Interreg Baltic Sea Region
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BEST

HSB

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Efficient structures and practical experiences of Industrial Waste Water Treatment

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Content

- Introduction
- Structure of Industrial Waste Water Treatment
- Approved Technologies
- Evaluation of the costs for the treatment
- New developments

Introduction:
Goal of the industrial waste water treatment

- **Protection of the receiving waters**
  (surface water, groundwater)
- **Treatment before discharge**
- **Recycling of the waste water flow**
- **Recycling of valuables from the wastewater**
  e.g. raw material, nutrients, metals
- **Usage of the energy contented in the water**
  e.g. using resiudes from the treatment or the complete waste water

Examples of industrial plants near the Baltic sea

http://www.heatroadmap.eu/resources/HRE4_EHA_5_3%20to%2012.pdf

Main waste water components to be considered

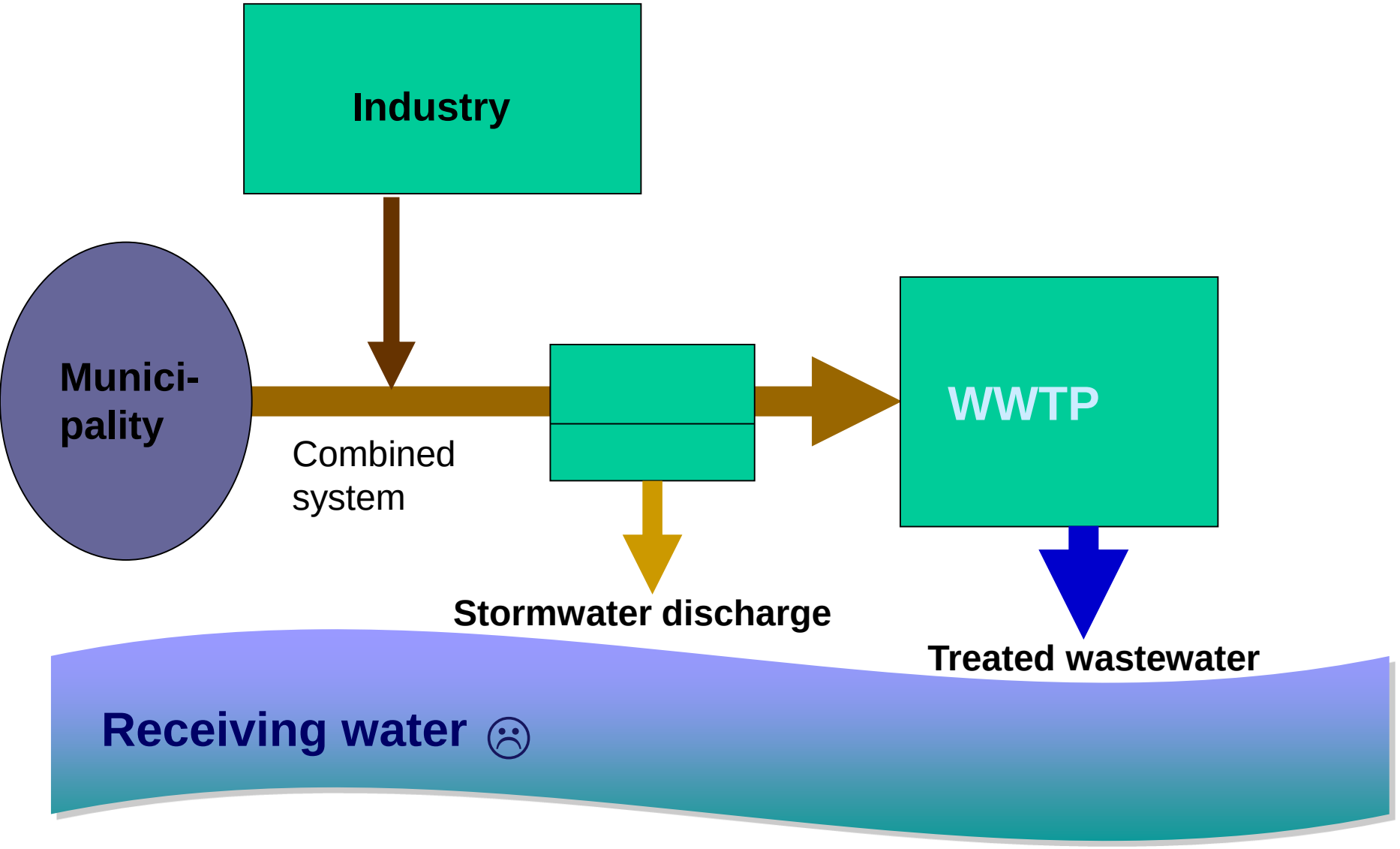
- **Particles**
  e.g. sand, stones, screws, bones, feathers
- **Organic compounds**
  biodegradable, non-biogedradable,
  measured in the sum as COD or BOD_5
- **Nutrients**
  nitrogen, phosphorous
- **Hazardous components**
  cyanide, arsen, phenol, chrome, mercury,
  organic compounds like aromatic hydrocarbones etc.
  - many thousands of parameters -

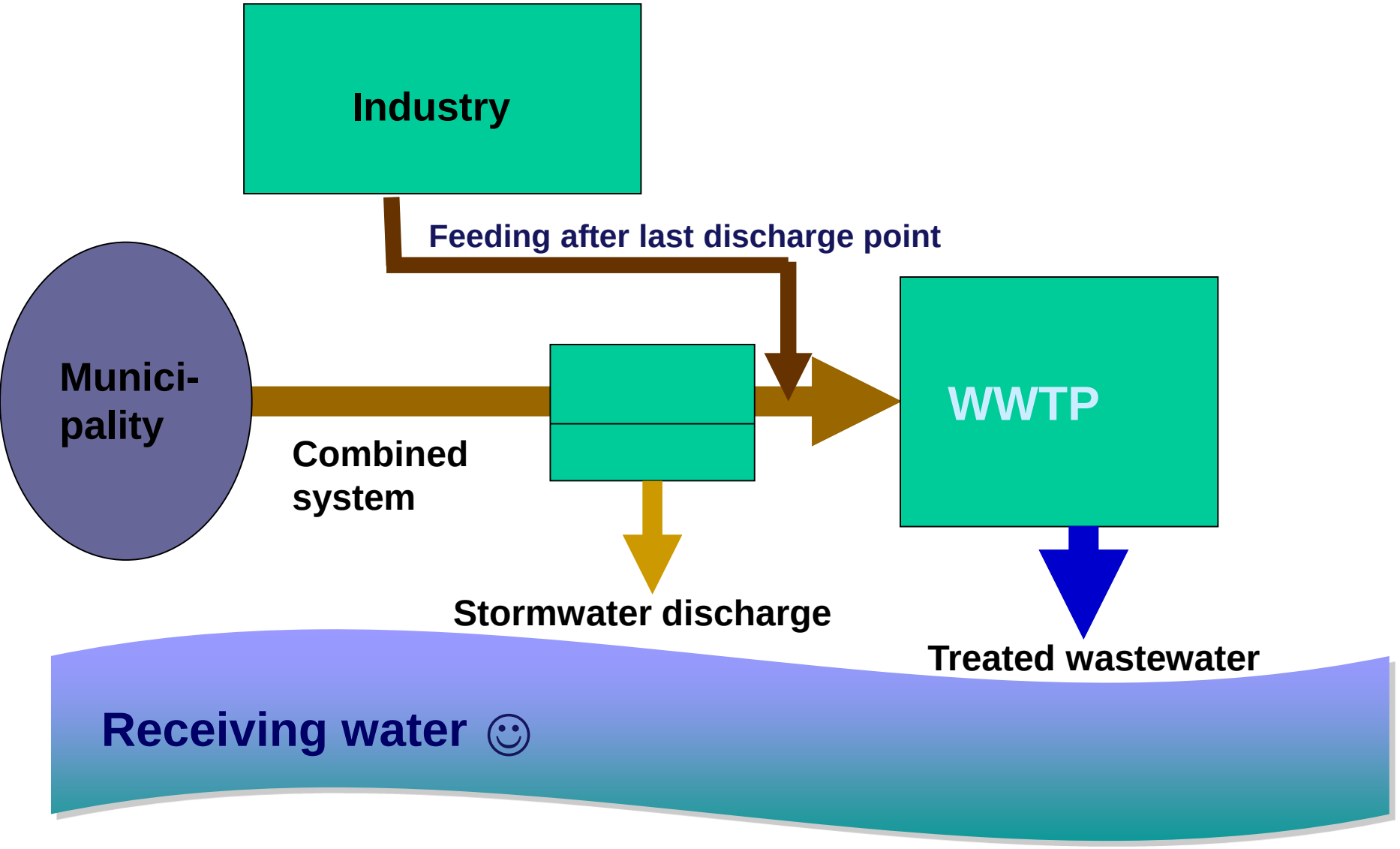
Structure of Industrial Waste Water Treatment

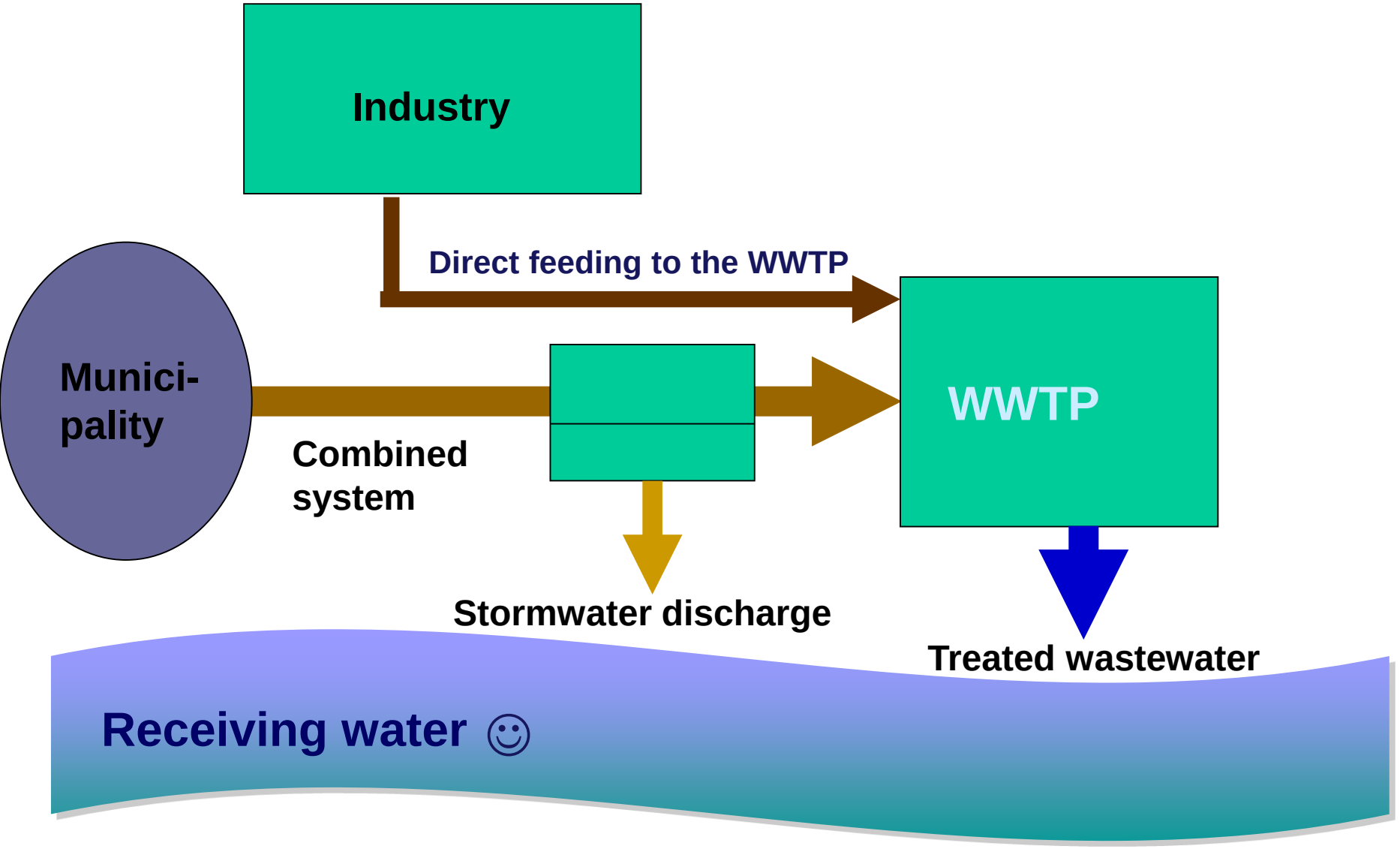
- Indirect discharge
- Direct discharge
- Internal Reuse

