Wat. Sci. Tech. Vol.17, Amsterdam, pp.1491-1494.
Printed in Great Britain.

0273-1223/85 $0.00 + .00

WASTEWATER TREATMENT PLANTS IN AMSTERDAM

R. Kruize

Public Works, Amsterdam, Oostoever 10, 1064 GV Amsterdam, The Netherlands

Amsterdam was one of the very first municipalities in the Netherlands which constructed biological treatment plants. In 1923 the first pilot plant was put into operation. Before 1934 only trickling filters were used. None of these trickling filters is still in operation at this moment. The first activated sludge plant was built in 1934. Amsterdam controls 5 wastewater treatment plants at this moment, which operate according to the activated sludge system.

TABLE 1 Wastewater Treatment Plants in Amsterdam

	Hydraulic capacity (m^3/hour)	Biological capacity (p.e.)
Amsterdam-West	2,600	300,000
Amsterdam-South	5,000	270,000
Amsterdam-North	2,200	140,000
Amsterdam-East	19,000	750,000
Groote IJpolder	2,000	65,000

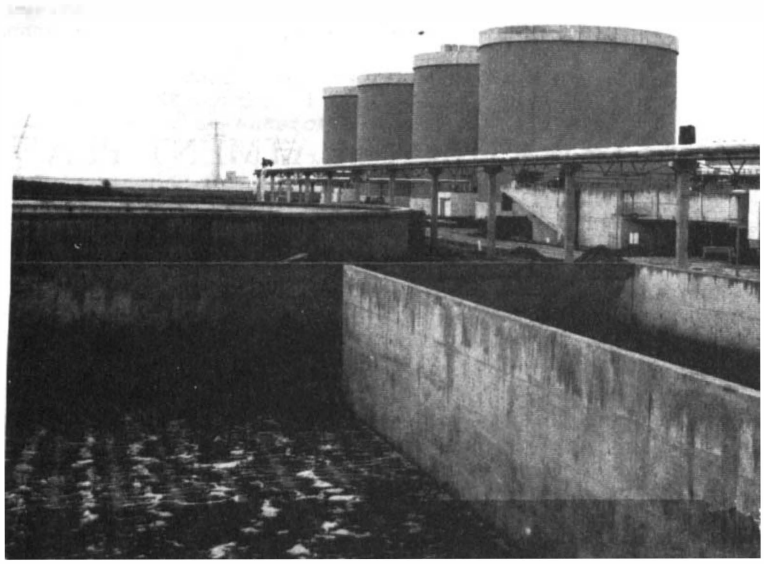
Activated Sludge Process

The wastewater treatment plants West, South, North and East, where mainly domestic wastewater is treated, are all designed as low loaded activated sludge systems with sludge digestion. The aeration tanks are designed as plug-flow systems with diffused air aeration. The design of the aeration tanks has changed several times during the last 50 years. At first the "spiral-flow" system was used in 1934, followed by the "ridge and furrow" system from 1939 to 1960, the "Inka" system at the wastewater treatment plant Amsterdam-North in 1967 and 1871 and the homogeneous positioning of the diffusers on the flat bottom of the aeration tanks after 1975.

At the wastewater treatment plant Groote IJpolder a very low loaded activated sludge system with simultaneous aerobic sludge stabilisation has been designed. Sludge digestion was not applicable because discharges of industrial toxic compounds would have inhibited this process. The influent flow as well as the oxygen demand of the activated sludge process will fluctuate strongly. For this reason the aeration system is designed as a diagonal aeration system with diffused air aeration and separate propulsion by Landox-rotors. The capacity of the compressors will be adapted to the oxygen demand of the activated sludge, which can be determined by measuring the respiration rate of the activated sludge. The average flow velocity inside the aeration tank will be 0.3 m/s. The energy input needed for propulsion is about 1,25 W/m^3 . The oxygenation efficiency is expected to be over 4 kg O_2/kWh.

At all treatment plants more than 90% of the organic matter is eliminated and

more than 85% of the TKN is oxidized. At this moment phosphate removal and disinfection is not practised at any plant in Amsterdam.



Sludge Processing

At the existing plants in Amsterdam the primary and secondary sludge are, after thickening, digested together at a temperature of 29-33°C. The content of the heated digesters is thoroughly mixed by the injection of biogas at a number of places at the bottom of the digesters or by pumping (through external heat exchangers). Dewatering of the digested sludge at the treatment plants West, South and North takes place in lagoons. The digested sludge of the treatment plant East is dewatered in filterpresses after conditioning with lime and ferric-chloride. Per m^3 sludge, 5.3 kg ferric-chloride and 13.6 kg quicklime is used. The dewatered sludge has an average dry matter content of 37.2%.

