Odour removal with a trickling filter at a small WWTP strongly influenced by the tourism season

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Abstract Etaples-Le Touquet's wastewater treatment plant (WWTP) is based on a coastal area of the Artois-Picardie region. The pollution load can vary from 20,000 p.e. to 60,000 p.e. over a weekend or in summer. The Collectivity and the Water Agency decided to cover and ventilate the main odour source points of the plant. The foul air was directed to a 2,500 m^3/h inorganic bed biofilter (Alizair®) for odour control. An odour monitoring took place during the first year of operation taking into account cold and warm seasons, high and low tourism seasons.

The Alizair biofilter appeared an appropriate odour control process for small sized wastewater treatment plants, easy to operate and efficient even in areas where tourism seasons have a great impact on the pollution load arriving at the plant. The neighbourhood did not complain about odours any more and the operator was very confident with such a simple and effective system.

The local Authorities and the Water Agency agreed to recommend Alizair biofilters with an autotrophic biomass adapted in the case of an old WWTP that cannot be up graded any more or for large pumping stations and wastewater storage prior treatment.

Keywords Odours; biofilter; autotrophic biomass; tourist area; small size WWTP

Introduction

Professionals involved in wastewater treatment and those providing odour control services report a generally increasing awareness of odours. Odour control for wastewater facilities encompasses a broad range of activities used to minimise odour release in the gas phase, treat odour or modify the odour in the gas and liquid phases, and increase the atmospheric dispersion and dilution of released odours. Proper odour control is closely tied to wastewater system design, including sewer, liquid and solids process designs. Hydraulic factors also have an impact on odour because wastewater turbulence results in the release of odorous compounds.

Odorous substances that are emitted from domestic wastewater collection and treatment processes include both inorganic and organic gases and vapours. Inorganic gases include hydrogen sulfide (H_2S) and ammonia (NH_3). Many of these odorous substances result from the anaerobic decomposition of organic matter containing sulfur and nitrogen. However, odours may also be generated by aerobic decomposition and solids-processing methods that include heat treatment. Sewer gas includes highly odorous compounds such as mercaptans, organic sulfides and organic nitrogen compounds such as amines.

For collectivities, Water Agencies as well as plant operators, odour control is a crucial issue even more in a tourist area. The difficulty is to find adequate solutions that answer to several determinant criteria. The solution ought to be:

- effective even with sudden high loads of wastewater,

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- economically viable for small size WWTPs (below 80,000 population equivalent, p.e.) in terms of investment, water and energy supply, reagents, personnel time,
- simple to operate and maintain (no requirement of qualified personnel),
- compact as usually WWTPs do not have excess space for additional treatment processes.

Case study

Etaples-Le Touquet's WWTP is based on a coastal area of the Artois-Picardie region and was commissioned in 1985. The pollution load of Le Touquet's WWTP can vary from 20,000 p.e. to 60,000 p.e. over a weekend or in summer. The plant is presented in Figure 1.

Etaples-Le Touquet WWTP is a biofiltration plant that was initially considered as a reference in architectural and landscape integration. It presented a good efficiency in carbon and nitrogen removal. However, long residence time in sewers (up to above 24 hours) generated odour emissions. Therefore, the operator received complaints from the neighbourhood.

Local authorities decided in association with the Water Agency and the operator of the plant to cover the principal odorous processes, ventilate and connect them to an Alizair® trickling filter for odour control. The main characteristics of the Alizair® biofilter are an inorganic filter bed media and an autotrophic biomass.

The implementation of such a full-scale set-up was considered as a trial for similar WWTPs in the Region to ascertain its adequacy for local circumstances where the WWTP's load varies widely and suddenly. In the case of Etaples-Le Touquet's WWTP, it was taken as a priority.

A monitoring of the unit during its first year of operation was therefore undertaken from June 1998 to June 1999. The potential odour point sources of the plant were monitored in parallel.

Methods

Implementation of a new odour control approach

Ahead of the air treatment, the reduction of odour nuisance on the plant began with:

- prevention of anaerobic fermentation in the sewers
- reduction of water falls causing gas release
- cover up of every odour source
- optimisation of air extraction from confined areas

The wastewater intake, the biosolids mixer and filter band were then identified as the main odour point sources and ventilated. Foul air was canalised to an Alizair unit shown in Figure 2.