Structure of industrial waste water treatment

- **Indirect discharge**
  - The industrial wastewater will be discharged to the public sewer (if required after a pre-treatment)
  - Mixing with the municipal, commercial and other industrial wastewater streams
  - The treatment costs for the industrial waste water in the sewerage network and in the treatment plant have to be considered
  - The characteristic of the sewerage system has to be considered


Industry
Munici-pality
Combined system
WWTP
Stormwater discharge
Treated wastewater
Receiving water ☹


Industry
Feeding after last discharge point
Munici-pality
Combined system
WWTP
Stormwater discharge
Treated wastewater
Receiving water ☺


Industry
Direct feeding to the WWTP
Munici-pality
Combined system
WWTP
Stormwater discharge
Treated wastewater
Receiving water ☺

Control of the industries in the catchment area

- **Cadaster of indirect dischargers**
  with basic information and all measurements
- **Waste water sampling and analysing**
  standard sampling/ additional sampling
  - cost distribution to be agreed
- **Sewer biofilm control**
  in case of toxic parameters
  or sludge pollution problems
- **BREF (Best available techniques Reference Document)**
  detailed information about production processes and benchmarks for maximum allowed specific pollution

Structure of industrial waste water treatment

- **Direct discharge – Separate treatment**
  - **The industrial production wastewater will be discharged directly into a receiving water body**
  - **Significant dependency from the type of production (changes in production, seasonal impacts)**
  - **Evtl. unilateral composed wastewater**
    (evtl. dosage of nutrients required)
  - **The sensitivity of the receiving water may have significant impact to the requirements**

Example for direct discharge:

Woold Pulp Factory
Estonian Cell

Anaerobic Treatment

Aerobic Treatment

Structure of industrial waste water treatment

- **Internal Reuse – up to ZLD (Zero Liquid Discharge)**
  - No connecetion to the sewerage system
  - No discharge possibility
  - The waste water from the production will be reused in different qualitites in the factory
  - Significant dependency between production and the wastewater treatment
    (Start-up phase, problems in the production)
  - Only seldom realized because of high costs
  - Requirement in textile industries in India and Bangladesh (imo this makes no sense)

Industrial Wastewater treatment - closed water cycle in the fibre board production in Switzerland

Structure of Industrial Waste Water Treatment

- Collection of specific waste water in separate networks or in one area
- Specific treatment technology can be applied to that specific waste water

Olive processing waste water network in Pillas/ Spain

8 Tanneries are resettled from Damascus center into the Industrial Park Adra in Syria

Structure of Industrial Waste Water Treatment

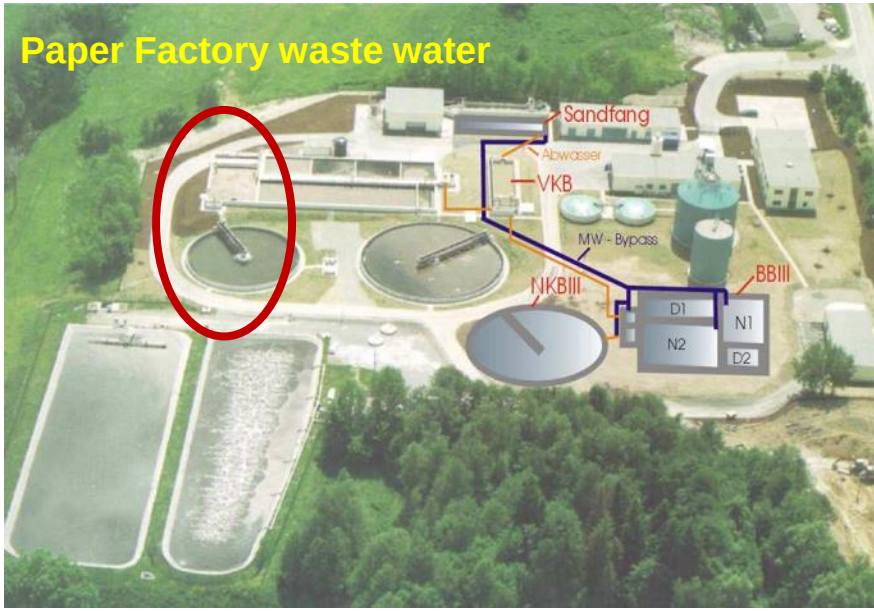
- Collection of several industries in Industrial parks
- Pre-treatment requirements have to be adjusted
  (e.g. not to collect only unbiodegradable wastewater)
- Treatment of organic residues to be considered

Industrial Park
HOECHST Frankfurt,
served by infraserv

Where is a pretreatment plant located?

- At the companies site
- On the municipal waste water treatment plant
- Separate location

Paper production waste water treated on the area of the municipal waste water treatment plant site



Who is operating the treatment facilities?

- Own staff of the company
- Experienced staff from the municipal waste water treatment plant
- Operation through a separate partner

BECKs pretreatment facilities operated by hansewasser Bremen

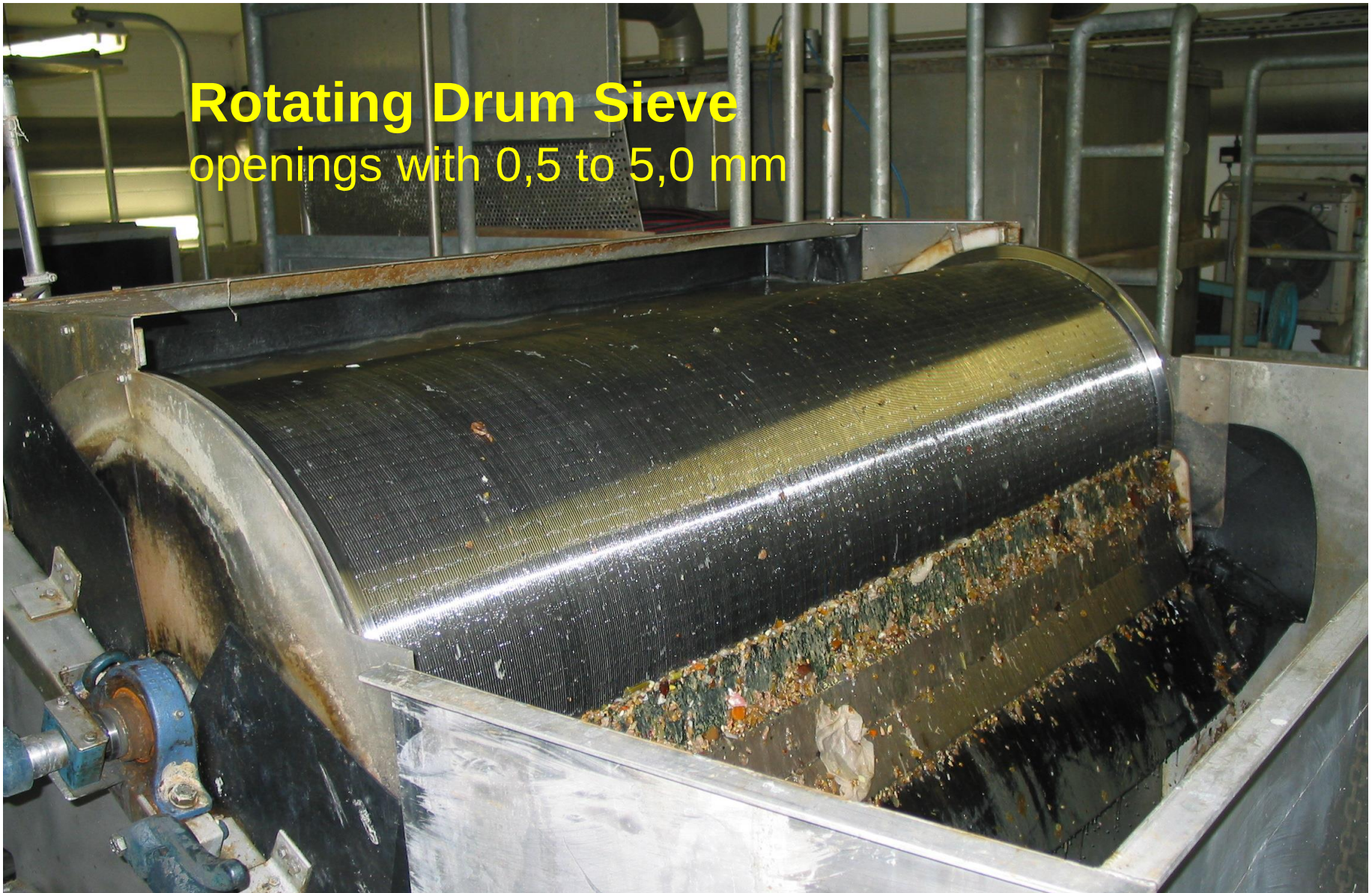
Technologies to be considered

- **Particles removal**
  sieves, sedimentation, filtration, membrane
- **Equalization of the flow**
  storage tanks (mixing, equalization, pre-degradation)
- **Organic compounds degradation**
  aerobic or anaerobic biological systems,
  suspended biomass/ biofilm systems/ pellets
- **Nutrients removal**
  with biological treatment or with precipitation
- **Hazardous components separation/ elimination**
  biological treatment, oxydation H_2O_2/ Ozone etc.,
  membrane treatment for separation

