

Water Treatment of Tertiary Sewage Effluent to Boiler Water VGB Quality

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PASSION FOR CHEMISTRY

Case Study Summary

- A power station in Malaga, Spain treats tertiary sewage effluent up to demin water quality fit for boiler use
- Part of the ZLD water management scheme
- Permit required the power station not to use potable water for operations

Challenges

- Reduce N and P
- Reduce Hardness
- Reduce TOC
- Reduce Bacteria
- Remove TDS
- Remove SS
- Remove colloids to reduce SDI to acceptable levels for RO operation

Feedwater Quality vs Required Water Quality

Table 1 Raw water quality

Parameter	unit	value
Susp. solids	ppm	35
TOC	ppm	36
DOC	ppm	15
BSB ₅	mg/l	26
SDI	%/min	n.m.
Bacteria	1/ml	152.000
pH	-	7 - 8
Cond.	μS/cm	2800
Hardness	ppm CaCO ₃	360
Alkalinity	ppm CaCO ₃	350
Fe	ppm	0,3
Mn	ppm	0,3
Ba	ppm	n.m.
SiO ₂	ppm	17
PO ₄	ppm	24
NH ₄	ppm	54

Table 2 Target quality after treatment (MIX outlet)

Parameter	unit	value
Cond.	μS/cm	< 0,10
Na, K	ppm	< 0,01
DOC	ppm	< 0,30
Fe	ppm	< 0,01
SiO ₂	ppm	< 0,01

Legend:

BSB₅ = BOD₅

DOC = Dissolved Organic Carbon

SDI = Silt Density Index

MIX = Mixed Ion Exchanger

Detailed Analysis of the TOC in Feedwater

Table 3: LC-OCD analysis of the raw water

	µg/l	%	µg/l	%	µg/l	%
TOC	14604	100	13039	100	16163	100
POC	1288	8.8	1393	10.7	1248	7.7
DOC	13315	91.2	11646	89.3	14914	92.3
HOC	1457	10.0	697	5.3	1277	7.9
CDOC	11848	81.2	10950	84	13638	84.4
Biopolymers	2702	18.5	2632	20.2	3094	19.1
Humic substances	3225	22.1	2768	21.2	3683	22.8
Building blocks	2455	16.8	2137	16.4	2866	17.7
Neutrals	3475	23.8	3413	26.2	3994	24.7
Organic acids	n.d.		n.d.		n.d.	
Biopolymers	Polysaccharides, proteins, amino sugar				MV >> 20000	
Humic substances					MV ca. 1000	
Building blocks	Fractions of humic substances				MV 300 – 500	
Neutral substances	Monosaccharides, alcohols, aldehydes, ketones				MV < 350	
Organic acids					< 350 dalton	

Legend:

HOC = Hydrophobic Organic Compounds

CDOC = Coloured DOC

LC- DOC = Analytical Technique, Liquid Chromatography with Organic Carbon Detection

Final Plant Theoretical Concept

Table 5 Final plant concept

		Waste water	Floccul. FeCl ₃	Ultra-filtration	Activated carbon	Reverse osmosis1	Reverse osmosis2	CO ₂ reduct.	Mixed bed
DOC-Red. %				15 %	80 %	85 %	80 %		10 %
DOC	mg/l	15		12,8	2,6	0,39	0,08		< 0,08
BOD	mg/l	26		15					
SDI	mg/l	n.m.		< 2	-				
Keime	K/ml	152.000		< 10	-	< 1	-	-	
pH	mg/l	7 - 8		-	-	4,6	4,0	5,5	7 - 8
Cond	μS/cm	2800		-	-	26	3,0		< 0,1
PO ₄	mg/l	24	< 3	-	-	0,01	< 0,01		
NH ₄ -N	mg/l	54		-	-	1,8	0,3		
Ca	mg/l	145		-	-	1	< 0,1		
CO ₂	mg/l	(10)		-	-	150	150	10 (20)	
SiO ₂	mg/l	17		-	-	0,3	0,02		< 0,01
TSS	mg/l	35		< 1	-	< 1	< 1	< 1	< 1

Variations

- Option to Dose PAC in the clarifiers
- Option to dose Lime in the clarifier to reduce hardness
- MMF After the clarifier
- Use of the Carbon Filter as a Biofilter by dosing micro air bubbles upstream