
Anaerobic Digestion Options for Industrial Wastewater

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Industrial Wastewater Treatment
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Anaerobic Digestion : why?

- ...“Anaerobic Digestion is now the most cost and space-effective method available for bulk COD reduction in a wide range of biodegradable effluents and wastes”
- ...“Anaerobic Digestion is the most environmentally sustainable method of effluent treatment”
- ...“Anaerobic Digestion produces renewable energy in the form of methane-containing biogas”



Biothane Products and Services

- **Anaerobic**
 - **Biothane[®] UASB**
 - **Biobed[®] EGSB**
 - **Biobed[®] MP**
 - Biobulk[®] Contact
 - SEAD and mcSEAD

- **Aerobic**
 - Aerothane[®] Flash aeration
 - Activated sludge (oxidation ditch, SBR, etc)

- **General**
 - Biopuric[®] (sulphur removal from biogas)
 - Biogas handling equipment
 - Biomass & nutrients
 - Full in-house analysis, laboratory and pilot test facilities

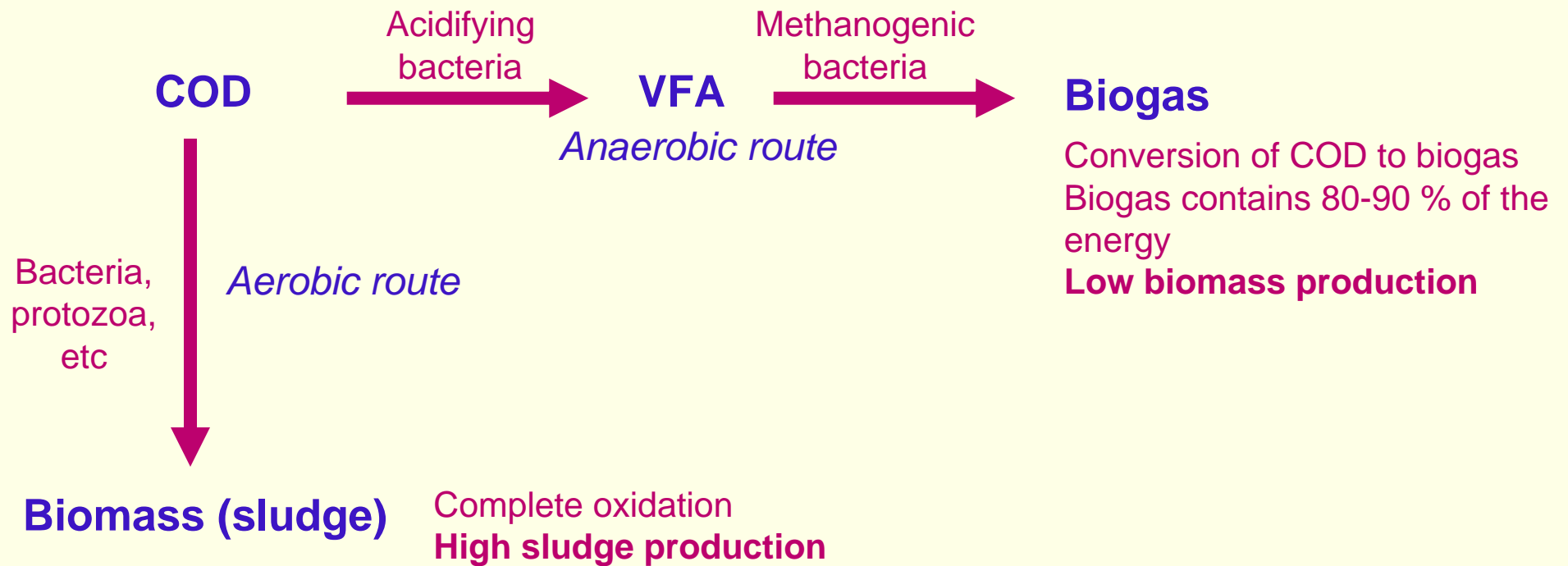


Wastewater treatment : COD removal

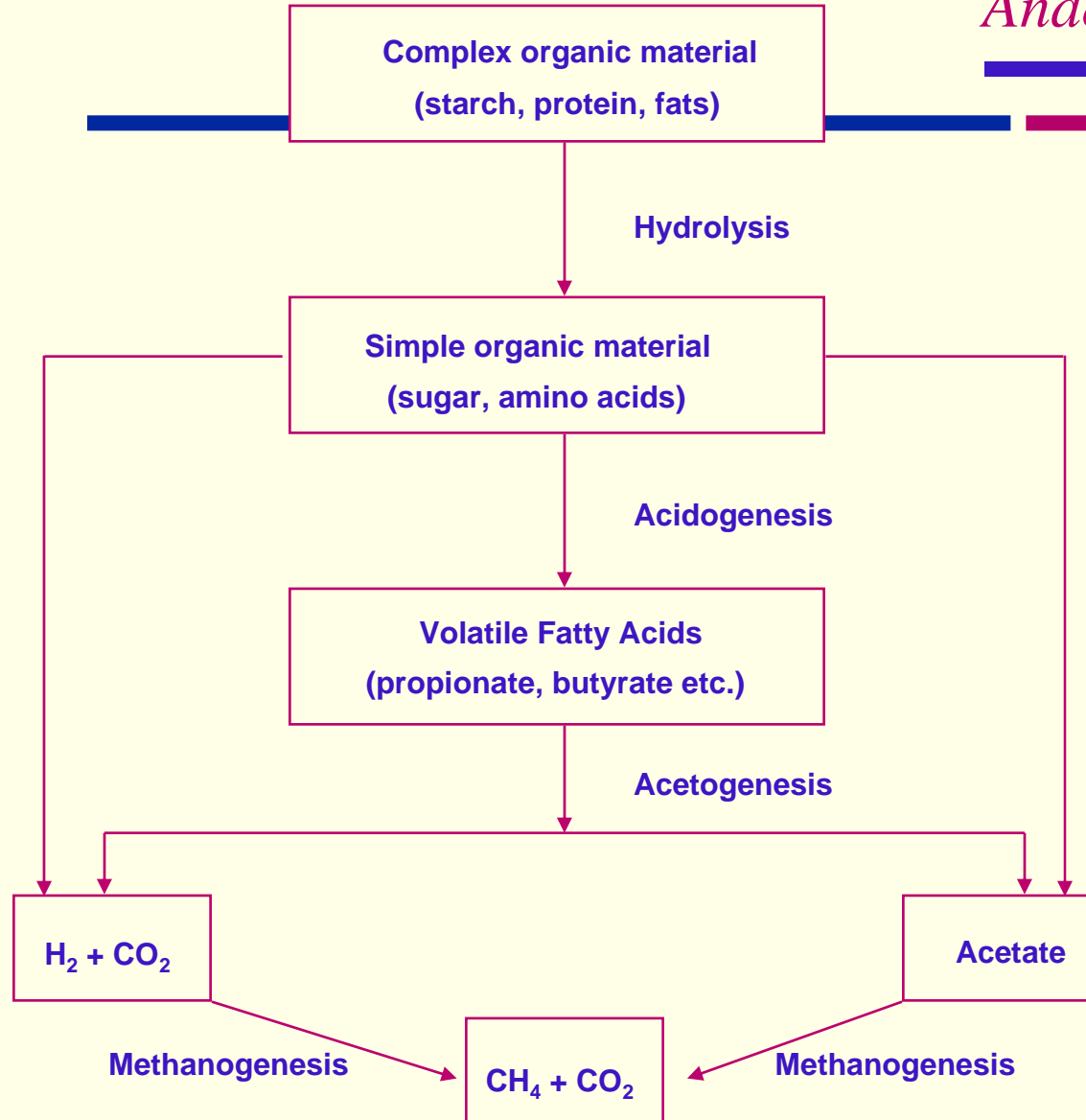
- **Organic components in wastewater can (normally) be quantified with COD (Chemical Oxygen Demand) measurement**
- **Two possibilities for removal of COD by means of biological wastewater treatment:**
 - **Aerobic** conversion to Carbon Dioxide and Biomass
 - **Anaerobic** conversion to Carbon Dioxide and Biogas