The Alizair odour control unit implemented at Le Touquet's WWTP was a 2,500 m^3/h (1,470 cfm) trickling filter with inorganic bed media (schist). The filter was bottom loaded with foul air and an homogeneous air distribution through the bed was ensured with a first layer of gravel below the proper filter medium. A discontinuous water spraying helped maintain an adequate moisture in the filter bed for bacterial growth as well as the regulation of the biomass volume during dry phases. The gas-liquid contact was in a countercurrent

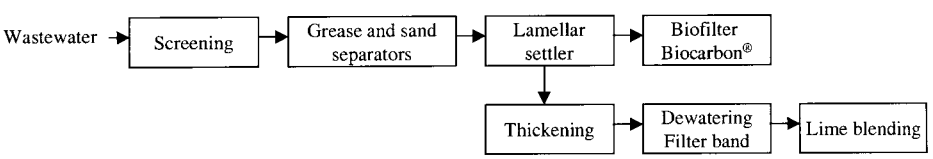

Figure 1 Etaples-Le Touquet WWTP scheme

Figure 2 Alizair trickling filter at Le Touquet's WWTP in the north of France

mode within the filter bed. A pH gradient developed in the filter bed and gave the possibility to absorb ammonia and make it available for bacterial assimilation or nitrification. The superficial filtration rate of the Alizair process was 500 $m^3/m^2/h$ (27 cfm/ft^2) with a 5 to 6 second contact time. The biomass that developed on the filter bed was autotrophic and used only inorganic carbon as nutrient. The filter leachate, after collection in the sump, was discarded and recycled at the head of the plant (3 m^3/d). It removed biodegradation by-products and especially the acidity due to H_2S oxidation in sulfate from the filter bed.

Monitoring

Monitoring of the Alizair trickling filter was carried out during the first year of operation taking into account high and low load periods as well as cold and warm seasons. The monitoring included a global monitoring of odour emissions from the wastewater treatment plant looking specifically at fugitive sources of nuisances. Sulfur and nitrogen compounds were monitored over a year at the plant. Physico-chemical measurements of odorous compounds were carried out. They included on site analyses of instantaneous air samples with gas chromatography and electrochemical detection, as well as average sampling of nitrogen and sulfur compounds by absorption respectively in acid solution and a mercuric chloride solution followed by specific chromatographic analyses.

A neighbouring consultation took place asking to report odour troubles specifying date, time and location of the problem.

The raw water quality, operational parameters of the plant and local meteorological conditions (temperature, hygrometry, wind strength and direction) were gathered. The data were related to odour monitoring and complaint records.

The monitoring took place at five periods of the year as follows in Table 1:

Table 1 Monitoring schedule

Date	Temperature	Tourist period	Load
30 June to 2 July 1998	Warm	No	Low
13 to 15 July 1998	Warm	No	Low
17 to 19 August 1998	Warm	Yes	High
10 to 12 February 1999	Cold	No	Low
13 to 15 February 1999	Cold	Yes	Low to Medium

Results and discussion

Monitoring of odour source points

The main odour source points could be identified during the five main monitoring periods undertaken at Etaples-Le Touquet WWTP. The wastewater intake and biosolids treatment works appeared to be the main sources of odour, as could be expected. The night soil tank was pinpointed as a temporary but strong nuisance source during the first monitoring periods. Levels above 15 mgS/m^3 in H_2S and up to 10 mgS/m^3 in CH_3SH were measured on some occasions. It was therefore ventilated and connected to the odour control unit. The results are presented in Table 2.

Table 2 Odour monitoring at Etaples-Le Touquet WWTP

	Warm period						Cold period			
	Low load				High load		Low load		Medium load	
Dates	1998		1998		1998		1999		1999	
	06/30 to 07/02		07/13 to 07/15		08/17 to 09/19		02/10 to 02/12		02/13 to 02/15	
H_2S (mg S/m^3)										
Main wastewater intake	1.48	15.40	8.18	2.81	>> 15	>> 15	5.34	5.12	7.64	7
Filter band	1.60	0.31	< 0.01	< 0.01	>> 15	>> 15	< 0.01		< 0.01	
Biosolids blending	0.30	< 0.01	< 0.01	< 0.01	0.33	0.71	< 0.01		< 0.01	
Night soils	>> 15	6.84	< 0.01	>> 15	0.81	0.43	0.13	4.46		
					08/20 to 08/21					
Grease separator inlet					0.21	0.28		1.75	2.84	
Grease separator overflow					0.34	1.47				
					08/25 to 08/26					
Lamellar settling tank					0.36	0.65		1.67	3.65	
Biofilter					< 0.01	1.55		< 0.01		
					08/17 to 09/19					
CH_3SH (mg S/m^3)										
Main wastewater intake	0.10	< 0.01	< 0.01	0.11	3.34	< 0.01	0.37	0.21	0.28	0.21
Filter band	0.11	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01			
Biosolids blending	0.06	< 0.01	< 0.01	< 0.01	0.07	0.06	< 0.01			
Night soils	10.17	0.64	< 0.01			< 0.01	0.03	0.16		
					08/20 to 08/21					
Grease separator inlet					< 0.01	< 0.01				
Grease separator overflow					< 0.01	< 0.01		0.01	0.05	
					08/25 to 08/26					
Lamellar settling tank					< 0.01			0.02	0.13	
Biofilter					0.12	0.44		< 0.01		

Throughout the year, the temperature ranged from 10°C to 22°C in the warm period and –7°C to 7°C in the cold period. The ambient air moisture always varied from 45 to 100% even over a 2-days period. Those conditions enhanced odour emissions especially during the monitoring in August 1998 where high temperatures were associated with high COD content in wastewater.

