



Experiences with PHA production in pilot scale on the STP Wuppertal- Buchenhofen

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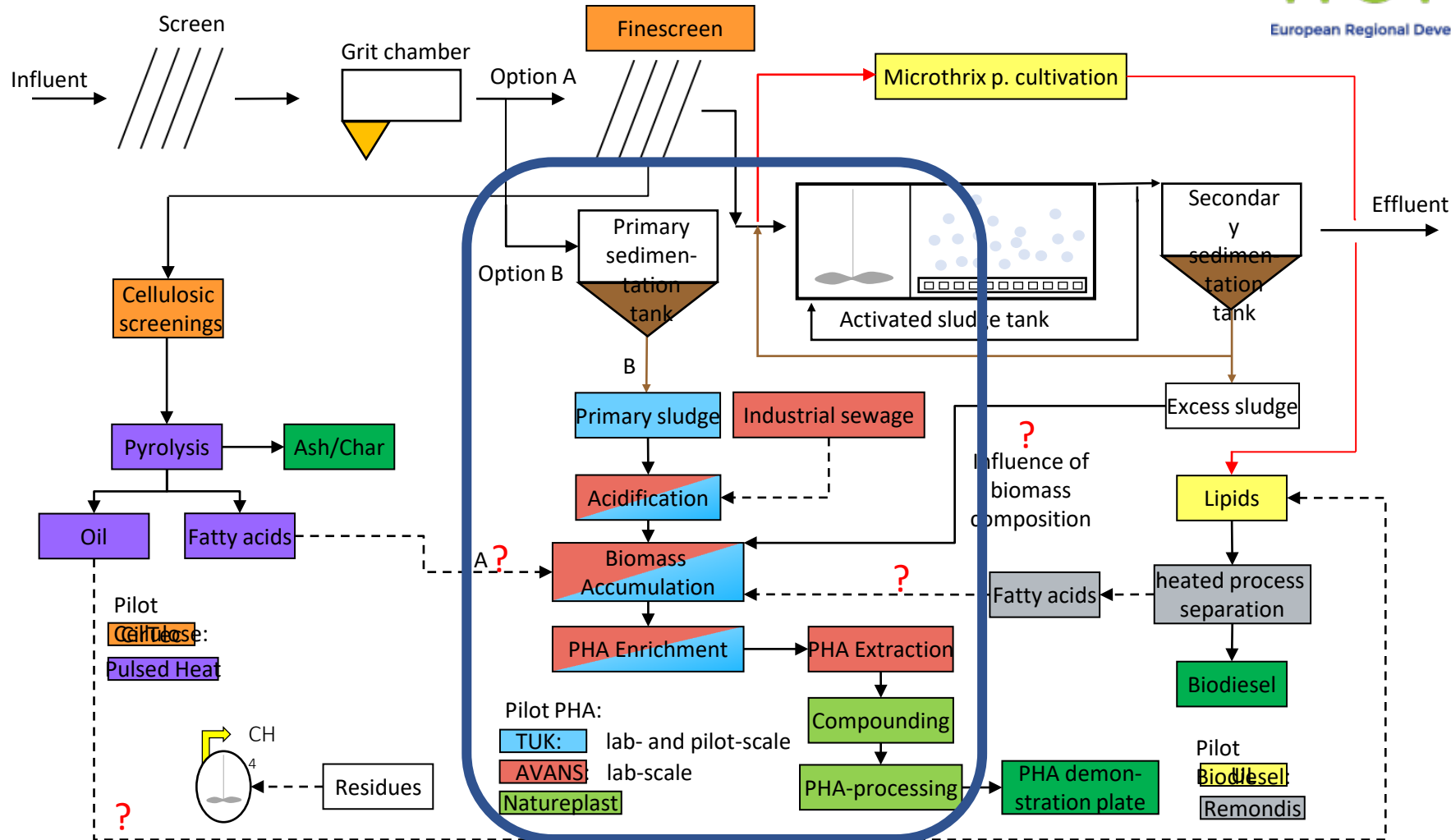
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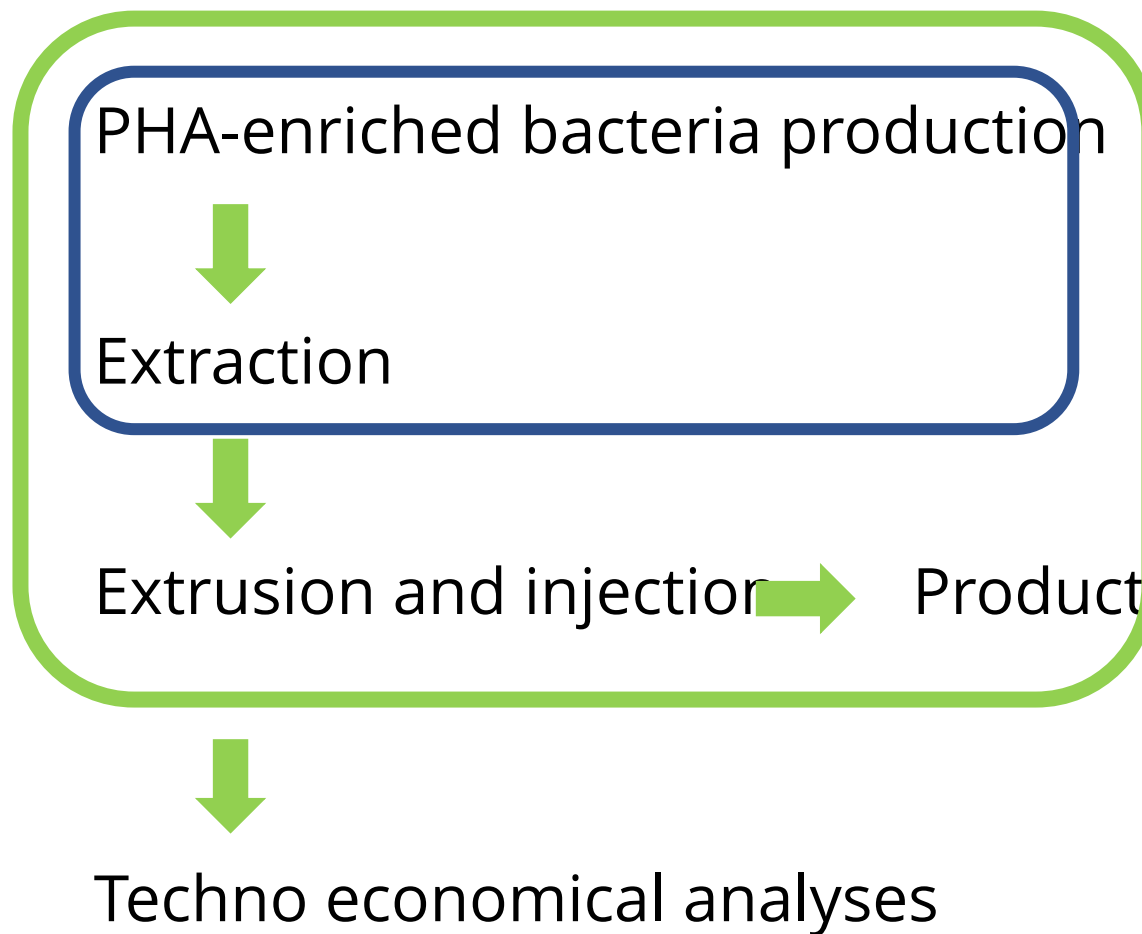
