Viikinmäki wastewater treatment plant
Viikinmäki wastewater Treatment Plant

Based on the load, the Viikinmäki wastewater treatment plant in Helsinki is the largest in Nordic countries. The wastewater treatment plant processes wastewater from industry and 800,000 people in Helsinki and its seven neighboring municipalities. The average wastewater flow is 280,000 m$^3$/day and the peak flow is 700,000 m$^3$/day. Of the total flow into the plant, approximately 85% is domestic wastewater and 15% is industrial wastewater.

In the treatment process at the activated sludge plant operating with the simultaneous precipitation method, the wastewater is treated mechanically, chemically and biologically. The treated wastewater is fed through a 16-kilometre discharge tunnel into the sea sufficiently far from the coastline. The sludge separated from the wastewater is digested, and the biogas generated in the digestion process is used to produce heat and electricity for the wastewater treatment plant. The dried and digested sludge is processed into garden soil in the composting field. The designed capacity of the biochemical section of the Viikinmäki wastewater treatment plant is 310,000 m$^3$/day. The design value for the BOD$^7_{(ATU)}$ load is 69,000 kg/day, 2,100 kg/day for the phosphorus load and 15,500 kg/day for the nitrogen load. When calculating 70 g BOD$^7_{(ATU)}$/inhabitant, the resulting population equivalent is 840,000.

After the wastewater treatment plant was commissioned in 1994, the process has been made more efficient and the capacity of the plant has been increased several times. At the start of 1998, denitrification was made more efficient by changing over to the DN process. The effectiveness of denitrification was increased further when the after-filtration unit was introduced at the end of 2003. At the start of 2004, the eighth activated sludge line was started in order to increase capacity. The maximum capacity of the plant was reached in 2014 when the 9th biological treatment line was introduced.

100 years of wastewater treatment

The first wastewater treatment plants in Helsinki were built in the 1910s to save the Töölönlahden Bay. At first, wastewater was treated with crushed stone filters and septic tanks but, as early as the 1930s, the first active sludge plants in the Nordic countries were commissioned in Helsinki. Before the Viikinmäki wastewater treatment plant was commissioned in 1994, a total of 12 wastewater treatment plants had operated in the Helsinki area.
**VIIKINMÄKI WASTEWATER TREATMENT PROCESS**

**Incoming wastewater**
- Q_{in}: 290,000 m³/day
- BOD₅: 270 mg/l
- SS: 290 mg/l
- N-tot: 50 mg/l
- P-tot: 6.0 mg/l
- COD: 600 mg/l

**Sludge digestion**
- Mesophilic process
- Retention time: 14-17 days
- 4 digestion tanks
- Volume: 10,000 m³ in total
- To be digested: 2,400-2,900 m³/day
- Solids content: 3.4%

**Biogas**
- Biogas produced: 13.4 million m³/year

**Drying sludge**
- Dried sludge: 65,000 t/year
- Solids content: 29%

**Sludge processing**
- Composted: 100,000 m³/year
- Reprocessed to soil products: 80,000 m³/year

**Metsäpirtti soil**
The digested and dried sludge is transported from Viikinmäki to the Metsäpirtti composting field in Sipoo. The sludge is mixed with peat in a ratio of 1:1. The mixture is composted in stacks for approximately six months, after which sand and biotite are added to it. During the last processing phase, the soil mixture is screened (screen size: 20 mm). In the Metsäpirtti soil products, approximately 580 tonnes of phosphorus and 620 tonnes of nitrogen are recycled annually. The quality of the soil products is monitored by EVIRA.
The amount of wastewater and extreme climate phenomena increase; in addition, the wastewater treatment plant's current capacity is insufficient to achieve the results required by the increasingly strict treatment requirements. In addition to developing the process, increasing the plant's energy efficiency is also an important development target.

### Permit conditions for the Viikinmäki wastewater treatment plant

The treatment requirements in accordance with the currently valid environmental permit are:

<table>
<thead>
<tr>
<th>Permit conditions</th>
<th>BOD₅</th>
<th>Kok. P</th>
<th>Kak. N</th>
<th>COD₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit values</td>
<td>&lt; 10</td>
<td>&lt; 0.3</td>
<td>&lt; 75</td>
<td></td>
</tr>
<tr>
<td>Reduction %</td>
<td>&gt; 95</td>
<td>&gt; 95</td>
<td>&gt; 80</td>
<td>&gt; 85</td>
</tr>
</tbody>
</table>

* as a quarterly average

#### Technical specifications*

<table>
<thead>
<tr>
<th><strong>Incoming wastewater</strong></th>
<th>Number of inhabitants</th>
<th>Daily flow</th>
<th>Maximum flow</th>
<th>BOD₅</th>
<th>Total nitrogen</th>
<th>Total phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>900,000</td>
<td>290,000 m³/d</td>
<td>600,000 m³/day</td>
<td>266.4 mg/l</td>
<td>48.9 mg/l</td>
</tr>
<tr>
<td></td>
<td></td>
<td>76 106 kg/day</td>
<td>13,552 kg/day</td>
<td>1,673 kg/day</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Outgoing wastewater</strong></th>
<th>BOD₅</th>
<th>Total nitrogen</th>
<th>Total phosphorus</th>
<th>COD₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit values</td>
<td>&lt; 10 mg/l</td>
<td>&gt; 80 % reduction</td>
<td>&lt; 0.3 mg/l</td>
<td>&lt; 75 mg/l</td>
</tr>
<tr>
<td>Results</td>
<td>4.3 mg/l</td>
<td>4.0 mg/l</td>
<td>0.19 mg/l</td>
<td>40.4 mg/l</td>
</tr>
<tr>
<td>Reduction</td>
<td>98 %</td>
<td>91 %</td>
<td>97 %</td>
<td>93 %</td>
</tr>
</tbody>
</table>

#### Chemical consumption

<table>
<thead>
<tr>
<th>Ferrous sulphate</th>
<th>Hydrated lime</th>
<th>Methanol</th>
<th>Polymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,274 t/year</td>
<td>2,152 t/year</td>
<td>2,677 t/year</td>
<td>133 t/year</td>
</tr>
</tbody>
</table>

#### Biogas and energy

<table>
<thead>
<tr>
<th>Production of biogas</th>
<th>Energy consumption in the process</th>
<th>Total consumption</th>
<th>Production of energy</th>
<th>Self-sufficiency in electricity</th>
<th>Self-sufficiency in heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>14,4 mil. m³/year</td>
<td>34,515 MWh</td>
<td>40,022 MWh</td>
<td>36,258 MWh</td>
<td>91 %</td>
<td>100 %</td>
</tr>
</tbody>
</table>

#### Costs**

<table>
<thead>
<tr>
<th>Operating costs</th>
<th>Personnel costs</th>
<th>Outsourced services</th>
<th>Materials and equipment</th>
<th>Renovation investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>11,6 M€/year</td>
<td>2,6 M€/year</td>
<td>3,6 M€/year</td>
<td>3,6 M€/year</td>
<td>2,0 M€/year</td>
</tr>
</tbody>
</table>

* Information from 2017

** Does not include the further processing of sludge
Wastewater treatment plant area

1. Inlet pumping static
2. Screens
3. Sand removal
4. Preliminary aeration
5. Preliminary aeration
6. Aeration
7. Secondary settling
8. Biological after-filtration
9. Methanol station
10. Machine and equipment areas
11. Digestion tanks
12. Intermediate storages
13. Sludge dryer
14. Gas holder
15. Energy station
16. Main building
17. Incoming air
18. Outgoing air
19. Heavy traffic