Approved Technologies

mechanical-physical	physical-chemical	physical-biological	biological
screen, sieve	neutralisation	Mixing and equalization with biological partial de-gradation	aerobic
filtration	precipitation		anaerobic
sedimentation	emulsion cracking		suspended biomass
flotation	flotation with flocculants		fixed film
centrifugation	in cineration		
adsorption	wet oxidation		
evaporation			
equalization			
mixing			

and combinations of the technologies


Rotating Drum Sieve
openings with 0,5 to 5,0 mm

Rotating Drum Sieve in chicken factory

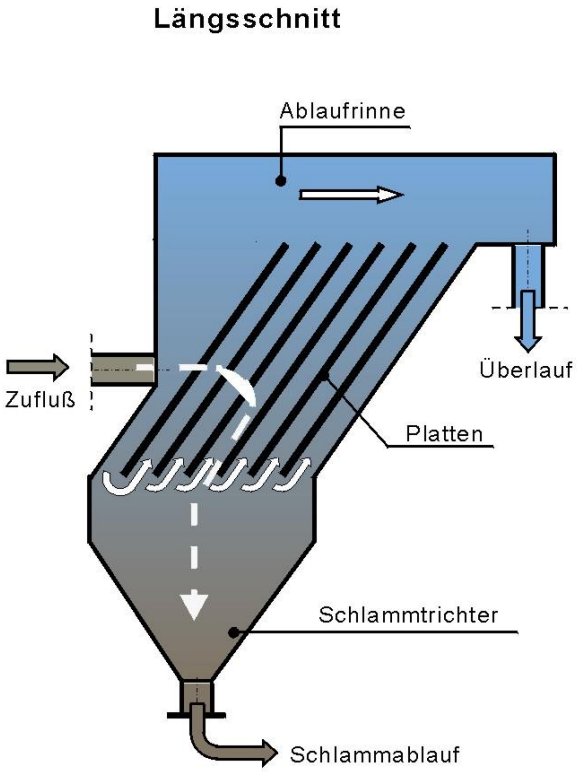
Screen in chicken factory

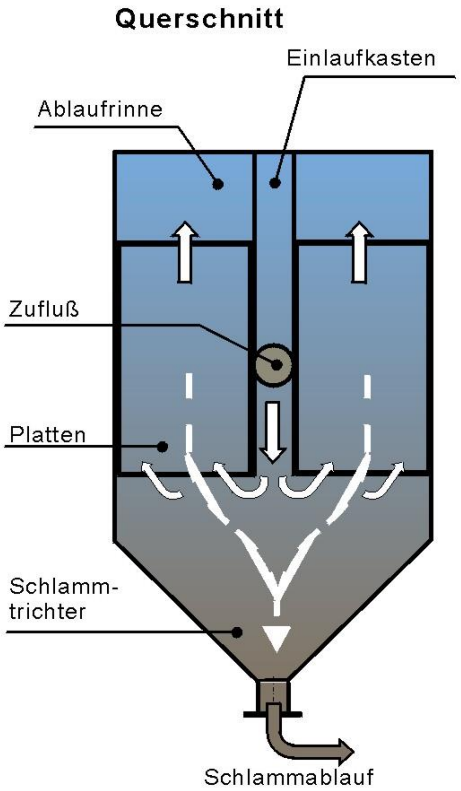
Sedimentation tank (United Sugar Stach factory, India)

Lamella separator for effective sedimentation

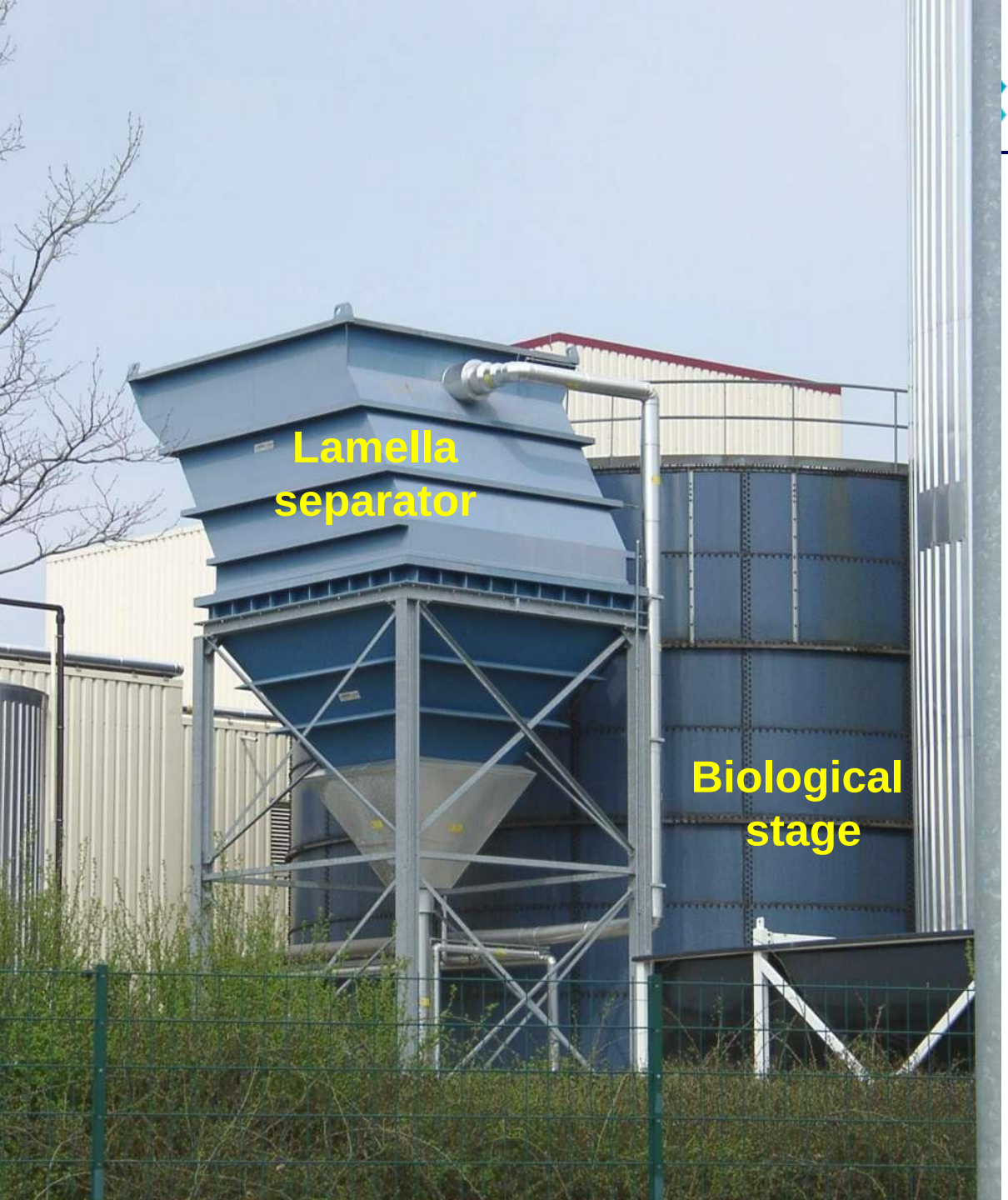
only 1/8 of the area compared with sedimentation required

Foto: Axel Johnson Engineering





Compact sedimentation with three Lamella Separators



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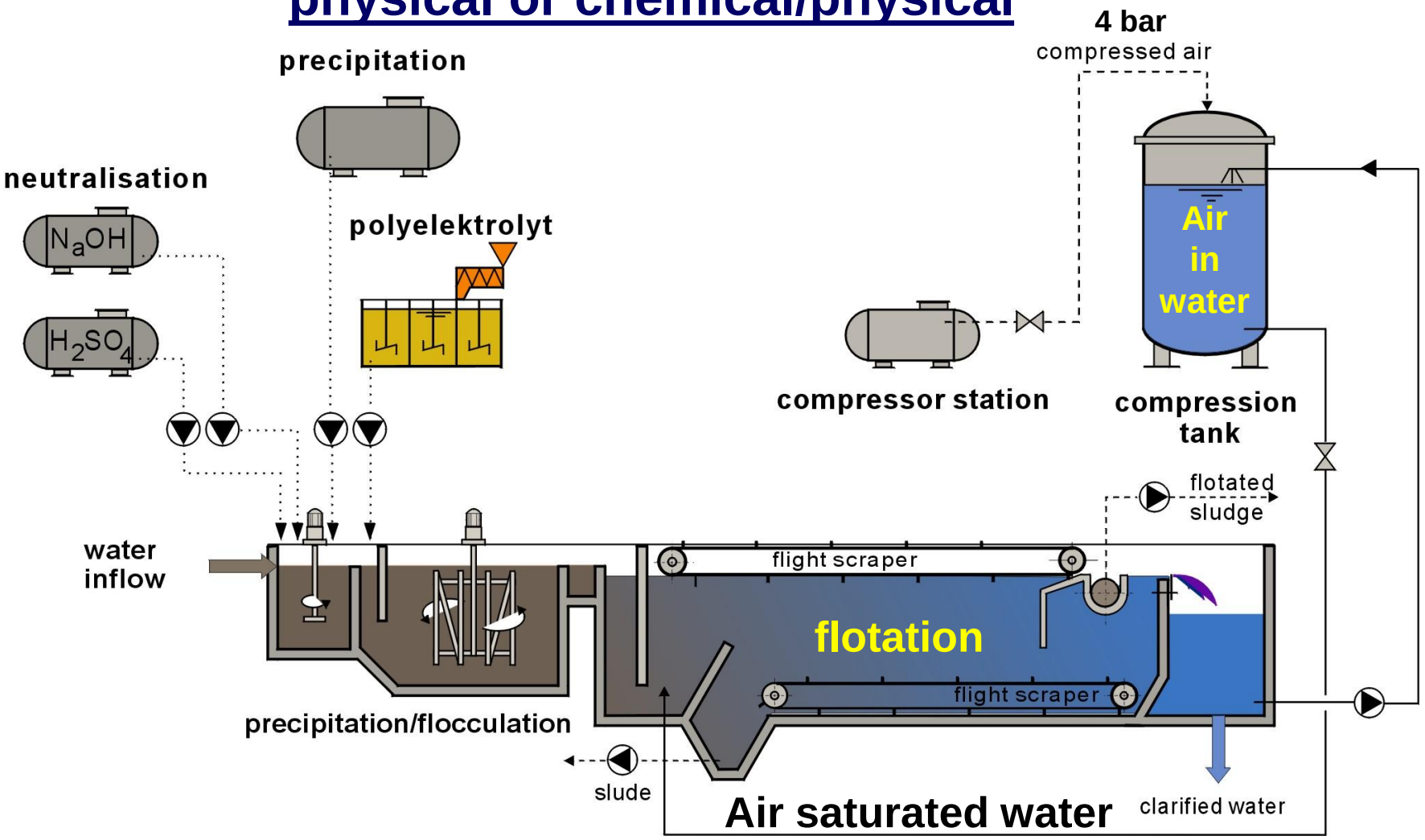
Lamella separator

used for sludge sedimentation in a biological stage of fish farming waste water treatment plant (instead of a final clarifier)

