Combining the production of renewable energy with innovative urban drainage systems – The KREIS Project

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Concept for future urban material flows

New Alternative Sanitation Systems (NASS)

**Blackwater 2-Material-Flow-System**

**Minimum Water Quality Standard**

1. **Utilisation Place/Source**
   - rainwater
   - service water
   - drinking water
   - treated rainwater
   - white/drinking water

2. **Material Flow and Transport**
   - rainwater
   - blackwater
   - greywater
   - low loaded greywater

3. **Treatment options**
   - C-elimination
   - hygienisation
   - recovery of nutrients
   - phase separation
   - stabilisation
   - red. micro-pollutants

4. **Reuse Product**
   - treated rainwater
   - rainwater
   - org. plant nutrients
   - biogas
   - treated wastewater
   - vegetable biomass
   - min.-org. plant nutrient
   - treated wastewater
   - service water
   - white water
   - sludge
   - vegetable biomass

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1) higher water quality possible for usage
2) makes sense only for kitchen wastewater

Source: [DWA, 2008]
This realisation of the HWC is the largest demonstration of a resource oriented sanitation concept working with vacuum technology for the collection of concentrated blackwater in Europe.
The Urban Quarter Jenfelder Au

- Revitalisation of a former military site
- 45 ha total area, 35 ha reconstructed
- Realisation: 2012 - 2018
- More than 600 accommodation units about 2,500 inhabitants
- High energy standards
- Commerce and green areas
The vacuum drainage of blackwater was thoroughly examined. Advice on construction and operation of the system was handed out by the KREIS-researcher team, as a system failure would cause a considerable acceptance loss.


Greywater Sampling

Sampling procedure and compilation of daily flow proportional samples

Average loads of greywater sampling campaign Berlin “Block 6”

### Average concentrations of blackwater in Lübeck “Flintenbreite”

<table>
<thead>
<tr>
<th>Parameter</th>
<th>n</th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
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<td>org. matter</td>
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<td>acetic acid</td>
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<tr>
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<td>mg/l</td>
<td>1412</td>
<td>108</td>
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Blackwater Digestion

- 8 CST- reactors,
- 4 UASB- reactors,
- Volume 40 L each
- Online-measurement of gas quantity and quality (CH$_4$, CO$_2$, O$_2$, H$_2$, H$_2$S)
- Continuous feeding ~2kgCOD/m$^3$

The CSTR operated in stable conditions with volumetric loadings of up to 5 kg COD/m$^3$ reactor volume*d.
For the UASB it was possible to increase the volumetric loading to 12 kg COD/m$^3$ reactor volume*d.
pharmaceutical products in blackwater and degradation

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<tr>
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<th>Diclofenac</th>
<th>Ibuprofen</th>
<th>Metformin</th>
<th>Metoprolol</th>
<th>Amoxicillin</th>
<th>Carbamazepine</th>
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<td>mean [µg/l]</td>
<td>11.6</td>
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<td>standard deviation [µg/l]</td>
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<td>111.3</td>
<td>934.8</td>
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<td>451.1</td>
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<td>median [µg/l]</td>
<td>3.35</td>
<td>305</td>
<td>835</td>
<td>41</td>
<td>460</td>
<td>120</td>
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pharmaceutical degradation rates aerobic vs. anaerobic CSTR & UASB

Actually constructed part of the treatment

Blackwater

Digestate of CSTR

Strainer

Heat exchange

Compensation tank

Mixing

Pump

Injector

Greywater

Sewer

Conditioning of digestate

Actually constructed part of the treatment
To avoid transportation costs and annoyance of residents, the liquid phase should be treated and recycled locally.

The digestate treatment together with the greywater after prior removal of nitrogen (deammonification) and phosphorus (precipitation) will be investigated in further research projects.

In order to generate usable products, the digestate must be separated into a low-solids phase and a muddy, solids and phosphate-rich phase.
organisational and institutional aspects

The KREIS project has determined the necessary coordination needs that are to be expected during the realization and operation on the quarter level.

Early cooperation management is necessary.

The acceptance of the system and of its compounds will be evaluated during the operation phase starting in 2017, based on methodologies developed in the KREIS-project.

Conclusions

Extracting recyclable materials and elimination of pollutants in source separated municipal wastewater of an urban quarter will be demonstrated in Hamburg Jenfelder Au.

In the preparatory research project KREIS, knowledge about volumetric quantity, concentrations and specific loads of grey- and blackwater was generated.

On the basis of these data and lab-scale experiments, valuable information for the large-scale implementation of the HWC could be gained.

Methods for cost analysis and investigations of acceptance were adapted to the project boundaries.
This fairy tale will never come true… but we can work on it!