Anaerobic vs. Aerobic



Anaerobic degradation route



Anaerobic vs. Aerobic

	Anaerobic	Aerobic
Energy consumption	<ul style="list-style-type: none">• Low (normally net production)<ul style="list-style-type: none">• Biogas production• 0.07-0.1 kWh/kg COD	<ul style="list-style-type: none">• High<ul style="list-style-type: none">• Air input• 0.7-1 kWh/kg COD
Sludge production	<ul style="list-style-type: none">• Low<ul style="list-style-type: none">• 0.03-0.1 kg/kg COD• Value	<ul style="list-style-type: none">• High<ul style="list-style-type: none">• 0.2-0.6 kg/kg COD• Disposal costs
Land area required	<ul style="list-style-type: none">• Low<ul style="list-style-type: none">• Compact installation	<ul style="list-style-type: none">• High<ul style="list-style-type: none">• large surface area



Anaerobic Digestion : summary

- **Low OPEX (low energy and nutrients consumption)**
- **Low biomass production, biomass can be stored for long period of time (can be many years, but normally 1 - 2 years)**
- **Production of energy-rich biogas**
- **Low maintenance (limited amount of rotating equipment, use of long life materials)**
- **Compact structures, hence low surface area requirements**
- **Can be operated on/off, even on weekly cycle**



Anaerobic Digestion : basics

- **Particularly good at breaking down complex organics**
- **Most cost-effective method for bulk COD reduction on a wide range of Industrial Wastewaters**
- **Invariably used as a pre-treatment process**
 - 70 - 95% COD removal (BOD 80 - 95%)
 - No N and P removal
 - Sulphide formation
- **Relatively high process temperatures 25 - 37 °C**
- **COD of raw wastewater > 1,500 mg/l**
- **Exceptions prove the rule!**



Anaerobic Digestion : conclusions

- **Most suited to warm, medium to high-strength wastewaters**
 - sewage treatment in warmer climates
 - Industrial Wastewater Treatment, primarily in the Food and Beverage, Paper and Organic Chemical Industries.
- **High-rate systems rely on granulated sludge**
 - Rate limiting factors are maximum biomass specific methane generation rate and biomass concentration.
- **Drivers:**
 - maximum benefit out of the Capex leads to...
 - process intensification and...
 - development of higher rate systems with smaller footprint.

