Case study: integration of new sanitation technologies into current wastewater infrastructures exemplified by the Treatment Plant for Education and Research at the University of Stuttgart

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Outline

• Motivation
• Objectives
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Motivation
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Splitting of wastewater streams on a household level

Faeces with flushwater, toilet paper and urine → Blackwater

Urine with flushwater → Yellowwater

Faeces with flushwater without urine → Brownwater

Domestic wastewater without urine und without faeces → Greywater

Nutrient and energy recovery

Water recycling
Motivation

How could the energy potential in blackwater be used, while best exploiting existing infrastructures?

HYDRAULIC RESERVE CAPACITIES IN MUNICIPAL DIGESTERS IN WWTPs EXIST

**BUT:**

Blackwater

1% TSS

7 L/(PE·d)

(PS+ES)$_{thickened}$

4% TSS

2 L/(PE·d)

HRT=25 d

20 d ↔ 2.5 L/(PE·d)
Objectives
Objectives

OBJECTIVES
• Assessment of the feasibility of blackwater co-digestion in municipal digesters and impacts upon plant operation

HOW?
• Through inhabitant-specific mass and volume balances

WHY?
• Resource-oriented systems are a necessity for the longer-term wastewater treatment
• Technology and ideas for resource-oriented sanitation exist; however, the integration in wastewater infrastructures has usually been neglected.
Materials and Methods
Materials and Methods

Treatment Plant for Education and Research at the University of Stuttgart

HRT_{actual} = 66 \text{ d}
HRT_{desired} = 20 \text{ d}
Mass and volume balances for the actual state

8,483 PE
1 PE=120 g COD/d
Results and Discussion
Results and Discussion

Mass and volume balances: 10 \% transition
Results and Discussion

Mass and volume balances: 90 % transition
## Results and Discussion

Benefits of the transition to resource-oriented sanitation systems

<table>
<thead>
<tr>
<th>Measure</th>
<th>Benefits</th>
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<tbody>
<tr>
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<td>N recovery potential</td>
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<tr>
<td>Blackwater collection</td>
<td>0% $N_{in}$</td>
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<tr>
<td>Set-up dewatering digested sludge</td>
<td>20% $N_{in}$</td>
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<tr>
<td>Set-up N recovery from sludge liquor, $\eta=60%$</td>
<td>1.4 g N/(PE·d)</td>
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<tr>
<td>Set-up blackwater thickening</td>
<td>24% $N_{in}$</td>
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<tr>
<td>Set-up N recovery from sludge liquor and blackwater supernatant, $\eta=60%$</td>
<td>1.7 g N/(PE·d)</td>
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<td>66% $N_{in}$</td>
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<td>4.6 g N/(PE·d)</td>
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Conclusion and Outlook
Conclusions

- No major structural alterations in the plant are required
- The means used is appropriate
- Conventional WWTPs can be beneficially integrated into transition concepts
- Blackwater co-digestion improves energy balance and nutrient utilization within the plant

CLUSIONS

- Decrease energy balance (35% reduction in power for aeration and 10% improvement in biogas generation)
- High nutrient recovery rates from sludge or and blackwater (up to 40% N\textsubscript{in} and 40% P\textsubscript{in})
- Nutrient recovery offsets unfavorable N/P ratio
- Centralized greywater treatment proved better in terms of process stability
The integration of new sanitation systems is promising, but must be carried out in accordance with the capabilities of existing infrastructures and precise examination of the boundary conditions.
Thank you!

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