007
Oeko-Technik-Park
Hannover, Germany

ECOSAN SYSTEM - APPLIED COMPONENTS	SOLID BIOWASTE	FAECES	URINE	GREYWATER	RAINWATER
COLLECTION		Vacuum Toilets	Urine Diverting Toilets, Vacuum Toilets and Waterless Urinals	Separate greywater collection	Reservoir
TREATMENT		Public wastewater system	Public wastewater system	Constructed Wetlands, Bio-reactor, Biological Rotating Contactor, "Ökowanne" bath tub	Soil-filtering
USE				Toilet flushing	Toilet flushing

1 General Data

Type of Project:
Re-fitting of ecological demonstration plants in existing buildings

Project Period:
Start of the project: 1995

Project Scale:
5 apartment buildings (with 104 apartments), school, church and farming area

Address:
Hanover, Germany

Planning Institution:
Stadtwerke Hannover and others

Executing Institution:
Stadtwerke Hannover and others

Supporting Agency:
*aqua*planer engineers

2 Objective of the project

- Operation and demonstration of environmentally sound technologies reducing the consumption of natural resources and targeting a closure of nutrient loops (focusing on water and wastewater)
- Testing and evaluation of technologies for water and energy saving under real life conditions combined with public awareness rising and Public Relations.
- Support of sustainable development and employment creation in the neighbourhood through ecological measures.
- Combination of environmental technology and environmental education and awareness raising, particularly for the neighbourhood and the local youth.

3 Location and general conditions

The *Oeko-Technik-Park* is located in the district Sahlkamp, in northern Hanover.

Figure 1: *Oeko-Technik-Park* Hannover, Germany *(source: Oeko-Technik-Park)*

It is a joint project of the following organisations:

- *Stadtwerke Hannover* (public services), responsible for the overall coordination
- *aqua*planer consulting engineers for public relations, maintenance and optimisation
- BauBeCon Immobilien GmbH with 5 apartment buildings of 104 apartments
- Epiphanias Evangelical-Lutheran Church Community with church, community centre, kindergarten and 4 apartments
- The Stadtteilbauernhof Sahlkamp as a district farm
- The Elementary School Haegewiesen with its school building for 500 pupils between the age of 6 and 12.

4 Technologies applied

In the water and wastewater sector the technologies focus on a reduction of drinking water consumption esp. for toilet flushing. In total the park uses 5 greywater treatment units, 4 urine diverting toilets, 32 vacuum toilets, 2 waterless urinals, 1 infiltration ditch, 2 rainwater plants and 1 wastewater evaporation bed. In detail there are:

- 2 constructed wetlands (one for 24 and one for 1 apartment), both constructed as vertical flow systems with reed plants (saving appr. 1000 m³ drinking water per year).

data sheets for ecosan projects
ecosan sector project
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commissioned by:
Federal Ministry for Economic Cooperation and Development

- A greywater treatment plant with two bio-reactors for the greywater from 6 apartments with approximately 15 inhabitants (shutdown after 6 months, see chapter 11).
- A mini wastewater treatment plant using rotating biological contactor technology for 6 apartments (12 inhabitants) for the greywater from the bath tubs and washing machines in the same building (saving appr. 200 m³ drinking water per year).
- 2 Rainwater reservoirs for rainwater coming from the church and farm building roofs (saving appr. 200 m³ of drinking water per year and flat).
- 4 urine diverting toilets in apartments of the Epiphanias community and in the farm (saving appr. 30 m³ of drinking water per year).
- 32 vacuum toilets installed in 32 apartments with appr. 80 inhabitants (saving appr. 950 m³ (84% of standard flushing) drinking water per year).
- Two waterless urinal facilities in the boys´ toilets of the elementary school (saving appr. 700 m³ of drinking water per year).
- 12 unique bath tubs called *"Öko-wanne" in 12* apartments with special features for the reutilisation of greywater for toilet flushing (saving appr. 10 m³ drinking water per flat and year).
- A 60 m² greywater evaporation bed to treat the greywater of the farm bakery and production of willow.

5 Type of reuse

- All treated greywater and rainwater is reused for toilet flushing.
- The implemented technologies could allow a reuse of faeces and urine. However, this is currently not practiced.