Caviar production
Jessen/ Germany

To remove floating particles – Flotation

physical or chemical/physical



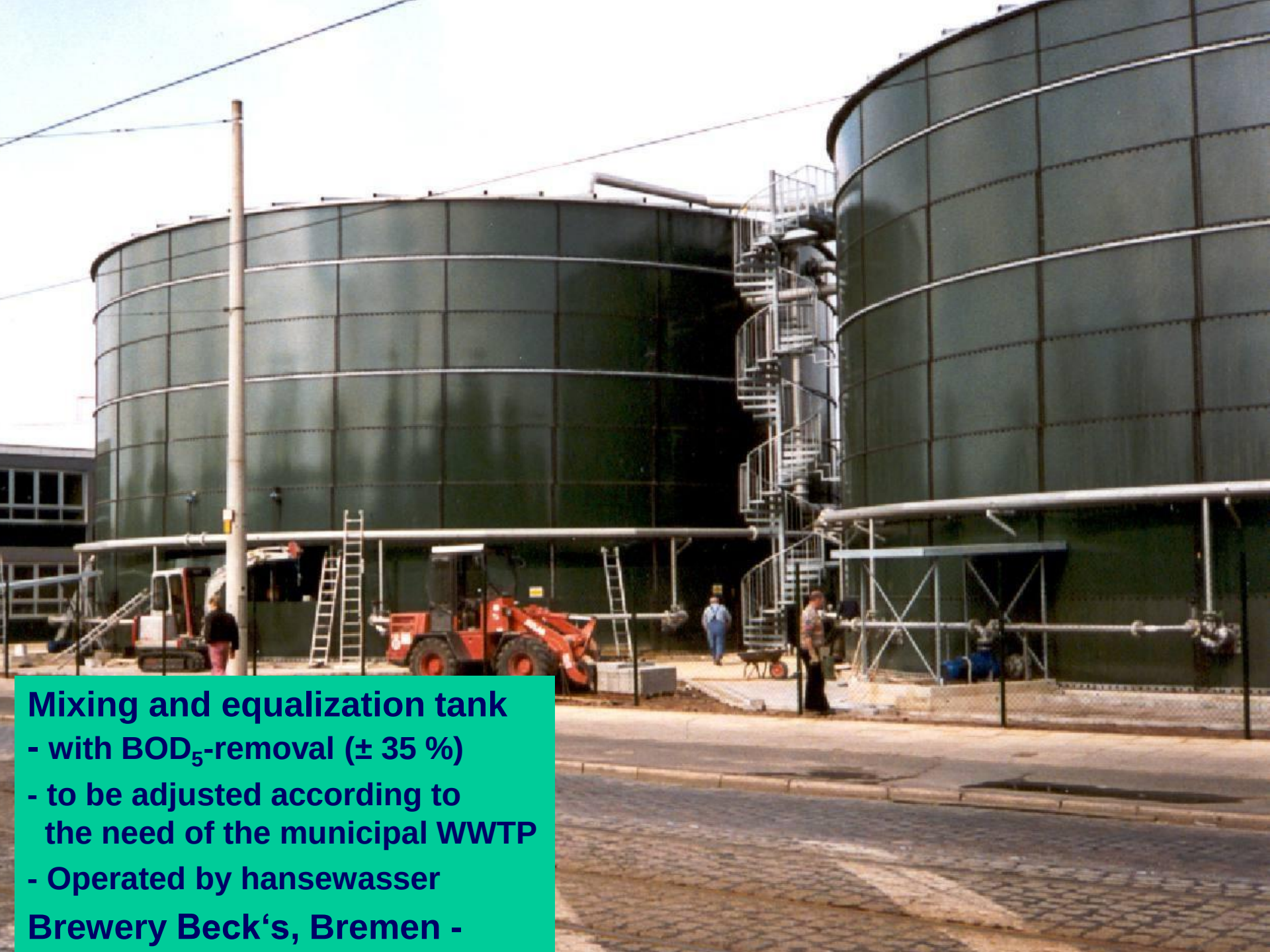
Flotation for the pre-treatment of meat processing wastewater

- Biological Pre-Treatment -

Indirect discharge of Pre-treated waste water from choclate factory (Kalev/ Estonia)

Costs for the indirect discharge – example -

Pollution class	1	2	3	4	5	6	7	8
BOD_5 (mg/l)	0 - 750			751 - 975	976 – 1,125	1,126 – 1,500	1,501 – 2,250	2,251 – 3,000



Mixing and equalization tank

- **with BOD_5-removal (± 35 %)**
- **to be adjusted according to the need of the municipal WWTP**
- **Operated by hansewasser**

Brewery Beck‘s, Bremen -

Mixing and equalization tank

- Brewery Lich -

Mixing and equalization with biological activity
(BOD_5 efficiency 25 – 65 %)

Activated Sludge Plant - Plant can be shifted to an other location

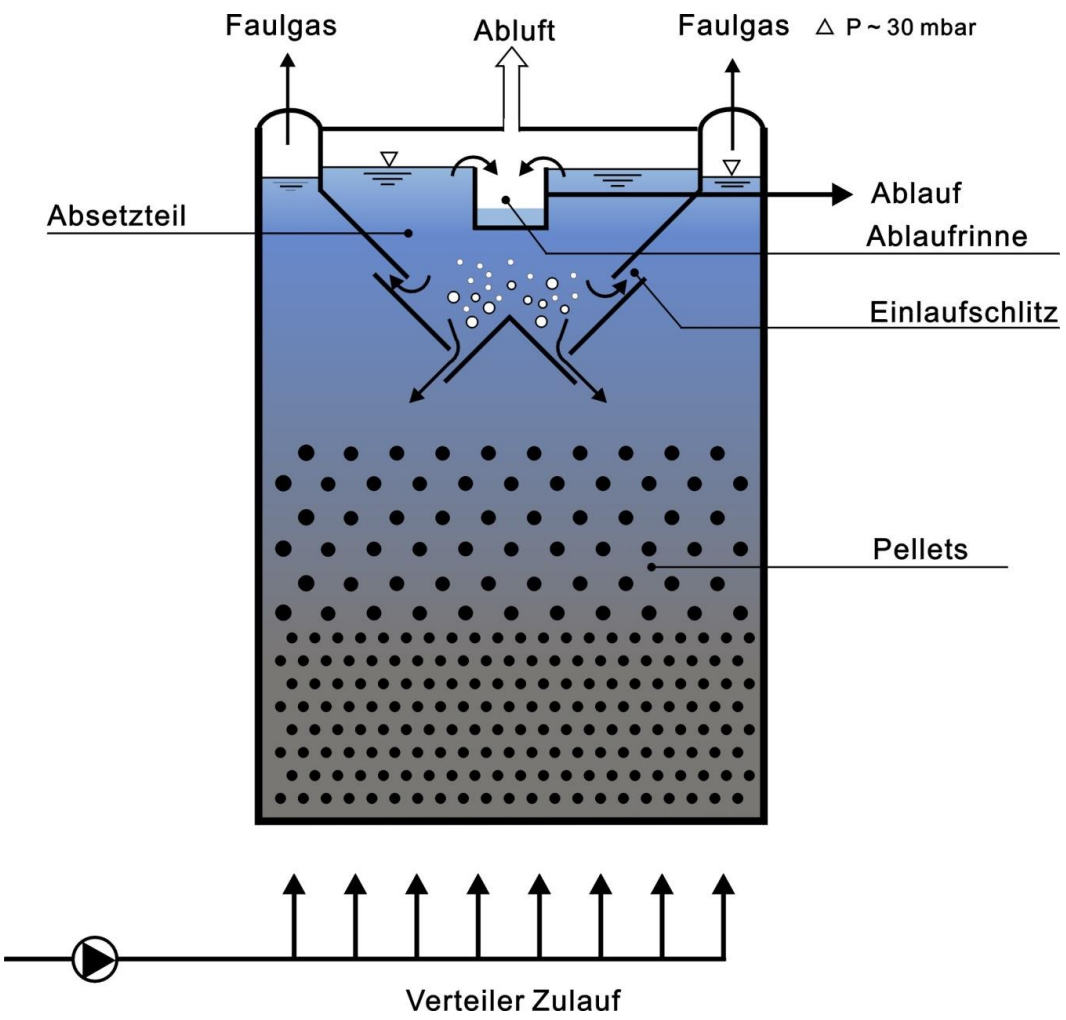
Industrial waste water treatment for fruit juice processing

