



SYSTEMIC

Circular solutions for biowaste

Factsheet
SYSTEMIC Outreach Location

Waternet (Amsterdam, The Netherlands)

A short introduction to Waternet

Waste Water Treatment Plant Amsterdam West (Waternet) is the second largest waste water treatment (WWT) plant of the Netherlands. It is treating the waste water of more than 1 million inhabitants of Amsterdam with an active sludge system, i.e. nitrification-denitrification and enhanced biological phosphorus removal (EBPR), a modified process by the University of Cape Town (MUCT). EBPR exploits the potential of some micro-organisms, known as Phosphate Accumulating Organisms (PAOs), to accumulate phosphate (as intracellular polyphosphate).

Feedstocks

Primary sludge from the primary sedimentation and activated sludge from the biological waste water treatment are anaerobically digested on site (Table 2).

Biogas production

Yearly 13 million cubic meter of biogas is produced and valorized in the CHP of the nearby household waste incineration installation. 20000 MWh of electricity is used per year on the WWTP and the rest of the electricity produced goes to the grid. 50000 GJ thermal energy is used for heating of the digesters.

Current process and disposal routes for end products

The digestate is dewatered by a centrifuge and the liquid fraction is recycled to the waste water treatment. The solid fraction of the digestate is incinerated because of the heavy metal content (Figure 2).

Problems and obstacles

This system is running successfully at Waternet, yet a few years ago they realized that there was a lot of scaling in pipelines and on the dewatering equipment which causes wear and tear on the centrifuge. A massive build up of struvite crystals ($MgNH_4PO_4 \cdot 6 H_2O$ (N-P-K, 5-28-0)) in the sludge holding tank was discovered.

Table 1. Technical information of the biogas plant

Date of construction	2007
Size (MWeI)	4
Volume (m ³)	34400
Digester type	Mesophilic digestion



Table 2. Origin of feedstock

Type	Mass per year
Waste activated sludge	325 kt
Primary sludge	325 kt
Total	650 kt

Table 3. Yearly biogas production and average composition

Component	Estimation
CH ₄ (%)	60
CO ₂ (%)	40
H ₂ S (ppm)	400
Total biogas production (Mm ³)	13
Biogas per tonne of feedstock (m ³ /t)	20



Figure 1. Struvite depositions in the pipes to the sludge holding tank

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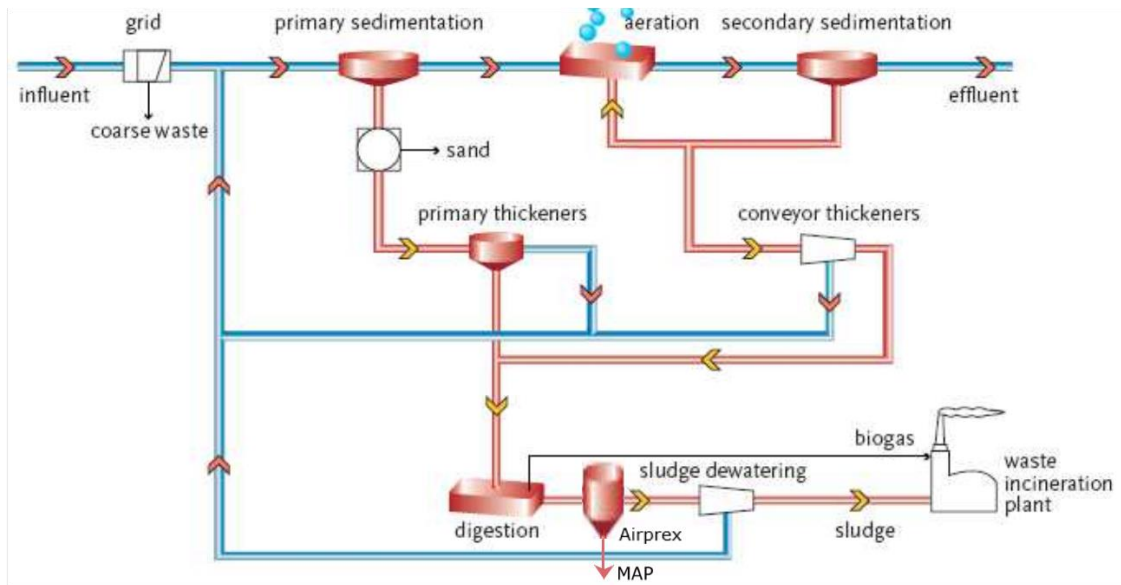


Figure 2. Scheme of the WWTP and digestate treatment

Two important factors were causing this struvite deposition.

1. The phosphorus captured in the biomass of the bacteria is released during anaerobic digestion and reacts with the present ammonium:

$$\text{Mg}^{2+} + \text{NH}_4^+ + \text{PO}_4^{3-} + 6\text{H}_2\text{O} \rightarrow \text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O} \text{ (mono-ammonium-phosphate or struvite)}$$

2. The design of the digester, where CO_2 is stripped through turbulence construction of the digester favored the formation of struvite crystals by a pH rise, pushing the equilibrium to the right.

Waternet started doing tests to precipitate the struvite in a controlled way in a reactor instead of in the pipes and the equipment.

Eventually, the AirPrex® system was built on full scale before the dewatering step and 95% of the ortho-phosphate from the digestate is removed as struvite. This is sold to ICL fertilizers Europe, also located in Amsterdam, who uses it as resource for the production of tailor made fertilizers.



Figure 3. Recovered struvite

Table 4. Average composition of the recovered products

	Mass (kton/year)	Dry matter (%)	N- total (g/kg)	P-total (g/kg)	K ₂ O-total (g/kg)
Raw digestate	650	3,6	-	41	-
Solid fraction after centrifuge	90	23,5	-	40	-
Liquid fraction after centrifuge		-	1000 (mg/L)	-	-
Struvite	500	> 90	50	126	0

Current drivers for interest in Nutrient Recovery and Reuse (NRR) Technologies

Currently only 20% of the total phosphorus present in the digestate can be recovered as struvite. Waternet has the ambition to increase the amount of recovered phosphorus substantially and was therefore selected as one of the outreach locations of SYSTEMIC.