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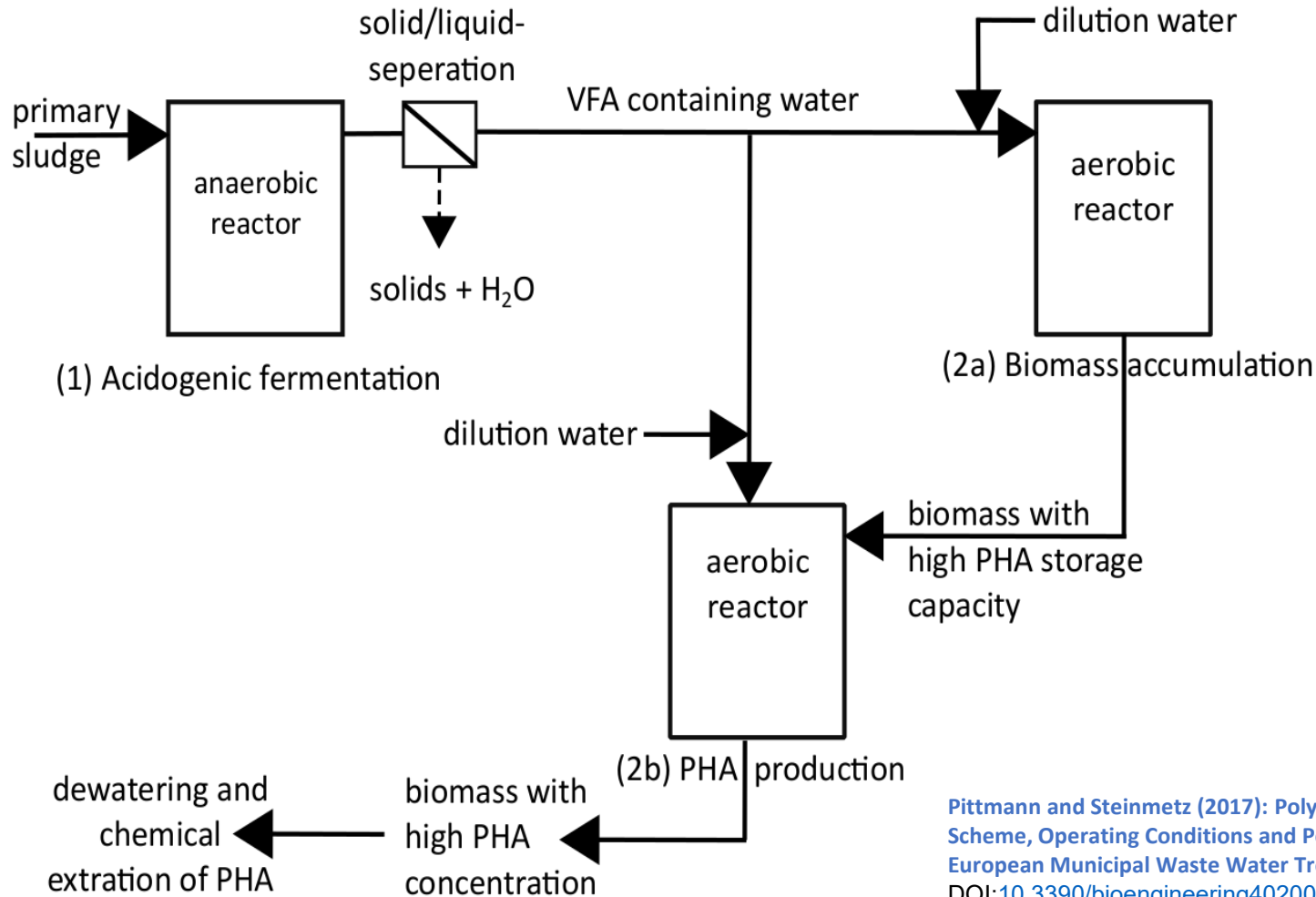
Pilot plant part of WOW!