Biofilm technology

Treatment of paper waste water with aerobic fixed film

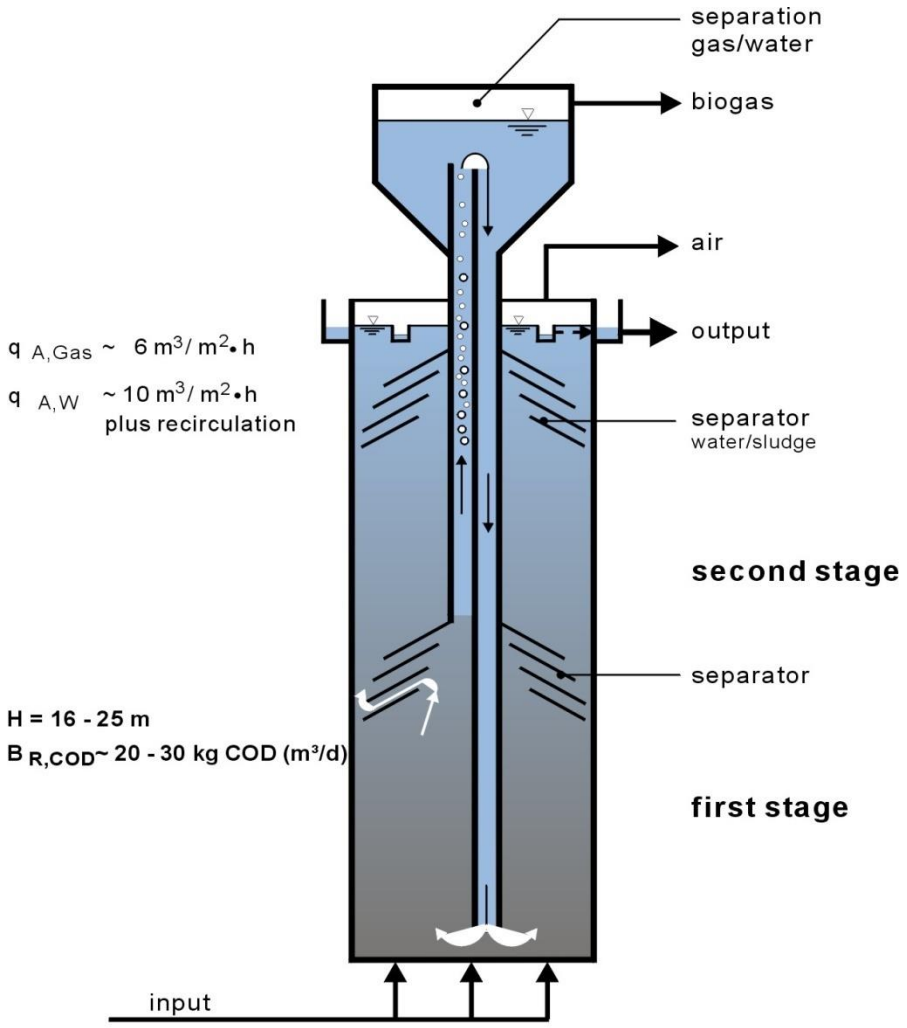
Anaerobic high loaded reactor

- fruit juice production -

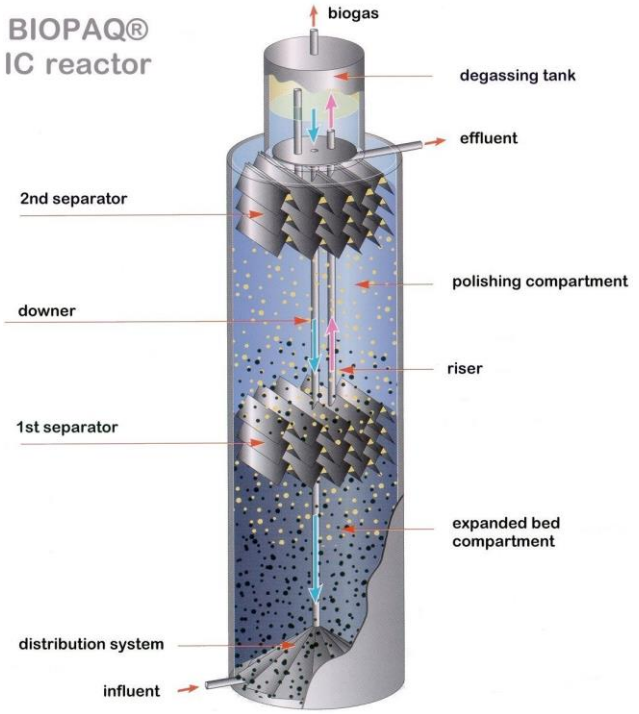


UASB-Reaktor for anaerobic waste water treatment

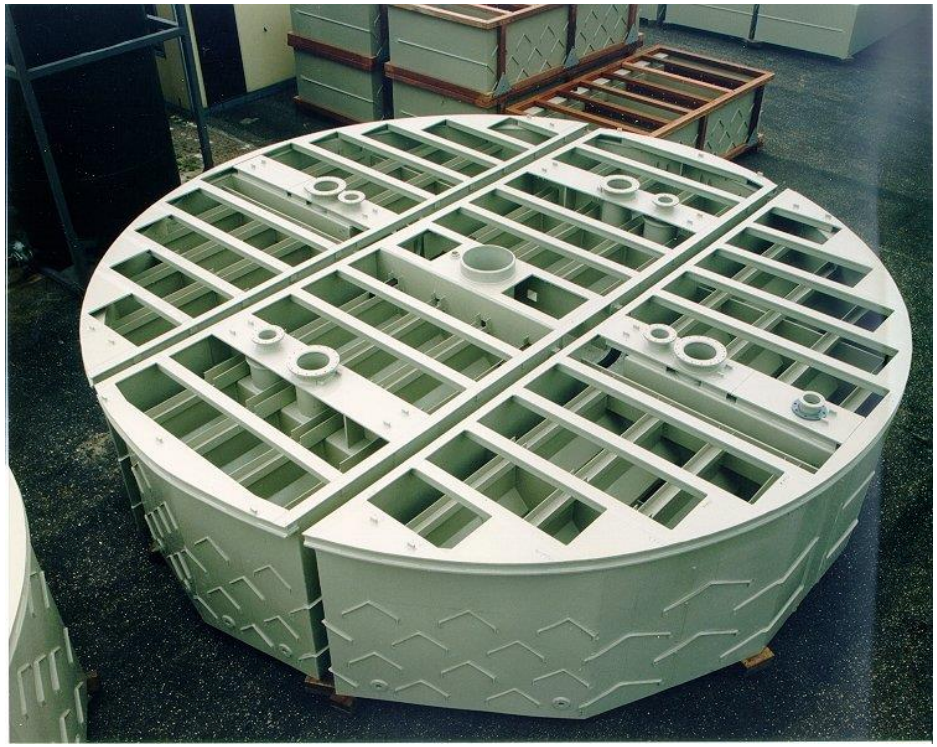
Upflow
Aanaerobic
Sludge
Blanket



reactor with integrated recirculation



Many different types of anaerobic reactors



Head of an Anaerobic reactor
(to separate biogas, sludge and water)

