

WWTP Marines, Spain

Upgrading a Municipal WWTP using AGAR® Technology

A Case Study

Case Study: Municipal plant

Start up: May 2007

Capacity: 380 m³/d

Abstract

In view of EU directives for effluent discharge, it was required to upgrade the local sewage plant in the town of Marines, Valencia (Spain). The technology chosen for the project was AGAR® (Attached Growth Airlift Rector) of AqWise - Wise Water Technologies Ltd. La Entidad Pública de Saneamiento de Aguas Residuales (EPSAR) has promoted the implementation of the AGAR® system in the Valencian Region, whereas SAEM Ingeniería was chosen as a co-designer company for the system. For the installation of the process in the existing aeration tank, the plant had to be shut down for only five days. Effluent quality, as measured along two months following the upgrade project, complies with EU directives as planned.

Sewage from the small town Marines, in the Valencia region, Spain, is treated in a centralized wastewater treatment plant (WWTP). Secondary effluent from the plant is discharged into a dry gully near the plant. According to current EU directives regarding the collection and treatment of urban

wastewater, in some cases WWTPs are required to remove nutrients (nitrogen and phosphorous) as part of their biological wastewater treatment (Table 1). The Marines plant was only designed for removal of organic carbon, and was not equipped with the components necessary for nutrients removal. In addition, the plant occasionally receives instantaneous peaks of organic load from the local food industry.

Parameter	Value	Units
BOD ₅	< 20	mg/l
TSS	< 25	mg/l
TN	< 15	mg/l
NH ₄ -N	< 10	mg/l
TP	< 5	mg/l

Table 1: Effluent criteria that apply to the plant in Marines.

Description of the original plant

The original plant included the following unit operations:

- Pre-treatment by mechanical screening with openings of 3 mm
- Biological treatment by extended aeration activated sludge process, in a single concrete tank. Air was supplied to the process through an array of fine bubble disc diffusers fully covering the tank bottom.
- Secondary settling in a rectangular settling tank, wherein, secondary sludge

from the bottom of the clarifier was circulated back to the reactor, as part of the activated sludge process.

- Excess sludge from the clarifier was transferred to the thickener and belt filter.

Treatment process parameters are detailed in Table 2.

Parameter		Value	Units
Aeration Tanks	No. of units	1	---
	Volume	422	m ³
	Depth	6.45	m
Secondary clarifiers	No. of units	1	---
	Surface area	42	m ²
	Hydraulic load	0.35	m ³ /m ² /d

Table 2: Process parameters

Shortcomings of the original design

Although the original plant was properly designed, it suffered from the following shortcomings:

- The process configuration was not suitable for nitrogen removal through nitrification / de-nitrification;
- In times of peak organic loads coming from a local canning factory, when sewage BOD₅ levels would rise to more than 600 mg/l and COD to more than 1,000 mg/l, plant performance would deteriorate, resulting in poor effluent quality.

The above reasons indicated that a change in plant configuration was necessary in order to achieve the goal of biological nutrient removal while facing fluctuations in the strength of the incoming wastewater.

The selected solution

The method chosen for the upgrade was an IFAS (Integrated Fixed-film Activated Sludge) system, based on the AGAR[®] (Attached Growth Airlift Reactor) technology of AqWise - Wise Water Technologies Ltd. The AGAR[®] technology incorporates a bio-film process in a completely stirred tank reactor. The bio-film develops on plastic carriers which move freely in suspension in the reactor tank, using air supplied from diffusers for both mixing and oxygen supply. In an IFAS system, a biofilm develops on plastic carriers, which are used in combination with conventional activated sludge. This combination takes advantage of the good settling properties of the activated sludge process with the increase in active biomass on the carriers. The result is sufficient nitrification and de-nitrification capacity without additional reactor volume, as well as short time for installation.

Design of the upgraded plant

The basin volume was divided into three consecutive stages using vertical partitions, which created a MLE process configuration: an anoxic pre-denitrification stage followed by one (or more) aerobic stages (Figure 1). The settled sludge from the clarifier and mixed liquor from the last aerobic stage were both recirculated to the anoxic stage.