PHA-pilot team



The process



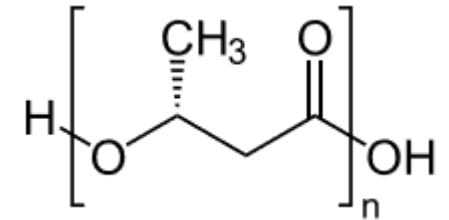
Pittmann and Steinmetz (2017): Polyhydroxyalkanoate Production on Waste Water Treatment Plants: Process Scheme, Operating Conditions and Potential Analysis for German and European Municipal Waste Water Treatment Plants, Bioengineering, Volume 4,2017. DOI: [10.3390/bioengineering4020054](https://doi.org/10.3390/bioengineering4020054)

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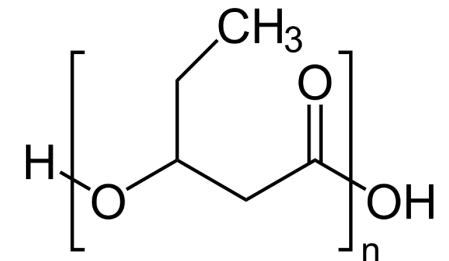
PHA- Production scheme

- 2 step process

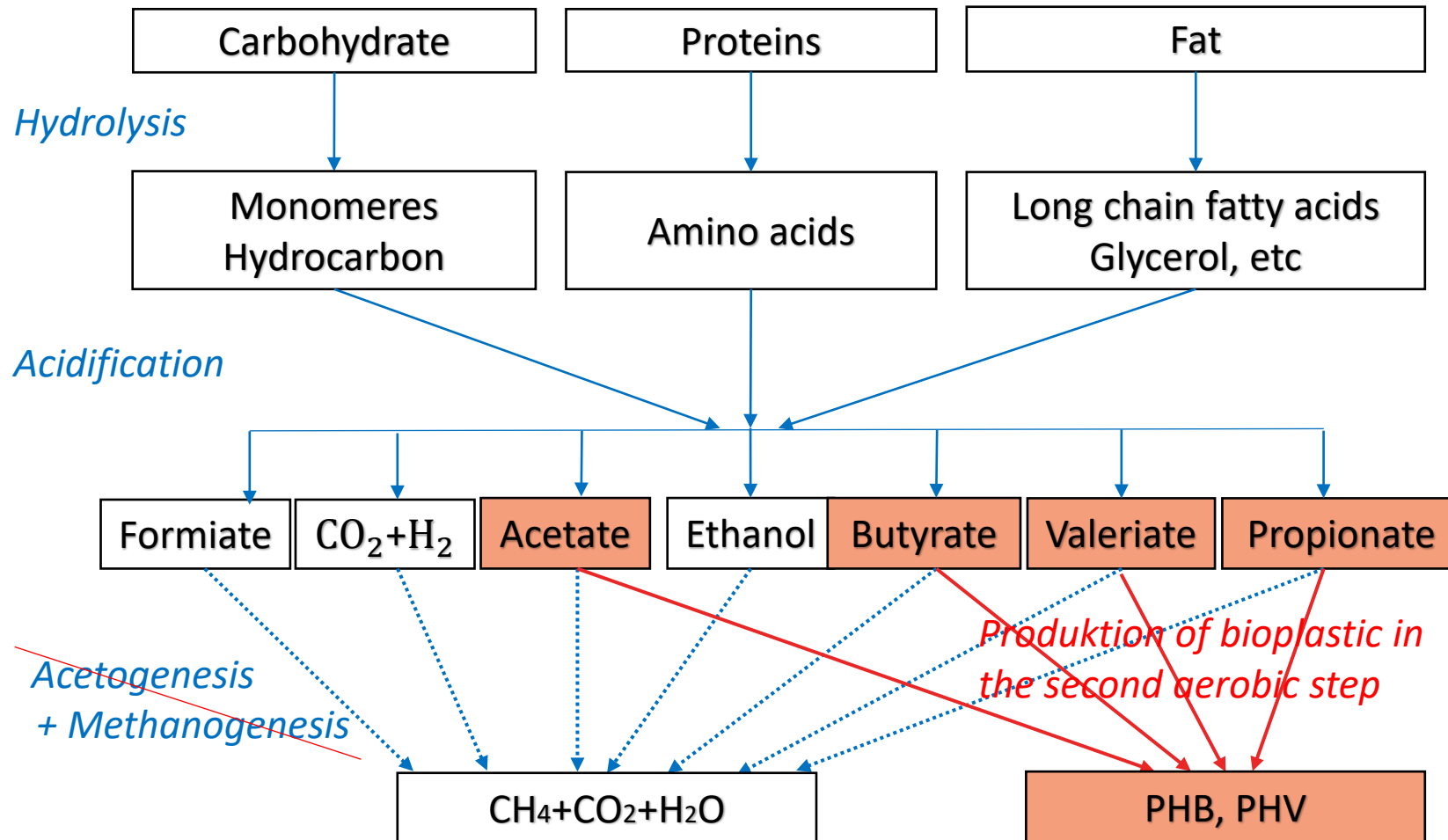
- PHB:



- PHV:



The process



- Anaerobic digestion till VFA
- Suppress methane fermentation
- pH < 6
- Retention time < 8d
- Usage of VFA for the second aerobic step as substrate for PHA production



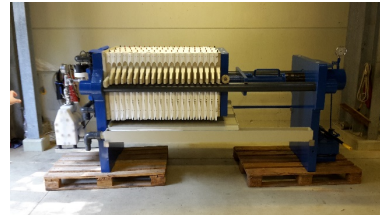
PHA-pilot

1.3 m³ Acidification

Primary
sludge



Chamber filter press



1 m³ VFA-storage
tank



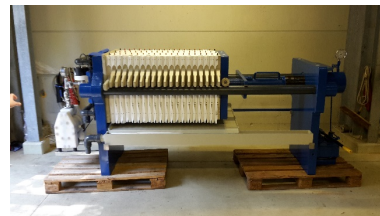
VFA

0.8 m³ Enrichment and
accumulation

VFA



CFP or centrifuge



Drying
cabinet



PHA-enriched
sludge



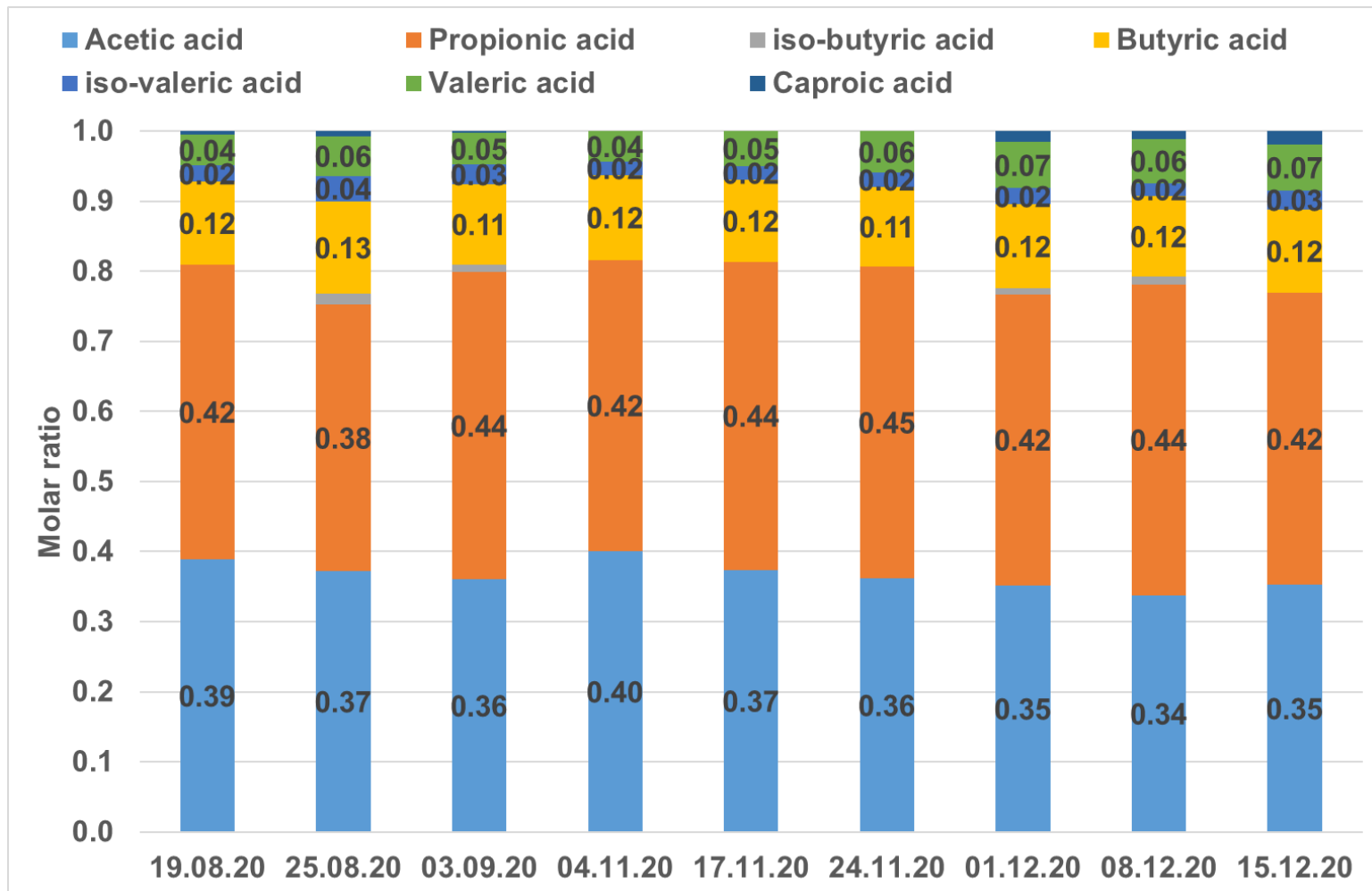
Excess Sludge
(Selection)