Anaerobic Diary wastewater treatment

Distillery with anaerobic treatment

Hannover/ Germany

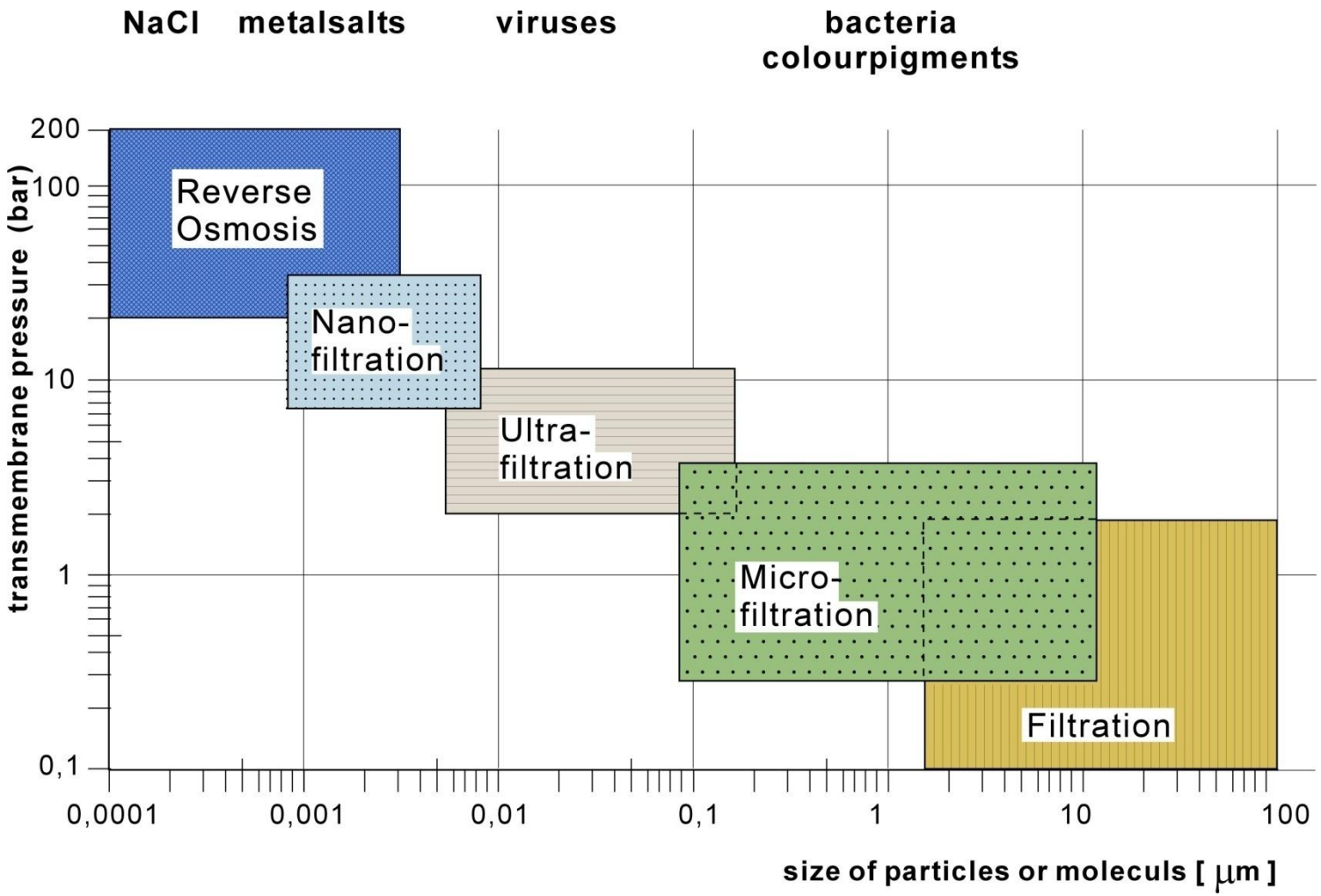

Wieninger Rupert Weizen.
Erfrischung pur!
WIENINGER BIER

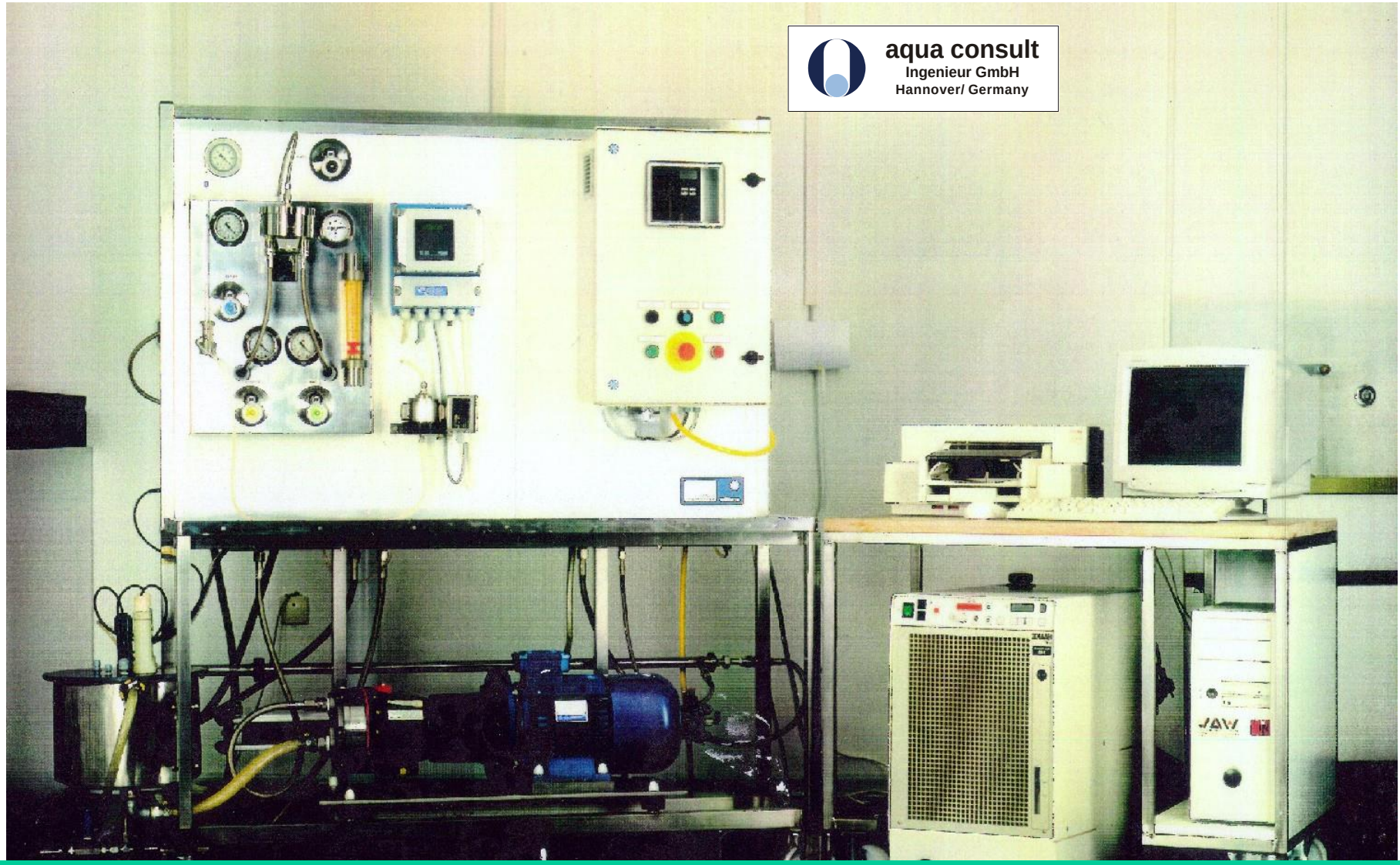
Anaerobic Treatment of brewery wastewater (UASB), inner-city

Anaerobic brewery waste water treatment in China


Methane is released
free to athmosphere
- no energy usage ☹
- strong air pollution ☹

Membrane technology





Membrane Test Plant for chosing effective membranes

Zero Liquid Discharge – closed water cycle using two-stage reverse Osmosis

Sludge treatment

- **Waste water treatment = production of sludge**
- **Sludge fractions might be reused (e.g. flotate in paper factories)**
- **Sludge residues from biogas plants – What to do?**
  (in Germany 7,500 biogas plants)
- **Thermal hydrolysis as conditioning before digestion**
  (to improve the performance and to replace chemicals)

Borregrad paper factory, Saspsborg/ Norway

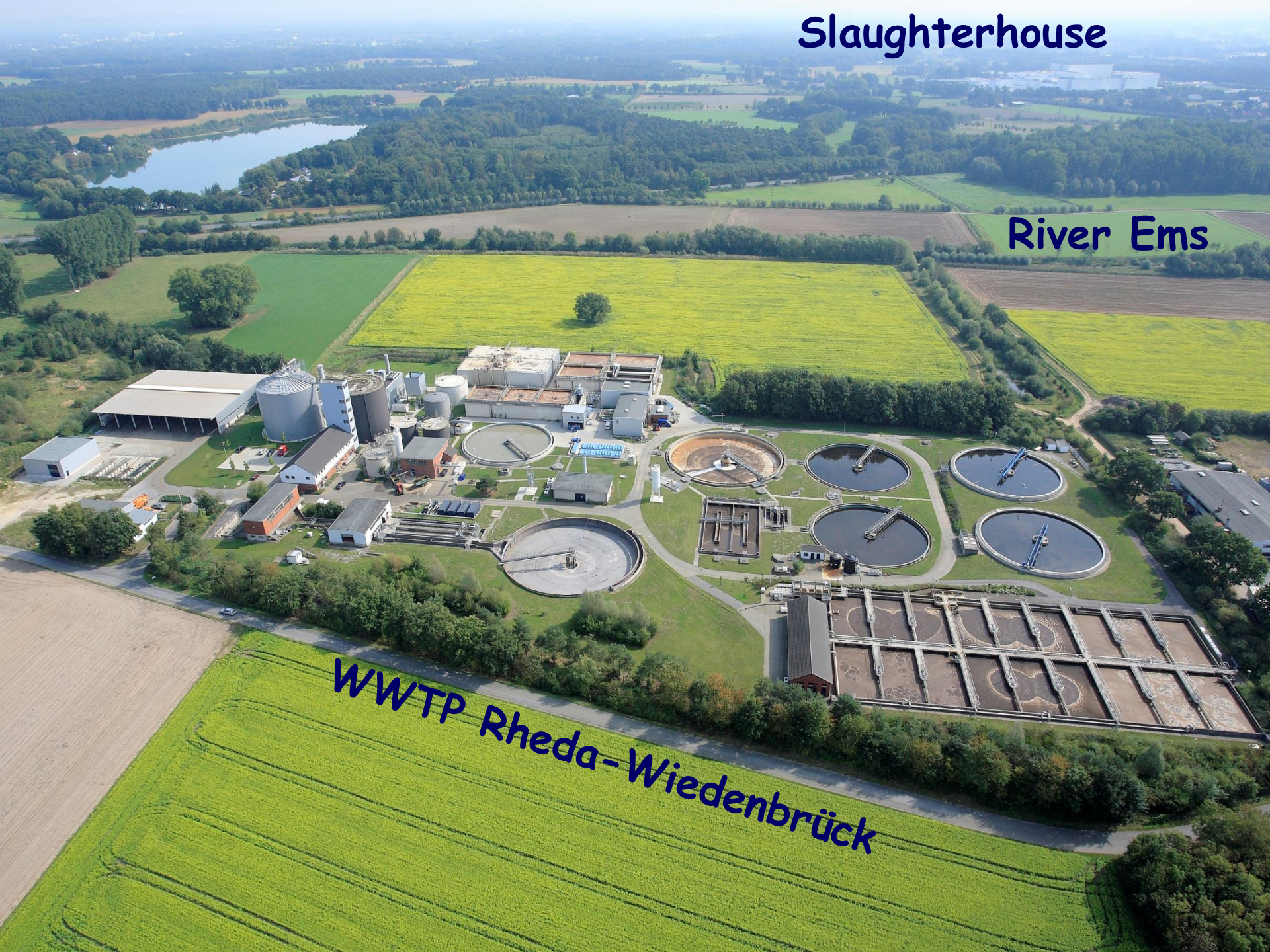
Co-Fermentation of organic residues with municipal sewage sludge

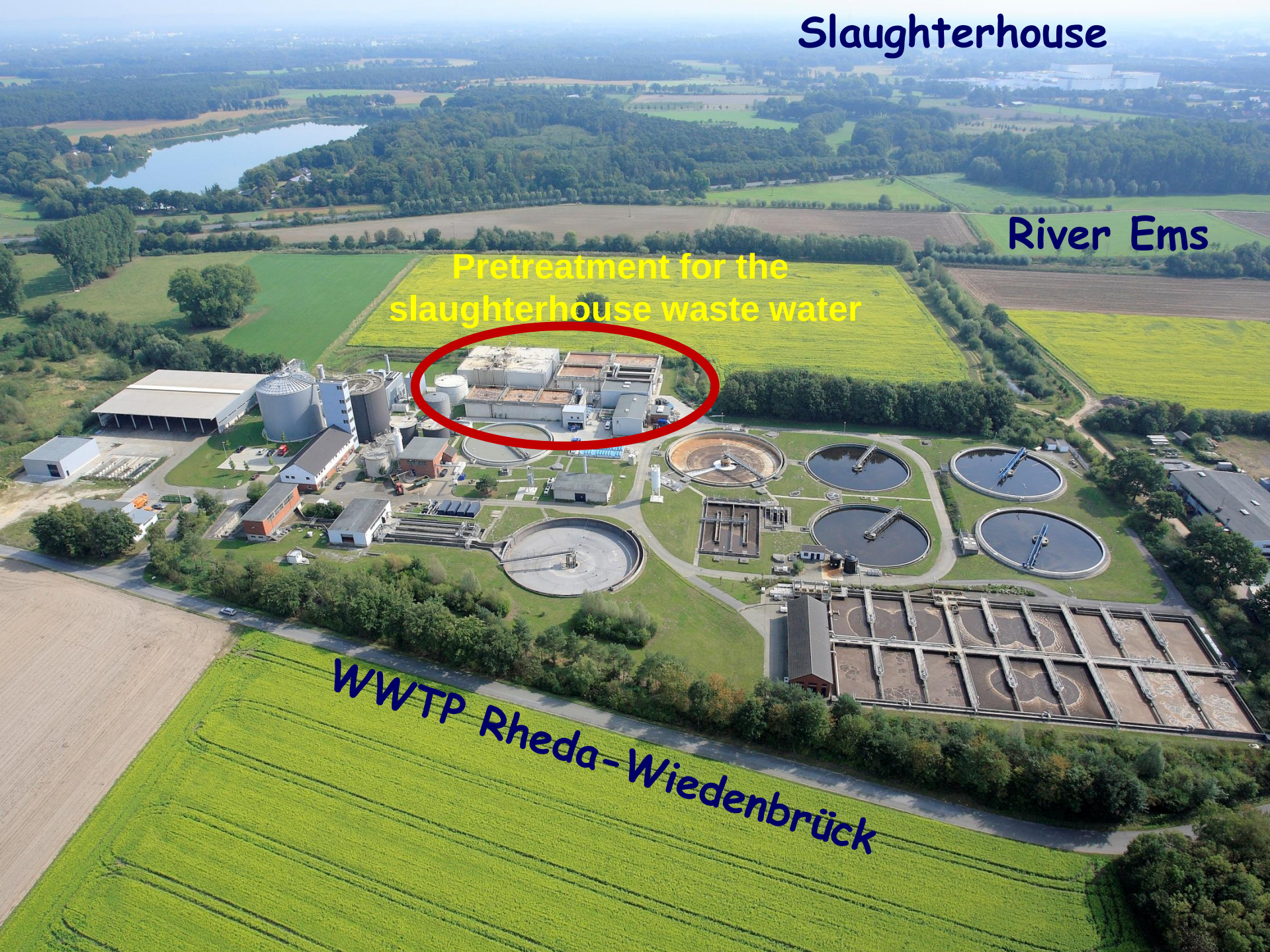
- Solution for the treatment of organic residues
- Equalization of the co-substrate characteristic through the (slowly) sewage sludge
- Higher efficiency of municipal digesters
  (up to 2,5 m^3 biogas per m^3 reactor volume
  instead of only 0,5 for municipal digesters)
- Energy autarkic operation of a municipal waste water treatment plant is possible