6 Further project components

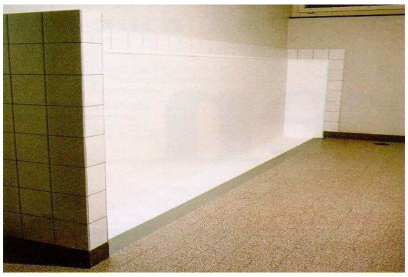
- Block heat and power plant, located in an apartment building (efficiency 93%, 80.000 kWh electricity and 180.000 kWh heat per year).
- 2 thermic solar panel plants of 24m² each and one of 5,5 m² for generation of warm water (energy gain of 8MWh/y and 2 MWh/y respectively, resulting in a 50% energy saving for warm water production).

Constructed wetland for 24 apartments

Rotating biological contactor for 24 apartments

Bio-reactor for 6 apartments

Oekowanne bathtub



Waterless urinal facility

Waterless urinal

Urine diverting and vacuum toilet

Vacuum pumping unit

Figure 2: Innovative Technologies installed in the *Oeko-Technik-Park (photo: Oeko-Technik-Park)*

- 4 solar collectors, each combined with a 140 l hot water storage tank on the roof and downstream electronic boilers for 4 apartments (operation proved to be difficult).
- Photovoltaic cells for energy gain.
- Heat pump with pipes located outside producing warm water for the kindergarten during summer.
- Water and energy cost controlling systems for the installations of Epi-phanias community, reading and reporting all meters digitally to the Stadtwerke Hanover for analysis. Results enable direct adjustments of the installations.
- Use of ecological construction materials, especially timber con-structions and green roofs at the district farm yard.
- Optimised thermal facade insulation combined with a roof central heating unit with condensing boilers for one renovated apartment block, reducing

heat energy demand by 50% (project supported by the EU).

- Loam bakery oven, fired with locally grown wood (in greywater-evaporation-bed) as educational project in the wastewater free bakery.

7 Project History

The *Oeko-Technik-Park* was promoted by the *Stadtwerke Hannover* in 1995. Since then six different institutions have been taking part in the project gradually.

The BauBeCon was the first to be implicated in the project. Their involvement began in 1992 when the planning for renovation of the buildings started.

The Epiphanias community joined the project in 1997 after the agreement of the church committee to a proposal submitted by a group of members.

The district farm has been involved since 1999.

8 Costs

1a. 60 m² constructed wetland:
Reedbed: 24.000 €
Pipeline network: 2.500 €

1b. 6 m² constructed wetland:
Reedbed: 1.500 €
Wages: 3.000 €
Pipeline network: 3.000 €

2. Biological rotating contactor:
For 24 apartments: 26.000 €
Separate pipeline network for 6 apartments: 6.000 €

3. Bio-reactor:
2 bio-reactors: 7.000 €
Pipeline network: 9.000 €

4. Urine diverting toilets:
per unit: 850 €

5. Vacuum Toilets:
Vacuum station: 33.000 €
32 vacuum toilets: 22.000 €
pipelines network: 22.000 €

6. Waterless urinal facilities:
No data

7. *Oekowanne* bathtub:
per unit: 850 €
Installation costs: 250 €

8. Rainwater reservoir
Reservoir: 15.500 €
Piping, pumping, drainage: 8500 €

9 Design information and technical specifications

1. Constructed wetland
They are constructed as vertical flow systems. The wastewater flows into a sedimentation basin, from where it is