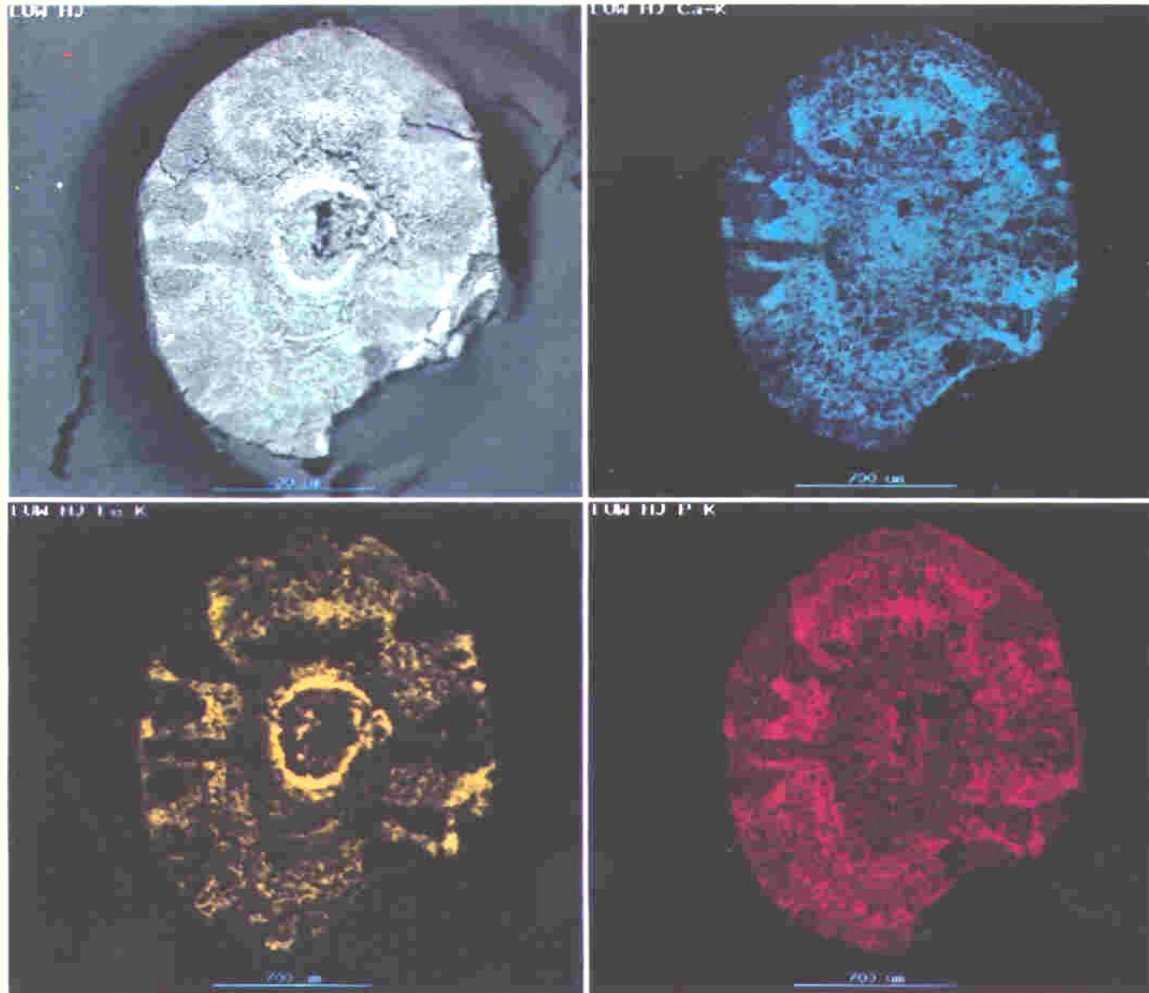


Granular sludge (1-3 mm)



EDAX microscopy

Coloured areas indicate where Ca^{2+} , Fe^{2+} and PO_4^{3-} are positioned in the granule.



Properties of granular biomass

- **No carrier material**
- **High settling velocity (60 - 100 m/h)**
- **60 - 80 kg dry solids/m³ sludge bed (approximately 80% VSS)**
- **Design COD conversion capacity: 10–30+ kg COD per m³ reactor volume per day**
- **Biomass production: 1 - 5% of the COD converted**