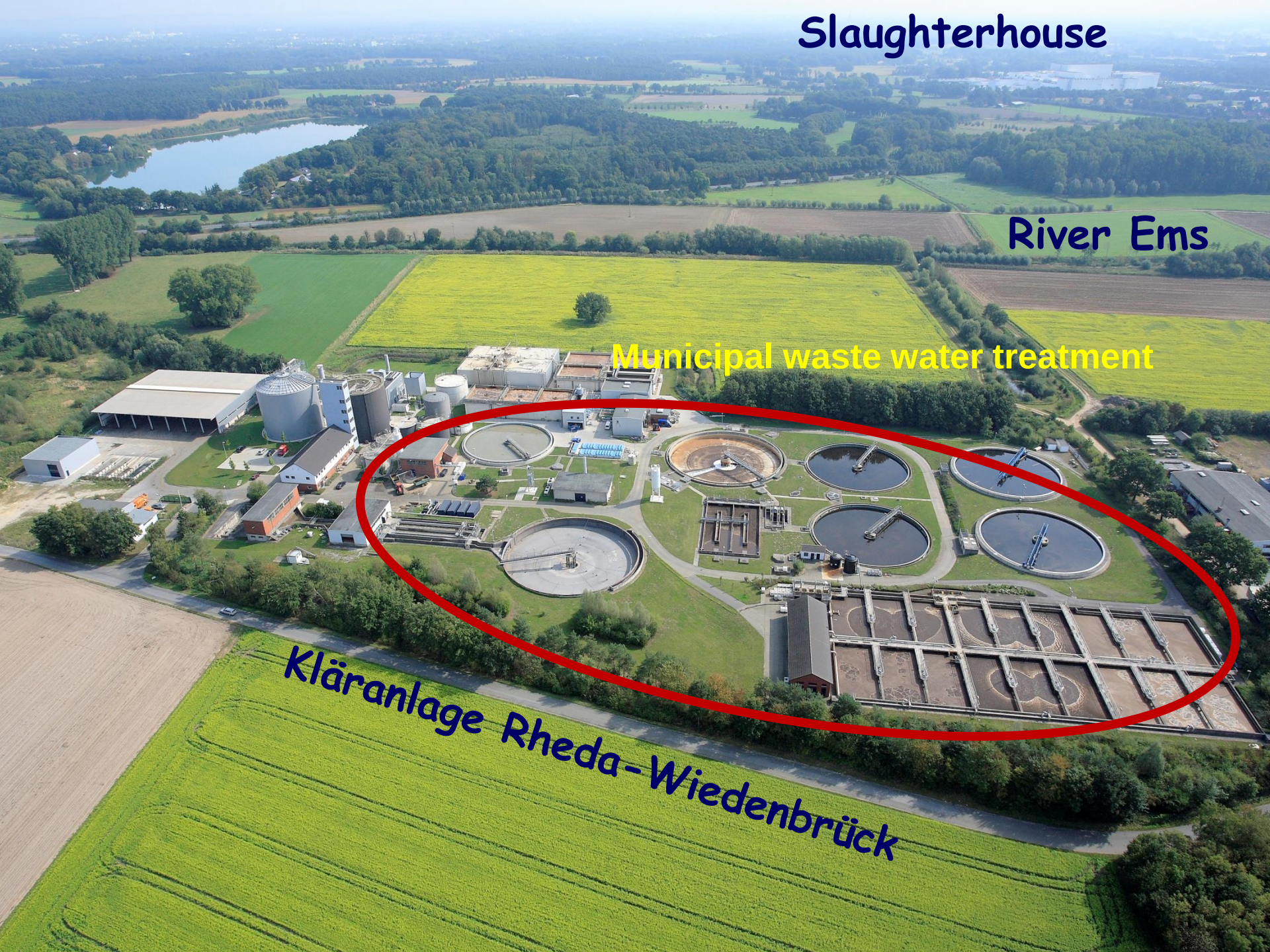
Example for Co-Fermentation

WWTP Rheda-Wiedenbrück

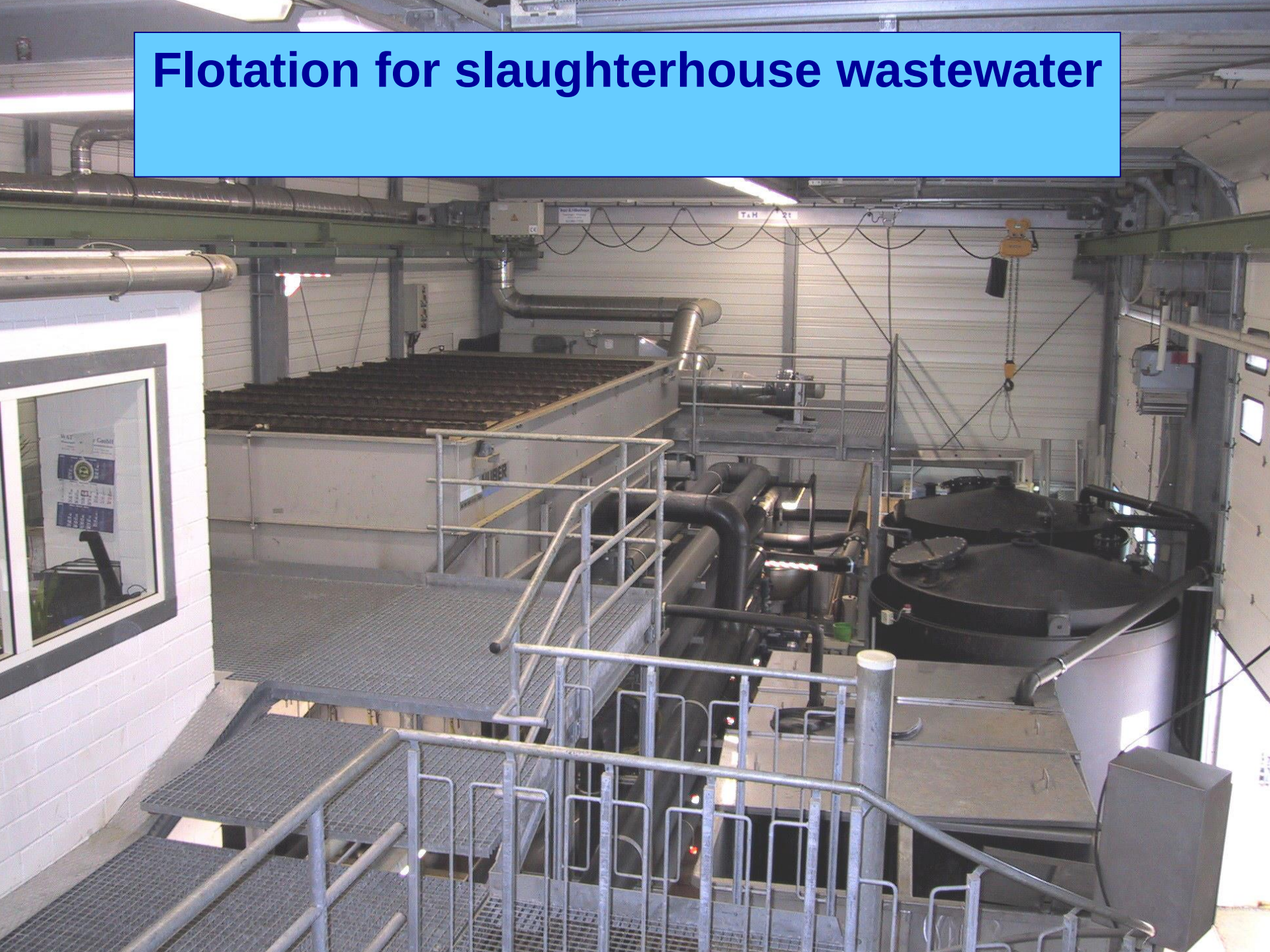
Slaughterhouse (capacity 30,000 pigs per day)