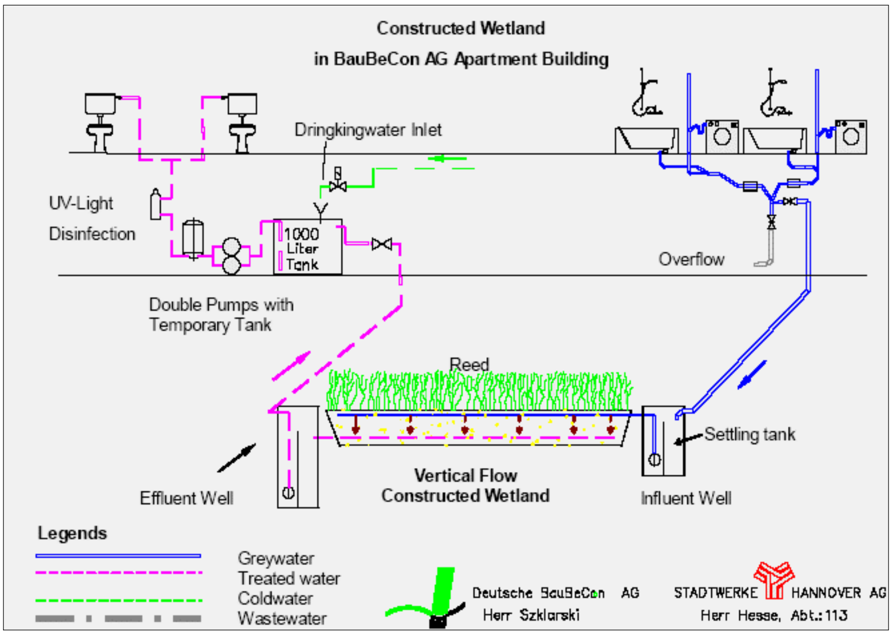


Figure 3: Constructed Wetlands Scheme *(graphic: Oeko-Technik-Park)*

pumped by plastic pipes with 50 holes into the surface layer of the reed bed. The depth of the reedbed is 1 m consisting of several layers:

- Geotextile (lowest layer)
- pond foil
- 20 cm drainage gravel 8/16 with drainage pipes DN 100
- Geotextile
- 60 cm sharp river sand 0-2, 20 cm filter gravel 2-8
- 20 cm drainage gravel with inlet pipes of AP DN 50
- reed plants (Phragmites Communis)

The treated water is stored in tanks before being used.

The plant is connected to the public sewer system in case of overloads.

2. Rotating biological contactor
The rotating biological contactor consists of four basins through which the greywater of bath tubes and washing machines of 6 apartments flows in sequence:

1. Settlement tank
2. Rotating biological contactor
3. Clarifier
   UV desinfection
4. Storage basin

Sedimentation sludge and surplus greywater is discharched to public sewer.

3. Bio-reactor
A bio-reactor consists of a 1.5 m³ container with hanging felt stripes acting as a bacteria carrier. Eight blowers supply oxygen to the activation system.

The treated water is taken from the lower part of the container for being used for toilet flushing after being disinfected with UV-light.

4. Urine diverting toilets
The toilets have a bowl separated by a bar into a small part for urine in the front and a big one for faeces in the back part. They have two flushing options:

- 0.25 litres for urine flushing
- 3 to 6 litres for a flushing of the whole bowl.

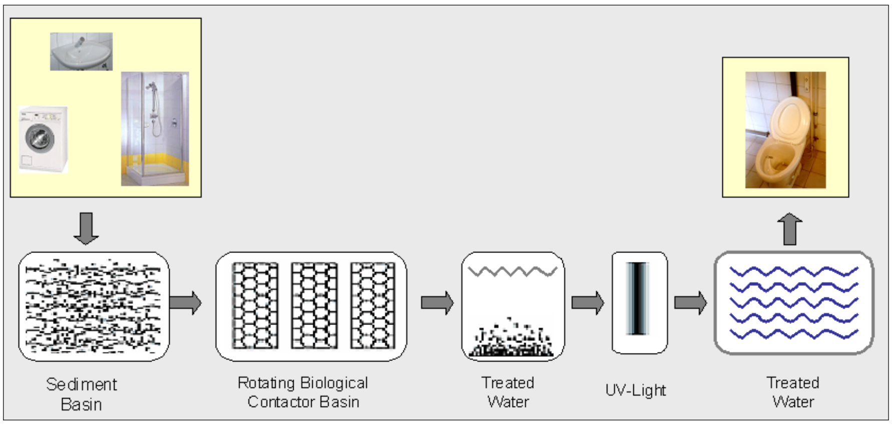


Figure 4: Rotating Biological Contactor Scheme *(graphic: Oeko-Technik-Park)*

5. Vacuum toilets
The vacuum system consists of a 500 l vacuum tank in the cellar connected with the toilets by PE pipes. With the flushing a membrane valve is opened for 2 seconds and 60 l of air with 1.2 l of flushing water are absorbed and pumped into the vacuum tank. From there it is disposed into the public sewer system. But it could also be led into a biogas plant or a tank truck for reuse in agriculture.

6. Waterless urinals
In the school toilets two communal waterless urinals have been installed. In contrast to normal urinals these waterless urinals have a special siphon filled with a bio-degradable liquid which is lighter than urine and which forms the stench trap.

***7. Oekowanne* bathtub**
The bathtub has got a 100 l temporary greywater storage tank with a circulation pump and ventilation underneath. The user can decide whether to use the greywater for toilet flushing or to discharge it into the sewer system directly.

8. Rainwater reservoir at church
The rainwater from half of the the church-roof (335 m²) is filtered in the 40 m² infiltration swale beside the church. The filtered water is collected and led by an infiltration ditch and a drainage pipe to the 16 m³ reservoir made of waterproof concrete. The overflow is infiltrated to the ground. The rainwater is pumped to an interim storage tank to be used for flushing two toilets and two urinals.