Typical process scheme

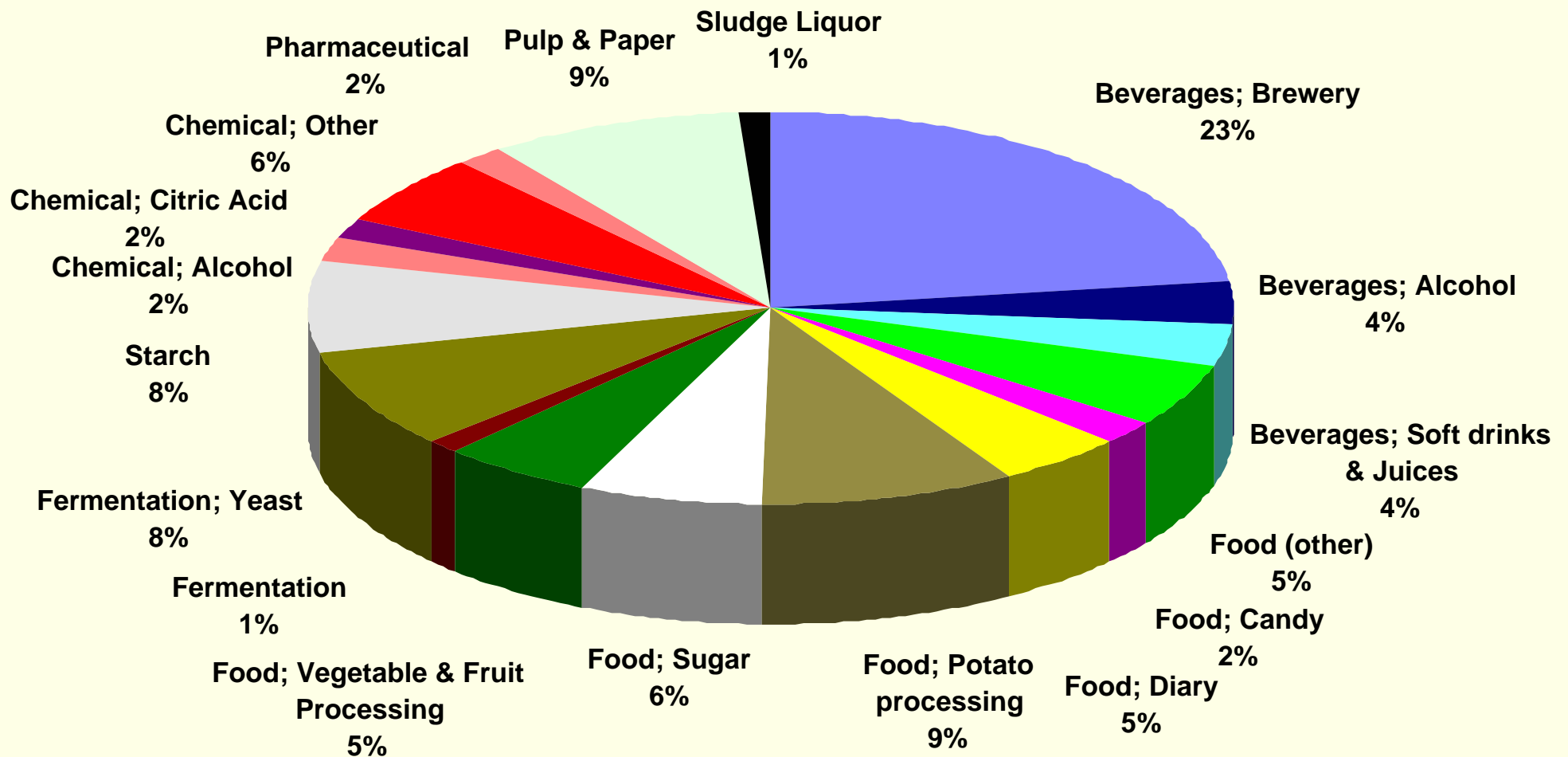
- **Balancing (hydraulic and/or COD peaks)**
- **Pre-treatment (FOG, SS removal)**
- **Anaerobic Digestion**
 - pH and Temperature control
