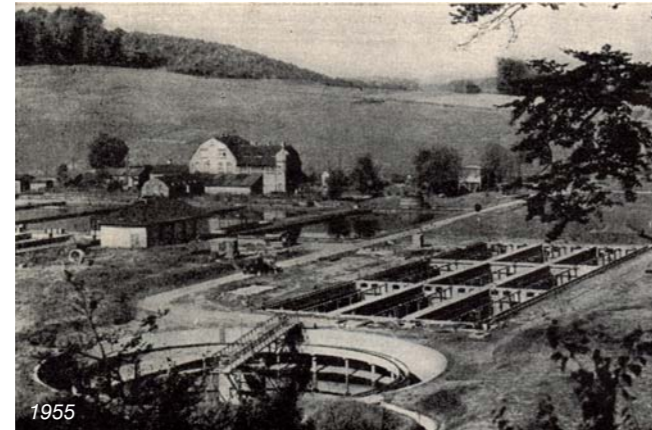


Wastewater treatment – a contribution to environmental protection

Wastewater has been treated for more than 100 years at Buchenhofen. As a result of industrialisation and dramatic population growth in the 19th century, the River Wupper became increasingly polluted by refuse and wastewater. The fish in the river died. As a result of the unacceptable quality of the water, sicknesses caused by contaminated water, such as typhoid, became a growing problem. In 1886, Dr. Wolff, a government official, stated in his report that the Wupper carried some 150 t of “refuse of all types” every day. In 1900, the former municipalities of Elberfeld and Barmen decided to build a wastewater treatment plant at Buchenhofen following the completion of the sewage systems. The first sections of a mechanical treatment plant were built at Buchenhofen between 1904 and 1906. Operation of the plant started on 1 June 1906. At that time, it consisted of two screens, one grit chamber and four sedimentation basins. The sewage treatment effect was based on the sedimentation of particles in the basins.

In 1930, the Wupperverband was established and was concerned mainly with the problem of the pollution of the Wupper. By 1939, five additional sedimentation basins had been installed at Buchenhofen wastewater treatment plant.

After the end of the Second World War, the association expanded the plant step by step from the 1950s to the 1970s until it was a major treatment plant with a biological treatment stage. Other milestones in the development of the wastewater treatment plant were the commissioning of a sludge digestion system (1947), the installation of gas engines driven by digester gas (from 1954), the commissioning of a sludge incineration unit (1977) and a flocculation/filtration system for phosphorus removal (1994).



Buchenhofen is Wupperverband’s largest wastewater treatment plant and can treat about 50 million cubic metres of wastewater from households, industry and commercial establishments every year. This corresponds to about twice the total capacity of the Wupper reservoir. Most districts of Wuppertal (with the exception of Ronsdorf and parts of Cronenberg) and some parts of Schwelm are connected to the treatment plant. Since 2000, the wastewater of the Bayer factory, which is pre-treated in the company’s own treatment plant, has also been treated at Buchenhofen.

The plant is equipped with three treatment stages. Initially, the wastewater is cleaned mechanically. Large items such as sanitary articles are removed by a screen. Grit is collected in the grit chamber. In the subsequent primary sedimentation stage, sedimented particles and floating materials are removed.

The mechanical stage is followed by biological treatment in the activated sludge and denitrification tank. In this tank, the organic materials (carbon, nitrogen and phosphorus com-

- 1 Screen building
- 2 Grit chamber (1,500 m³)
- 3 Primary sedimentation tank (9,450 m³)
- 4 Denitrification tank (49,000 m³)
- 5 Activated sludge tank (54,000 m³)
- 6 Secondary sedimentation tank (63,000 m³)
- 7 Flocculation/filtration unit (1,680 m²)
- 8 Pre-thickener (2,200 m³)
- 9 Mechanical thickening system
- 10 Buried digesters (18,300 m³)
- 11 Sludge inlet tank
- 12 Gas storage
- 13 Compact cogeneration unit
- 14 Sludge incineration unit
- 15 Operation building
- 16 Hydropower plant
- 17 Fish ladder



Photo: Stuttgarter Luftbild ElsäBer GmbH, 2009



pounds) contained in the wastewater are largely removed by microorganisms (activated sludge). Excessive concentrations of the nutrients nitrogen and phosphorus promote the growth of plants and algae, with a negative impact on fish and small organisms in the river. The next stage is a secondary sedimentation tank which separates the activated sludge from the treated wastewater by sedimentation.

