

Anti - fouling - System with copperstripes (AFS)

Measurements, expertise and conclusions

Measurements have been made in three different water treatment plants in Switzerland to find out the content (percentage) of copper in the waste water:

- Zürich-Werdhölzli population 670'000
- Winterthur-Hard population 135'000
- Wädenswil population 44'000

The measurement is difficult in the inflow to the water treatment plant. They are normally made in the sewage sludge or in the water outflow.

1. Copper-content in inflowing waste water

1.1. Zürich

a) *dry sludge*

copper in dry sludge	320 – 420 mg/kg DS
dry sludge/a	9496 t/a
copper/a	3419 kg/a

b) *outflow*

copper content	0.02 – 0.08 mg Co/l
waste water flow	73'214'800 m ³ /a = 2322 l/s
copper/a	366 kg/a

c) *inflow*

copper content	52 mg/m ³
copper/a	3785 kg/a

1.2. Winterthur

a) *dry sludge*

copper in dry sludge	300 mg/kg DS
dry sludge/a	2743 t/a
copper/a	800 kg/a

b) *outflow*

waste water flow	19'112'000 m ³ /a = 606 l/s
------------------	--

c) *inflow*

copper content	46 mg/m ³
copper/a	885 kg/a

1.3. Wädenswil

a) dry sludge

copper in dry sludge	180 - 260 mg/kg DS
dry sludge/a	2500 t/a
copper/a	1000 kg/a

b) outflow

waste water flow	3'500'000 m ³ /a = 110 l/s
------------------	---------------------------------------

c) inflow

copper content	314 mg/m ³
copper/a	1100 kg/a

2. Copper input in sewage from copper stripes (AFS)

2.1. Average project

heatexchanger length	39 m
copper stripes	13
length	0.83 m
width	0.02 m
thickness	0.003 m
	→ 0.00065 m ³
specific weight	1930 kg/m ³
weight	1.25 kg co/project

2.2. Waste water flow

40 l/s

2.3. Copper stripes = sacrificial anode

life span (EMPA, SGK, EAWAG)	15 Jahre min. / 25 years estimated
---------------------------------	------------------------------------

2.4. Additional copper input in the waste water with 1 AFS plant

0.0011 mg/m ³	WTP Zürich
0.0043 mg/m ³	WTP Winterthur
0.0236 mg/m ³	WTP Wädenswil
+ 0.02 ‰	WTP Zürich
+ 0.09 ‰	WTP Winterthur
+ 0.075 ‰	WTP Wädenswil

2.5. Potential of economic waste water heat recovery plants

Zürich	80 - 150
Winterthur	18 - 30
Wädenswil	3 - 7

2.6. Max. Copper input with all the economic reasonable plants in operation

Zürich	+ 2.30 ‰
Winterthur	+ 2.16 ‰
Wädenswil	+ 0.38 ‰

3. Technical expertise / Conclusions

WTP population	Inflow wtp mg Co/m ³ waste water	Anti-fouling-System (copper)			
		Max. co/plant		Max. co/total potential	
		mg	‰	mg	‰
> 500'000	50	0.001	0.02	0.115	2.3
80 – 500'000	50	0.004	0.04	0.103	2.1
10 – 80'000	300	0.024	0.07	0.120	0.4
< 10'000	600 max.	0.042	0.1	0.126	0.5

- The measured fluctuation of the copper content in public sewers is ± 20 %.
- The max. Increase of the copper content in waste water with an AFS is 0.02 ‰ with 1 plant or 2.3 ‰ with all possible economic plants running.
- **AFS can be integrated everywhere**
 - with public approval
 - with an input of copper not measurable much smaller than the fluctuations

4. Anti fouling system (AFS) to eliminate biofilm on heat exchanger surface

4.1. AFS



4.2. Construction

- Copper and stainless steel are not intermateable, copper being the material with a higher standing. Theoretically, the stainless steel could be depleted.
→ with an insulation between the two materials, even within the water, the depletion can be eliminated.
- Heat exchangers in waste water will and must have a life span of 50 years. Therefore, copper stripes will have to be replaced within that period once. The construction allows a replacement in a very short time, allowing the uninterrupted flow of waste water.