PHA-pilot objectives

- Long term operation under real conditions (all season)
 - Stability of VFA composition
 - Stability of PHA composition
- Operational aspects
 - Need of flocculants or other chemicals e.g. for acidification
 - Collect experiences (also with “side” devices like dewatering)
- Elaborate knowledge as a base for full scale implementation (planning and operation)

First results: VFA



- **COD_{VFA}**
 (6.5 ± 1.5) g/L
 (n = 9)
- **COD_{VFA}/COD_{hom,in}**
 0.16 ± 0.03
 (n = 6)
- **COD_{VFA} : NH₄-N : PO₄-P**
 100 : 4.5 : 0.8
 (n = 2)

First results: Pilot plant operation

- H₂S Production has to be considered in the acidification step (exhaust air, dense reactor configuration)
- Perlite improves dewatering
- Further process development with centrifuge to avoid acid flows

First PHA analyses from pilot (measured via GC- FID at TUK)

n = 6	g PHA / g TSS	HB (mass %)	HV (mass %)
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Preliminary analyses	0.13 ± 0.007	32	68
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1st Batch from lab pretest

- ✓ Enriched biomass
- ✓ Synthetic feed
- ✓ Addition of perlite as filter aid

Perlite composition

70–75	SiO ₂
12–15	Al ₂ O ₃
3–4	Na ₂ O
3–5	K ₂ O
0.5–2	Fe ₂ O ₃
0.2–0.7	MgO
0.5–1.5	CaO



