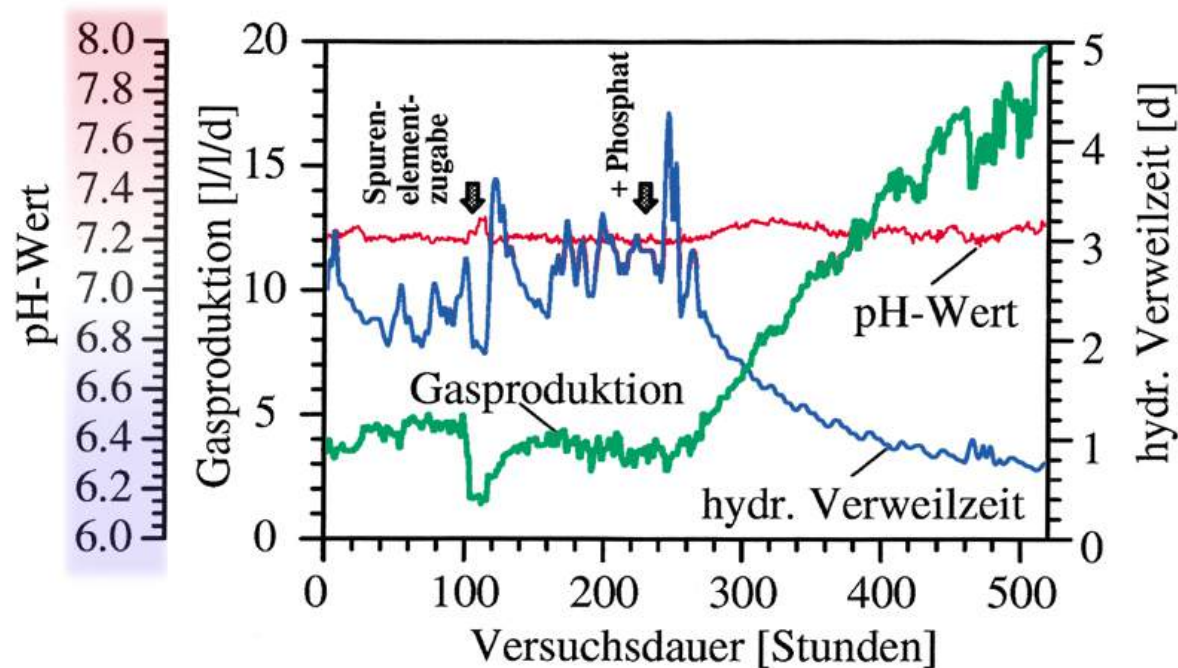
- Sugar cane as a new plant for high efficiency bioenergy production
- Yield 120 tons per hectar per year
- 28 MW electricity in an average sugar plant



## Design for a 28 MW CSTR dry fermentation plant in Brazil



## Micronutrient supplementation 1989



**Acinor 1000**

*0,8 l per day at 1 MW capacity  
Highly effective in minimum doses!*

### Micronutrient supplementation

- optimizes the biogas yield
- stabilizes the biological process and
- is indispensable for most substrates for dry and wet fermentation.



## Summary

- The mechanically mixed plug flow and CSTR dry fermentation systems
  - need small digester volumes and a small footprint
  - use high load fermentation
  - have very high viscosity in digester and need very special mixer
  - produce high biogas yields
- Dry fermentation systems are only useful for solid substrates like
  - Straw, press mud, energy crops and solid organic waste
  - not for manure and liquid waste like spent wash
- In comparison to wet fermentation systems they
  - need a much smaller digester volume
  - have a lower energy consumption for plant operation
  - need no or very low water for dilution



Thank you for your  
attention.

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