The largest part of the dewatered sludge is, after composting and mixing with sand and peat, used as fertilizer in public gardens and parks in Amsterdam. A small part of the dewatered sludge is used in agriculture. Recycling of the sludge is only practised if the concentrations of heavy metals within the sludge do not exceed certain maxima. In 1983 maximum allowable concentrations in sludge were fixed in the Netherlands for eight heavy metals (Table 2).

TABLE 2 Maximum Concentrations in Sludge for Agricultural Use (mg/kg dry matter)

Zn	2,000	Ni	100
Cu	600	Cd	5
Pb	500	Hg	5
Cr	500	As	10

Agriculture maximum dosage 2,000 kg dry matter/ha per year
Grassland maximum dosage 1,000 kg dry matter/ha per year

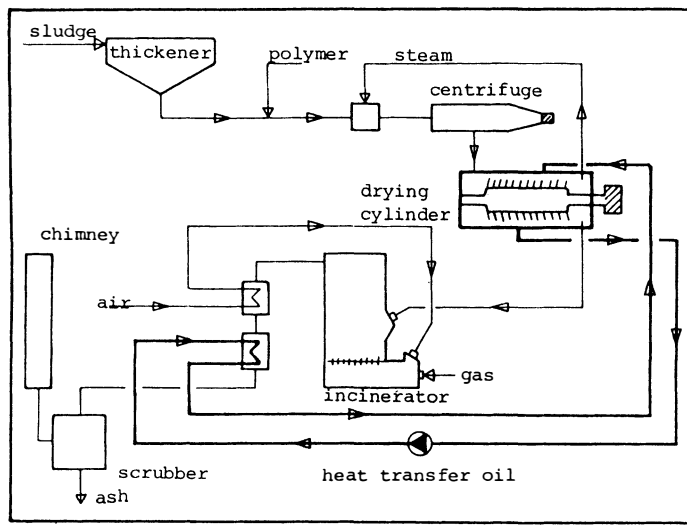
The sludge of the treatment plant Groote IJpolder is expected to have higher concentrations of heavy metals, than shown in Table 2, as well as micro-pollutants from industrial origin. For that reason the aerobic stabilized sludge will be dewatered in centrifuges, after chemical conditioning with polymers, dried and incinerated.

The incineration of sludge will take place at 800-900°C in a Fluidized Bed Reactor. An optimal heat recovery is obtained by:

1. Heating the incoming air for fluidization and combustion to 600°C by the exhaust gases from the incinerator.

2. The heat content of the exhaust gases is also used to dry the dewatered sludge from 15% to 26% dry matter content in a "Luwa" drying system. Sludge is injected into a cylinder with hollow walls, through which heat transfer oil is pumped. The heat transfer oil is heated by the exhaust gases from the incinerator from 170°C to 240°C. In the cylinder a rotor blade system acts as an Archimedian screw. The sludge is spread to the wall of the cylinder, where it is dried by the heat from the heat transfer oil. On attaining a certain deposit thickness it is removed and transported as dried sludge by the rotor blades.

3. The steam, produced in the drying cylinder can be used to heat the sludge before dewatering from 20°C to 50°C. It is expected that the polymer consumption will be reduced by 20% and the dewatering will be more efficient (3% higher dry matter content) at 50°C. When the sludge can be dewatered with centrifuges to a total solids concentration of 18%, the incineration will occur autogenously. Fuel is only required for stand by and start up of the Fluidized Bed Reactor.



Energy Supply

The biogas is used as fuel for boilers at the treatment plants West, South and North. The heating of the sludge digesters as well as the buildings on the site can be attained. Surplus biogas is burned. At the treatment plant Amsterdam-East the digester gas is used as fuel for internal combustion engines that are, in turn, used to generate electricity.

This electricity production amounts to 65% of the required capacity. The running costs (including depreciation and interest) are about 1.0 million guilders a year, while the reduction of the electricity account amounts to 1.3 million guilders a year. The heat produced by these combustion engines is sufficient to heat the digesters and buildings on the site. Before combustion the hydrogen-sulphide concentration of the biogas is reduced to less than 500 ppm by adding 40% ferric-chloride into the digesters.

Process Control

The ammonium concentration of the effluent of all aeration tanks is analysed daily to control the activated sludge process (nitrification is the most susceptible part of the activated sludge process). Three times a week the volatile acids concentration in each digester is analysed to control the digestion process.

An on-line toximeter has been developed for a continuous control at the wastewater treatment plant Groote IJpolder. From a small flow of activated sludge, which is continuously mixed with influent and artificial substrate (sodium acetate and ammonium sulphate), the respiration rate is determined. To avoid decrease of the respiration rate by temperature effects, the toximeter has a temperature control. When a rapid decrease of the respiration rate is noticed, the valves in the influent pressure pipes will be closed automatically by a computer signal. The wastewater is stored in a separate tank until the toxic discharge is terminated. The toxic wastewater can be treated later with chemicals or it can be dosed at a low rate to the activated sludge system.