Energy Benchmark for Wastewater Treatment Processes
- a comparison between Sweden and Austria

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International studies show that Sweden is using more energy than many other countries in wastewater treatment processes. To improve the energy efficiency for wastewater treatment plants (WWTPs) benchmarking can be an important tool.

A benchmarking study between WWTPs in Sweden and Austria is presented a thesis. The focus in the study, lies on electrical energy consumption of different treatment processes.

The thesis was written at the Leopold-Franzens University in Innsbruck, Austria, in cooperation with the department of Industrial Electrical Engineering and Automation, at the Faculty of Engineering, Lund University, Sweden.

Benchmarking for WWTPs

Benchmarking is about learning from other organisations and their best practices. By comparing different processes, improvements can be achieved and energy efficiency increased. With the goal of continued development and decreased energy consumption a benchmarking study encourages competition, which leads to improvements. In Austria, a benchmarking program between WWTPs has been carried out every year since 1999. The program has resulted in 30 % lower electrical energy costs.

A similar study has recently been carried out in Sweden. Due to increased energy consumption combined with rising energy prices, the Swedish Water & Wastewater Association, SWWA, initiated an energy saving program. The objective of the project was to survey the energy usage and from that determine where energy usage can be decreased.

On the basis of these two studies and on questionnaires, a comparison in energy consumption between Austria and Sweden has been carried out.

Energy consumption

The energy benchmark for Sweden and Austria presents results related to electrical energy consumption for large municipal WWTPs (pe>100000). See Figure 1 for the electrical energy consumption for the main processes in Austrian and Swedish WWTPs.

In the thesis, the electrical energy consumption is presented in kWh per population equivalent, pe. One pe is the reference- and mean value for the water usage and pollution in the wastewater caused by one person in one day, and is found by measuring the organic matter. To determine the amount of organic matter in the wastewater, a chemical oxygen demand, COD, test was used, calculated on a basis of 110 g per day and person.

In Sweden, WWTPs has a total electrical energy consumption of 42 kWh/pe$_{COD110}$ compared to Austria's value of 23 kWh/pe$_{COD110}$.

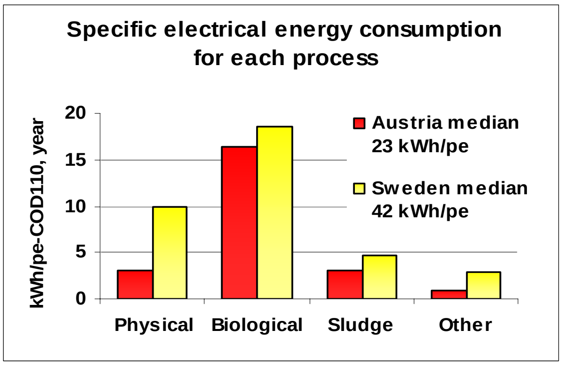

Figure 1. The electrical energy consumption in kWh/pe, year for main processes for larger WWTPs in Austria and Sweden.

Wastewater characteristics

Differences in energy consumption for WWT processes can be found in the characteristics of the influent wastewater and removal requirements.

According to the thesis, Swedish plants have higher influent wastewater flow (242 l/pe), than Austria (210 l/pe). This means that Austria has less diluted wastewater and also higher concentrations of influent organic matter, which provides better conditions for energy efficiency in the wastewater treatment processes. For influent wastewater characteristics see Figure 2.

In addition, Sweden has stricter emission legislation due to the sensitive aquatic environment. WWTPs with strict emission legislations require more electrical energy to manage the treatment requirements and to preserve good quality of the effluent wastewater. See Figure 2 for emission legislation in Sweden and Austria.

Parameter	Austria		Sweden	
Influent flow rate	210 l/pe, day		242 l/pe, day	
Unit	**mg/l**	**kg/pe, day**	**mg/l**	**kg/pe, day**
BOD_5	291	0.0611	176	0.0426
COD	547	0.115	473	0.114
Total nitrogen, N	44	0.0092	40	0.0097
Phosphorus, P	7.5	0.0016	6.4	0.0015
Ammonia, NH_4-N	26	0.0056	24	0.0058
Emission legislation				
BOD_5	15 mg/l		10 mg/l	
COD	75 mg/l		70 mg/l	
Total nitrogen, N	≥70%, T>12 °C		10 mg/l / ≥70%	
Phosphorus, P	1-2 mg/l		0.3-0.5 mg/l	
Ammonia, NH_4-N	5 mg/l, T>8 °C		10-15 mg/l	

Figure 2. Wastewater characteristics for influent water to large WWTPs in Sweden and Austria and emission legislation for effluent wastewater.

Energy savings for WWTPs

It is known that influent wastewater contains more potential energy than required for electrical energy usage at the plant. If that energy could be captured and used the wastewater treatment processes would be self-sufficient in terms of electrical energy.

Biogas is produced in the anaerobic process, which gives WWTPs the advantage as an energy producer. The biogas can be transformed into thermal or electrical energy by using a combined heat and power plant, CHP. Optimization of biogas production is important for more energy efficient WWTPs.

Besides installation of a CHP for increased energy production, the thesis point out many measures that can improve the efficiency of a plant. For example, control strategies for mixers and aeration systems should be installed together with easier available measurements to determine how much energy each process uses. Moreover, installation of new and efficient pumps can lead to increased energy savings.

Results

The results from the energy benchmark study shows that Swedish WWTPs uses approximately 45 % more electricity compared to Austrian WWTPs. This result is in line with other international studies. Hence, the potential for energy savings in Swedish WWTPs is high.

The most evident reasons for the identified differences are the differences in wastewater characteristics and emission legislation.

Repeated benchmark studies in Austria have resulted in 30 % decreased energy consumption. If the Swedish Association for Water and Waste can maintain an annual energy benchmark for WWTPs, similar results can be expected in Sweden within five years.

Moreover, installation of meter readers and improved control strategies will contribute to more energy efficient WWT processes.