Denitrification in the first anoxic stage utilizes the high BOD in the influent. Stage 2 of the reactor operates with activated sludge in order to achieve removal of any remaining BOD. Stage 3 of the reactor operates as IFAS, using both activated sludge and biomass carriers. While the activated sludge is aerated to maintain a low F/M ratio, nitrification is carried out on the biomass carriers. The aeration

system was re-arranged by moving diffusers from the anoxic zone (which was aerobic in the original design) to the aerobic stages.

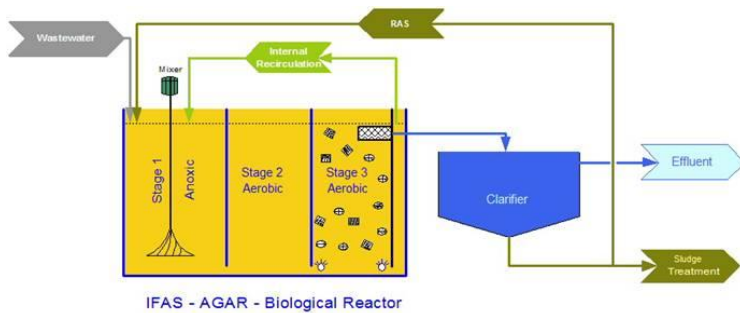


Figure 1: Process flow diagram

The installation procedure

Complete installation of prefabricated parts was completed in five days. The works included:

- Drainage of the aeration tank
- Installation of prefabricated partitions in the aeration tank
- Re-arrangement and testing of the aeration system
- Installation of wedge-wire screens for retention of the carriers in the reactor
- Installation of an internal recirculation pump
- Filling up of stage 3 with biomass carriers
- Resuming wastewater flow to the plant



Figure 2: Installation of prefabricated partitions



Figure 3: Plant after upgrade

Results

Effluent samples from the upgraded plant were analyzed regularly for two months after installation. The results presented in Figures 4-6 show gradual and steady convergence towards stabilization of the BOD₅, NH₄⁺-N and TSS values to below effluent quality requirements (Table 3).

Parameter	Raw influent	Effluent after plant upgrade	Regulatory requirement	Units
BOD ₅	350	< 10	< 20	mg/l
TSS	260	< 10	< 25	mg/l
TN	57	< 10	< 15	mg/l
NH ₄ ⁺ -N	54	< 1	< 10	mg/l
TP	7	< 1	< 5	mg/l