10 Operation and Maintenance

1. Constructed wetlands
They operate reliably, but should be visited once a month for inspection and twice a year for maintenance.

2. Rotating biological reactor
The plant should also be visited once a month for controlling and twice a year for maintenance. This small plant only operates at 25% capacity for the number of connected flats.

3. Bio-reactors – shutdown (see chapter 11)

4. Urine diverting toilets
O&M is similar to conventional WC´s. The realisation of the possible water saving depends on the users' discipline in using the correct part of the bowl and in flushing the correct volume of water.

5. Vacuum toilets
The operation is similar to conventional WCs, but due to the low pipe diameters clogging is a much greater risk. The vacuum pumping unit must be visited every three months for control and every six months for maintenance, while the toilets need a biannual maintenance of appr. 2 manpower hours. In case of blockage or failures of the vacuum unit a qualified plumber has to be available on a stand by basis.

6. Waterless urinals
For hygienic reasons the urinals are regularly coated with disinfectant oil, which additionally prevents urine deposits.

Correct cleaning (soft detergents) is crucial, because cleaning water can swamp out the siphon liquid, which leads to odour problems.

7. *Oekowanne* bathtub
Due to constructive limitations the maintenance and cleaning of the bathtub is very difficult for the users.

8. Rainwater reservoir
The plant should also be visited once a month for controlling.

11 Practical experience and lessons learned, comments

Most of the technologies work stabile and to the users' satisfaction and facilitate a saving of 50% of the water and energy demand. To be economically feasible without any subsidies, water and energy prices would currently have to be raised by 30%. Greater efforts for operation and maintenance are required than for conventional technologies - at least until the new technologies are more common.

1. Constructed wetlands
The constructed wetlands work satisfactorily and reliably. The treated water is clear, colourless and odourless. It is storable and has bathing water quality in accordance to the EU Directive. The plant works even at temperatures of temporarly minus 20°C.

Nevertheless there have been some small problems during operation:

- In the constructed wetland at the BauBeCon building 200 litres of sewage sludge accumulated in the settling tank.
- 2 years after start of operation a barrier layer formed in the reed bed. It could be easily removed by breaking the layer with a steel-pipe.
- If the toilets are not flushed for several weeks, a light deposit caused by the water is formed in the toilet bowl. But this can be easily removed with a toilet brush.

2. Rotating biological contactor
Until today the reactor works very well. The treated water is clear and odourless, storable and has bathing water quality in accordance to the EU Directive. This system is for economic reasons mainly suitable for apartment buildings or other bigger buildings.

Critical points:

- Due to aggressive air humidity corrosion problems at some minor components occurred in the system. Therefore appropriate corrosion-free materials should be used.
- There have been several problems in the UV-light area due to blockages.
- A lack of maintenance by the caretaker may cause a decrease of operational availability.

3. Bio-reactor
The bio-reactor was shutdown after half a year, because of malfunction.

4. **Urine diverting toilets**
See O&M. According to the personal

Figure 5: BauBeCon buildings, Sahlkamp district farm, Epiphanias church, elementary school Haegewiesen *(source: Oeko-Technik-Park)*

habits of the users not the full amount of urine can be separated.

5. Vacuum Toilets
In the beginning the pumping unit had several defects, but now works well. There have been remarkable costs due to blockages of the pipe work caused by incorrect use such as disposing cat and hamster litter, lambs wool etc. down the toilet. This shows the importance of close user supervision.

The flushing noise itself requires some customisation.

6. Waterless urinals
See O&M.

7. *Oekowanne* bathtub
The system doesn`t work to satisfaction.

- Maintenance is difficult (e.g. absence of a manageable revision opening, difficult cleaning of the storage tank).
- For hygienisation of the treated water the tubs were initially equipped with an anox installation, which quickly saponified and caused odour problems. This feature was changed to an aeration.
- The constant ventilation noise may be regarded as disturbing while the energy demand is reasonable (2,4 kWh/m³ service water).

8. rainwater reservoir
The system works well. Soil-treatment of the rainwater is a very good possibility for the cheap production of water when a high hygienic quality is needed. In general storage can be realised much cheaper than realised here (type of storage was designed this way for architectural reasons).

12 Available documents and references

http://www.oeko-technik-park.de/

Detailed information on the park and its components. Further material can be ordered via Internet (in German).

13 Institutions, organisations and contact persons:

Public Relations, maintenance and optimisation:

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