Picture of biomass with perlite

Extraction and Characterization



Extraction

- DMC
- Biomass/DMC ratio 6%

Characterisation of recovery and purity and

- TGA

PHA monomer composition

- Acidic methanolysis
- GC-MS

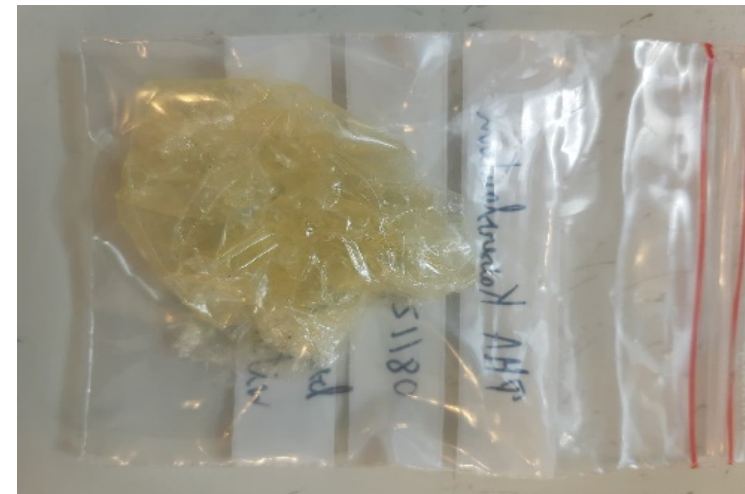


Reflux extraction

Extraction Results

TGA characterisation of biomass before extraction

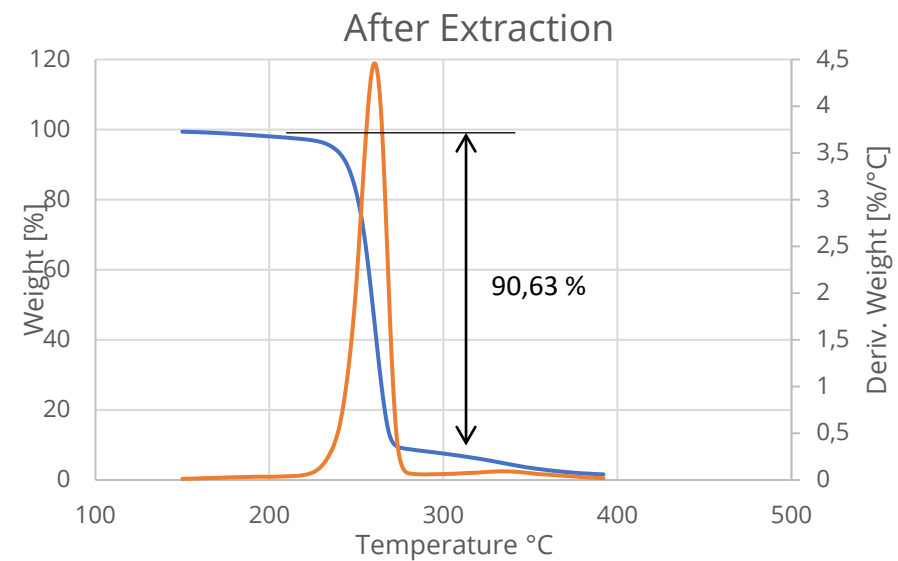
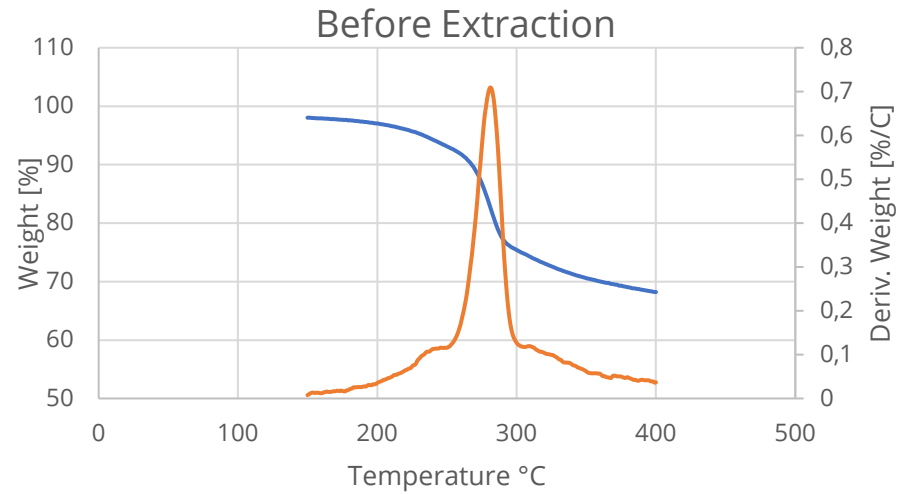
Moisture content (%)	1.8
Biomass ash content (%)	61.85
PHA content in biomass (%)	32.81