Table 3: Influent and effluent qualities for the upgraded plant

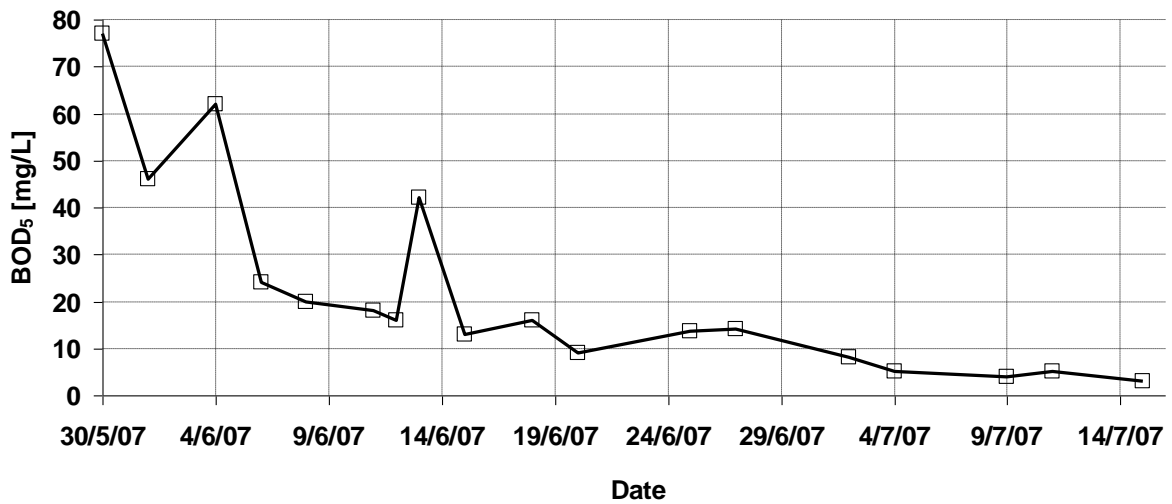


Figure 4: BOD₅ levels after upgrade

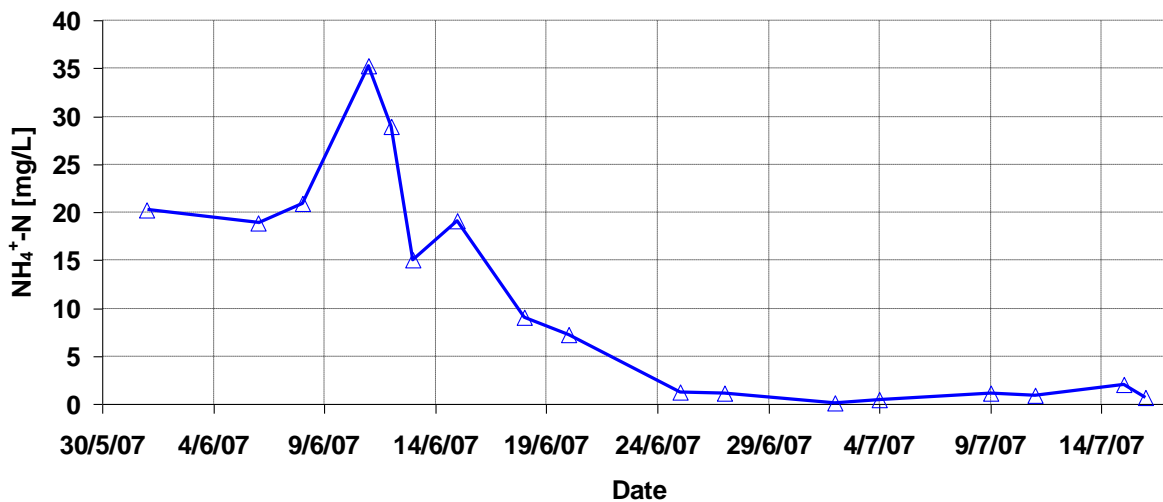


Figure 5: NH₄⁺-N levels after upgrade

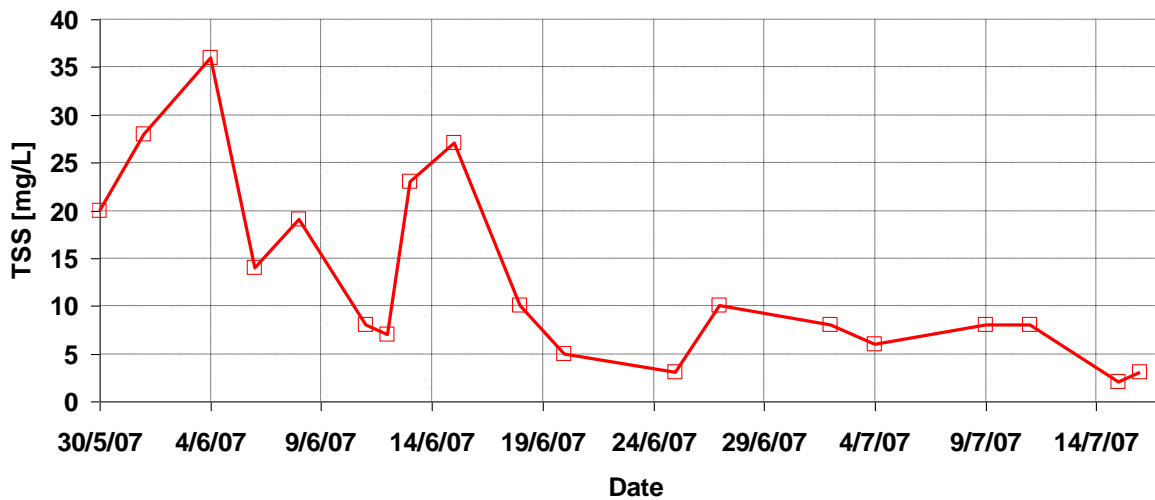


Figure 6: TSS levels after upgrade

Conclusion

The municipal WWTP of Marines was successfully upgraded to comply with EU discharge regulations using an IFAS configuration of the AGAR[®] technology. The upgrade project did not require additional reactor volume, and was completed with only a very short plant shut down. Results following the upgrade show constant nitrogen removal and better BOD removal.

Acknowledgements

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