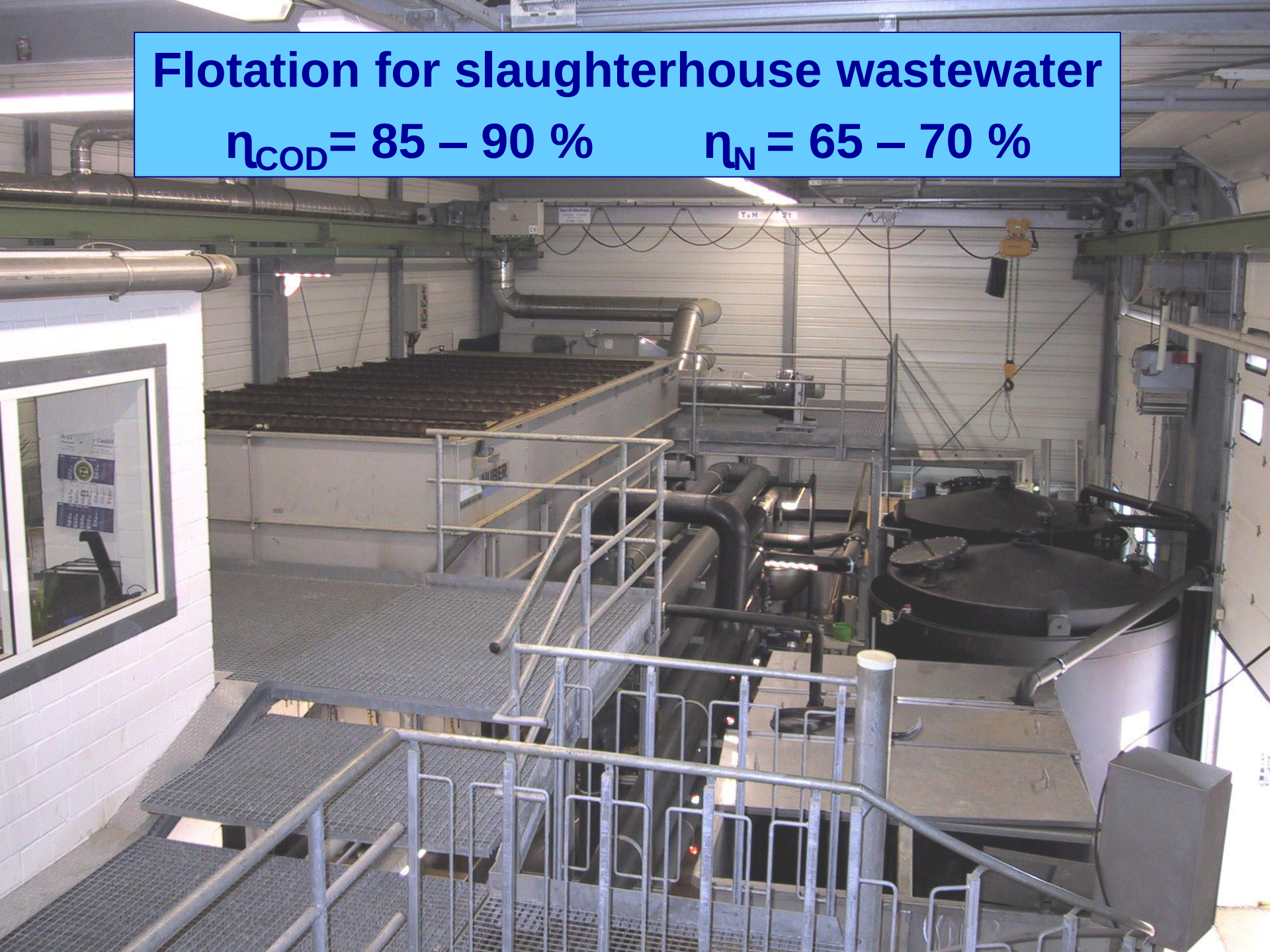

Slaughterhouse
River Ems
WWTP Rheda-Wiedenbrück

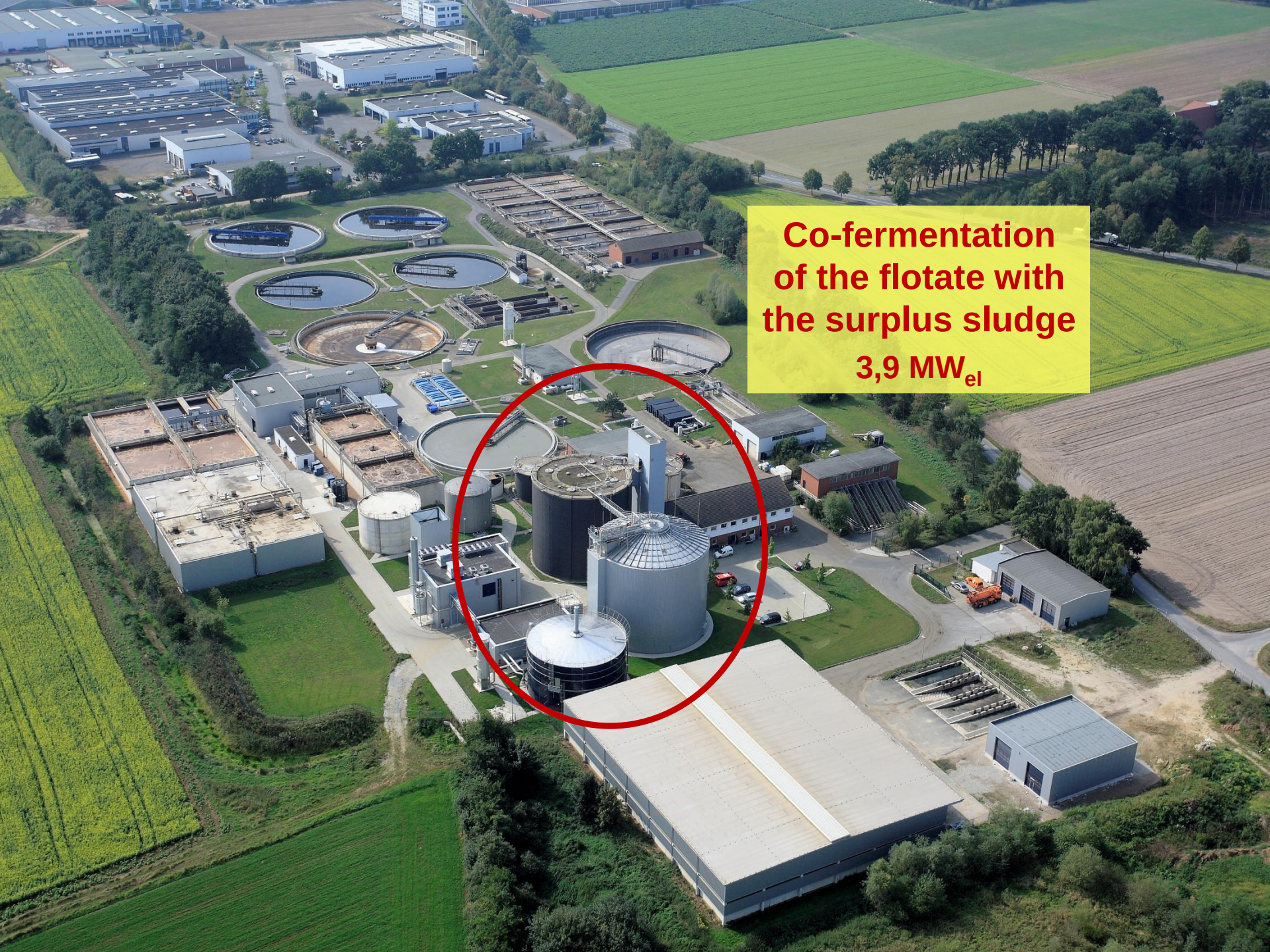

Slaughterhouse
River Ems
Pretreatment for the slaughterhouse waste water
WWTP Rheda-Wiedenbrück


Slaughterhouse
River Ems
Municipal waste water treatment
Kläranlage Rheda-Wiedenbrück

Flotation for slaughterhouse wastewater




Flotation for slaughterhouse wastewater
η_{COD}= 85 – 90 %
η_N = 65 – 70 %


Co-fermentation
of the flotate with
the surplus sludge
3,9 MW$_{el}$

Anaerob Pilot Plant


Anaerobic pilot plant
Reactor volume 4 x 80 l

Co-Fermentation of residues from Penicillin production and seage sludge (NCPC/ China) 华北制药项目的消化罐施工

Evaluation of the costs of the treatment

- **Invest and running costs**
- **Not to forget the sludge treatment costs**
- **Costs for combined treatment/ indirect discharge**
  - **evaluation according to usage of the facilities**
  - **relevant Parameter** **Q, COD/ BOD_5, N, P, SS**
- **Industrial waste water might be more or less expensive like municipal waste water**

Result of detailed cost calculation

Complete running costs considering financing and operation for 9 cities in Germany

Cost Splitting for waste water treatment plants in components

Parameter	Unit	R	I	W	H	W	Z	B	K	B	Aver-age
Capacity	PE	30.000	40.000	60.000	60.000	70.000	25.000	40.000	10.000	45.000	
Q	€ / m³	0,40	0,48	0,24	0,19	0,18	0,37	0,42	0,32	0,21	0,31
CSB	€ / kg	0,34	0,33	0,50	0,39	0,29	0,34	0,52	0,46	0,41	0,40
N_{ges}	€ / kg	4,65	3,91	3,74	1,32	1,82	3,15	4,18	4,10	2,31	3,24
P_{ges}	€ / kg	6,51	6,29	13,16	8,76	8,69	6,72	40,63	10,69	9,33	12,31
SS	€ / kg	0,14	0,05		0,85		0,69		0,61	0,53	0,48

New developments

- **Anaerobic treatment followed by full stream deammonification – solving the N-problem**
  (Example: Yeast factory waste water)
- **Deammonification:** NH_4-N ⟶ N_2
- **Organic content can be used for biogas production**
- **No problem with denitrification**

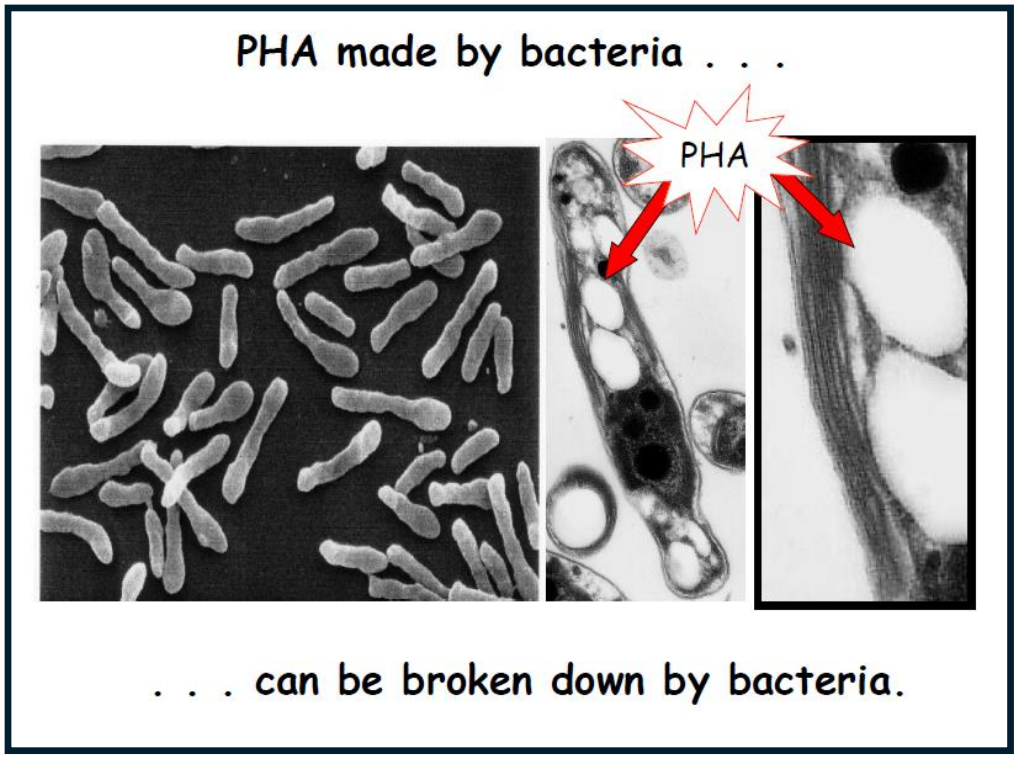
Yeast factory Schwarzenbach/ Germany

New developments

- Using aerobic granulars to reduce the footprint for biological treatment
- Perfect settling behavior
- Higher concentrations support the granular building

New developments

- **Production of Bioplastics from sewage**
  (Reserach projects under execution)



New developments

- Anaerobic treatment followed by full stream deammonification – solving the N-problem
  (Example: Yeast factory waste water)
- Using aerobic granulars to reduce the footprint for biological treatment
- Production of Bioplastics from sewage
  (Reserach projects under execution)
- **Zero Liquid Discharge … were is makes sense**
  (.. where it makes sense only!)
- **Co-fermentation of organic residues from industries – large scale application**

Conclusion

- **Technologies**
  for the treatment of all industrial waste waters are available, up to Zero Liquid Discharge
- **Most efficient solution**
  can be found with experience from planing, realization and operation
- **Realization of projects**
  mainly related to requirements from legal side, or/ and the economy through recycling (valuables, energy)
- **BEST (Best efficiency for Industrial Sewage treatment)**
  So it has just to be found the BEST solution …