Results of extracted PHA

	PHA extracted (g)	PHA yield (%) per TSS	PHA extraction yield (%)	PHA purity (%)
Average	0.69	13.75	36.03	90.54
Stand. Deviation	0.01	0.31	0.81	0.54

TGA purity

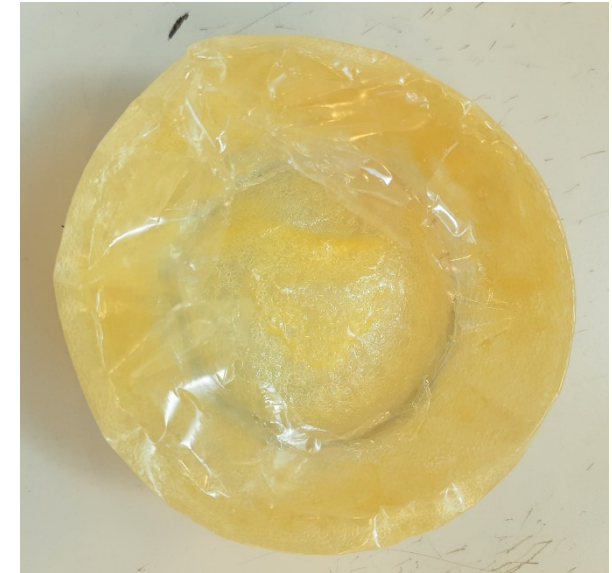


Extracted PHA

Bigger scale extraction

Results of bigger scale extraction

Amount of Biomass (g)	Biomass/Solvent ratio	PHA extracted (g)	PHA yield (%)	PHA extraction yield (%)
50	20	5.18	10.36	27.15

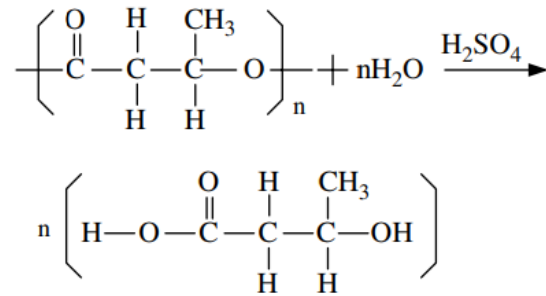


Extracted PHA from 50g of biomass

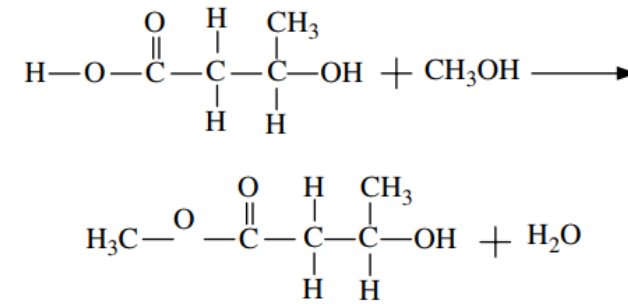
GC-MS

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(1)



(2)

Normalised GC-MS results

	HB (%)	HV (%)
PHB	100	0
Avans Sample	31,3	68,8
TUK Sample	37,5	62,9

Conclusion

- Long term operation is needed to gain insights into operational needs
- The pilot plant gives additional information to lab experiments
 - Stability of the process
 - Operation of “real” devices for full scale operation
- First results show
 - stable VFA composition
 - Suitable PHA composition
- Pilot produced PHA shows similar results to lab scale

Outlook

- Change the dewatering device
- Collect more data with primary sludge as substrate
- Collect more PHA for project partners to check suitability of the PHA material for endproducts
- Investigate industrial substrates (e.g. dairy, brewery)
- Derivation of dimensioning parameters and operational hints



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WOW!

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Production of bioplastics from sewage sludge

June 7, 2021- 14:00h - Online

- 14:00h : Welcome and introduction to WOW! project and the PHA production
- 14:20h : Virtual visit of the STP Wuppertal-Buchenhofen and the PHA pilot plant
- 14:40h : Time for discussion
- 15:00h: End of the meeting

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Thank You