 - COD removal; biogas production
- **Post-treatment (COD polishing, nutrient and/or Susp. Solids removal)**



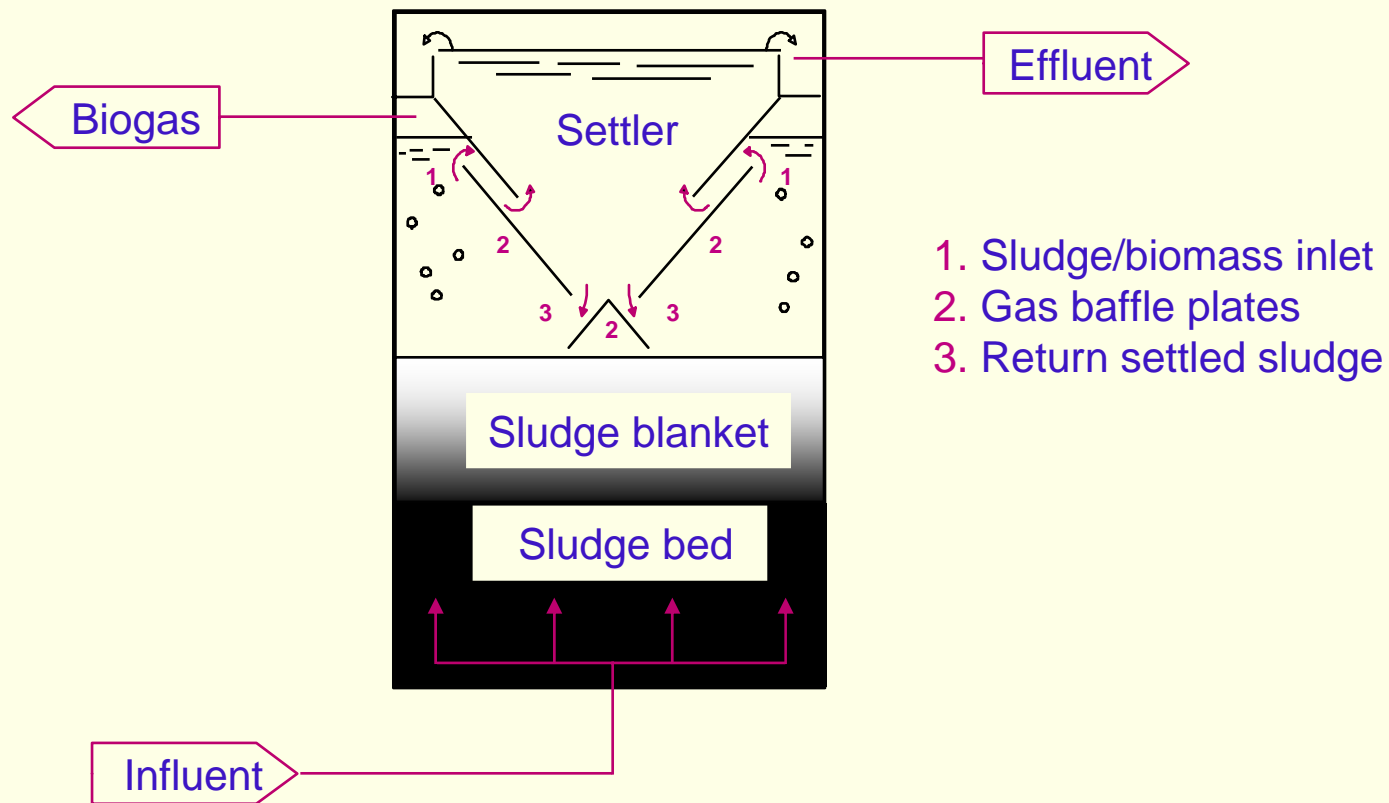
Two-stage Anaerobic - Aerobic treatment plant.