Only part of the phosphorus in the wastewater is removed in the biological treatment stage. For this reason, the wastewater is passed through a flocculation/filtration system in the third stage. The phosphorus is chemically bound in floc

by the addition of iron salts. In the various filtration layers, this floc is largely removed from the wastewater. After the wastewater has passed through the various treatment stages, it is discharged to the River Wupper.

As the microorganisms propagate in the activated sludge tank as a result of the nutrients available in the untreated wastewater, excess sludge which is no longer needed for the treatment process and the sludge from the mechanical treatment stage are removed from the cycle. The sludge is stabilised in digesters and then incinerated at Buchenhofen incineration plant.

Buchenhofen Wastewater Treatment Plant



“Clean” energy from sewage gas, hydropower and solar power

Wastewater treatment at a modern plant is highly complex and results in high energy consumption. At Buchenhofen sewage treatment plant, Wupperverband uses about 13 million kWh of electric power every year. This corresponds to the consumption of about 3,000 4-person households. In order to protect the environment and reduce costs, Wupperverband is committed to saving energy and using the renewable energy sources available at its plants.

The main factor in power consumption at the wastewater treatment plant is the aeration of the activated sludge tank. By optimisation, the annual power consumption of the entire treatment plant is to be reduced by about 600,000 kWh (5%). There is a long tradition of power and heat generation from renewable energy sources at Buchenhofen wastewater treatment plant.

In the 1940s and 1950s, treated sewage gas was sold as a motor vehicle fuel at Buchenhofen. From 1954, the sewage gas was used to power gas engines for power generation and the waste heat was used for heating. In 1998, the gas-fuelled power station at Buchenhofen wastewater treatment plant was replaced by a modern compact cogeneration unit which generates power and heat from the gas. By 2013, this cogeneration unit is to be replaced by a new unit with higher electrical efficiency.

The hydropower station at Buchenhofen wastewater treatment plant has been in operation since 1966. The latest modifications to upgrade the power station to the state of the art were made in 2012. A solar power system has been operated at the plant since 2008. In total, Wupperverband generates about 10 million kWh per year of clean electricity at Buchenhofen wastewater treatment plant from sewage gas, hydropower and solar power. About three quarters of the power consumption at the plant are therefore covered by electricity generated from renewable energy sources at the plant.

From 2010 to 2012, Wupperverband tested a process to remove traces of industrial chemicals and drugs from the wastewater using activated carbon. Over the past 20 years, there has been a significant improvement in the water quality of the Wupper. This success was possible as a result of the investment by Wupperverband in wastewater treatment, by local authorities in sewer networks and mixed wastewater treatment and by industry in the pre-treatment of production wastewater. Nowadays, the water of the Wupper is so clean that studies carried out over the past few years have identified 32 different species of fish in the river. Even the highly sensitive salmon, which requires especially good conditions, can now be released in the Wupper and its tributaries.



Further improvement in treatment performance

From 1997 to 2005, Wupperverband expanded the treatment plant without any interruption to operations to meet more stringent statutory requirements concerning treatment performance. The main objective was especially to remove nitrogen from the wastewater more effectively than had previously been the case.

The expansion of Buchenhofen treatment plant was a further milestone in the improvement of water quality in the Wupper. In addition, the expansion helps protect the Rhine and the North Sea. The total investment by Wupperverband in the expansion of the treatment plant was about 84 million Euros. At Buchenhofen treatment plant, some 85 % of the nitrogen and 95 % of the phosphorus are now removed from the wastewater.



Facts and figures

- Commissioning: 1906
- Last expansion of biological treatment stage: 1997 to 2005
- Last expansion of sludge treatment stage: 2005 to 2009
- Capacity: 600,000 inhabitants (“population equivalent” including inhabitants and equivalent values for industry and commercial establishments)
- Maximum inflow: 4,280 litres per second
- Annual wastewater capacity: up to 50 million m³/year

Energy

- Power consumption: about 13 million kWh per year
- Power generation (hydropower, sewage gas, solar power): about 10 million kWh per year

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www.wupperverband.de

Printed by:

OFFSET COMPANY, Wuppertal