Anaerobic Digesters installed



Biothane[®] UASB reactor



Positioning a UASB settler





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Biothane[®]UASB : summary

- High organic loading rate
- Small footprint
- Double-Baffle internal settler
- Highly settleable granular biomass
- Methane energy byproduct
- Economical operation
- Proven reliability

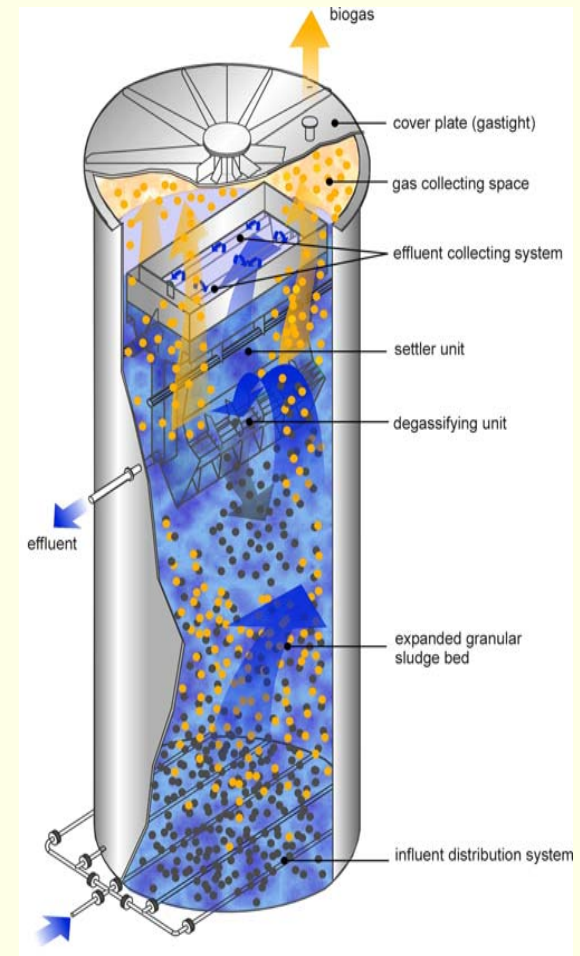
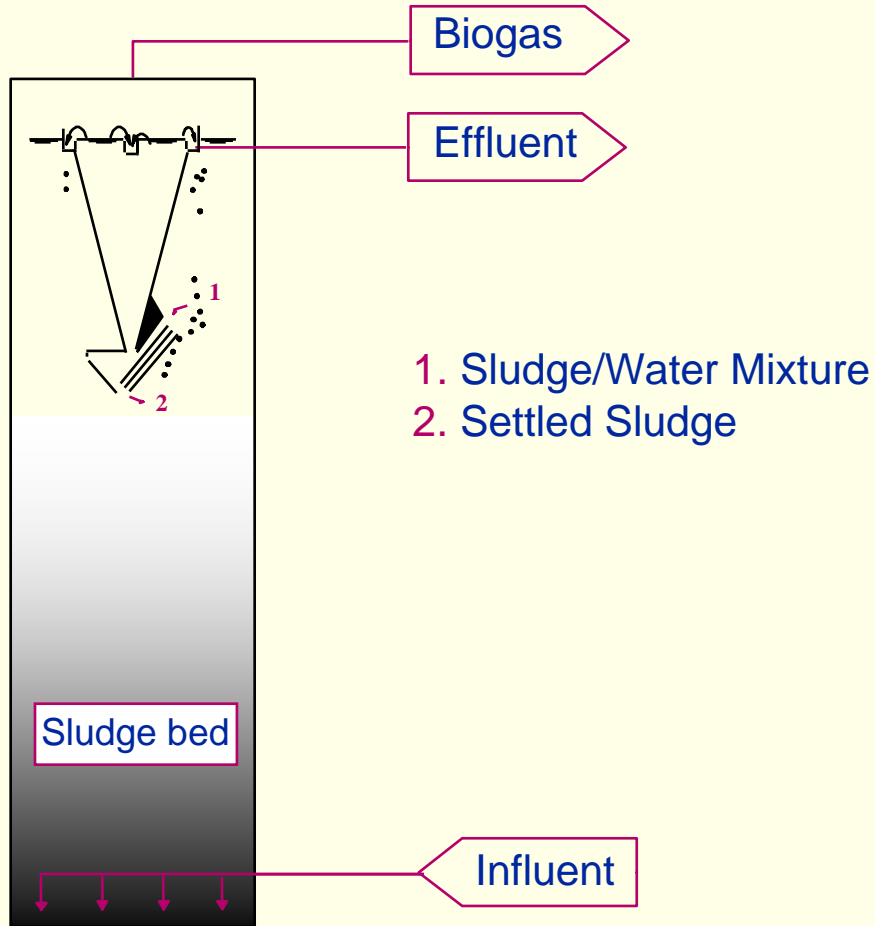


History of the Biobed[®] EGSB reactor

- **Mid eighties non-functioning Fluidized Bed reactors at Gist-Brocades**
 - Sludge wash out; time consuming re-seed; abrasion
- **R&D**
 - Use of granular sludge from Biothane[®]UASB; high velocities
- **Full-scale development of new settler and Influent Distribution System**
- **Refurbishment of FB reactors into Biobed[®] EGSB**
- **Patent application for Biobed[®] EGSB**



Biobed[®]EGSB



Biobed[®]EGSB and Aerothane[®]



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Biobed[®]EGSB (British Sugar, Wissington)



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Biobed[®]EGSB : summary

- Ultra high organic loading rate
- Extremely small footprint
- Sealed reactor design; total emission control
- Corrosion proof construction
- Patented Triple-Baffle internal settler
- Highly settleable granular biomass
- Methane energy byproduct
- Economical operation
- Proven reliability



Biobed[®]MP : modular system

- **Principle**

- pre-engineered design rather than custom-built
- based on long-term experience of many applications
- initially targeted at known applications

- **System based on:**

- 50 m³ Biobed[®]EGSB reactor module
- service module, with Conditioning Tank

- **Design guide (per module):**

- COD load: 1,000 kg COD/day
- hydraulic flow: up to 20 m³/h



Biobed[®]MP

- **short delivery time with limited on-site activities**
- **production under workshop conditions**
- **factory tested before shipment**
- **expandable and relocatable**
- **40' frame is compliant with standard container size allowing transport by lorry and container ship**



Biobed[®]MP (including flash aeration)



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Biobed[®]MP (Glen Ord Distillery)



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The future :

- **Ongoing process and engineering design development**
- **Even wider range of applications**
 - numerous drivers
- **History goes in circles ?!**
 - efficiency versus speed
-?