Odorous compounds detected at Le Touquet WTP were hydrogen sulfide (H_2S) at any time and very low levels of methylmercaptan (CH_3SH) or ammonia (NH_3) except in high load periods.

Odour emissions at the head of the plant were directly related to the influent load in chemical oxygen demand (COD), its septicity monitored with oxidant-reductor potential (ORP), and the specific use of sewer in high and low tourist season:

- Low load period: COD was usually below 500 mgO_2/l. ORP ranged from –100 mV to 10 mV in the cold season and is approximately 120 mV in the warm season. H_2S emissions were between 2 and 5 mgS/m^3. They could rise sometimes up to 15 mgS/m^3 in the morning during warm periods due to the association of long residence times in sewers, they were less used over night, and at higher temperature.
- High load periods: COD rose widely and ranged from 884 mgO_2/l to 1469 mgO_2/l. An ORP of approximately –80 mV revealed a strong septicity of the influent. Ambient temperature between 9.5°C and 22.6°C enhanced volatile odorous compounds emission. H_2S emissions were widely above 15 mgS/m^3.

Sulfur compounds emissions were limited at the lime blending emission due to the pH increase generated by the lime up to 12 trapping the sulfur compounds. Sulfur compounds emissions on the sludge treatment line were mainly generated by the operation of the filter band. H_2S emissions ranged from 0 to 1.6 mgS/m^3 in the cold season and were quite above 15 mgS/m^3 in warm and high load periods. Emissions decreased rapidly after stopping the operation of the filter band.

Other odour measurements were undertaken on the main treatment processes of the plant including the grit-grease removal, lamella settlers, the Biocarbon filters and the thickening plant. Odour generations were fugitive and most of the time below detection limit.

The odour monitoring at Etaples-Le Touquet over one year showed that the main odour source points were now covered, ventilated and the air directed to the Alizair odour control unit. The remaining odour source points not connected to the odour control biofilter were only fugitive odour source points.

Performances of the Alizair biofilter

The odour control biofilter was fully operational after only two weeks. From that moment, whatever the odorous compounds load at the biofilter inlet (from 0.56 mgS/m^3 to above 15 mgS/m^3 in H_2S), the biofilter exhaust air presented sulfur compounds levels below the detection limit. The trickling filter demonstrated good performances in odour control during the low load period (~1 mg/m^3 H_2S) as well as during high load periods (up to 70 mg/m^3 H_2S). H_2S and CH_3SH removal were at any time 99.9%. The main results are presented in Table 3.

In the case of ammonia, the removal could be as low as 50% however the initial low load was the reason for such removal. At any time, NH_3 emission at the Alizair filter outlet was lower than 0.6 mg/m^3.

An interesting part of the monitoring was that it showed the Alizair process reacted rapidly to sudden load in odorous compounds, even after several months (up to three months in this case) with nearly no load thus no real biological activity in the trickling filter. No lag time was noticed for this biological process to be efficient when a sudden excess load happened.

Table 3 Alizair biofilter results

	Warm period						Cold period			
	Low load				High load		Low load		Medium load	
Dates	1998		1998		1998		1999		1999	
	06/30 to 07/02		07/13 to 07/15		08/17 to 09/19		02/10 to 02/12		02/13 to 02/15	
H_2S (mg S/m³)										
Alizair inlet	2.10	2.86	0.56	2.06	>> 15	>> 15	1.44	3.83	2.92	2.38
Alizair outlet	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
CH_3SH (mg S/m³)										
Alizair inlet	0.14	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	0.12	0.03	0.02
Alizair outlet	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total sulfur compounds (mg S/m³)										
Alizair inlet	1.20		0.25		2.33		3.52		2.33	
Alizair outlet	< 0.01		< 0.01		0.02		< 0.01		< 0.01	
NH_3 (mg N/m³)										
Alizair inlet	0.21		0.25		0.50		0.05		0.05	
Alizair outlet	0.03		0.13		0.30		0.01		0.01	

Some complaints came from the neighbouring area during the two initial monitoring sessions in June and July 1998. The complaints mentioned temporary nuisances that could be related to the night soils tank not being ventilated or connected to the odour control biofilter at that time.

An interesting point to notice was that during the monitoring in August 1998 where high loads in H_2S, CH_3SH could be measured, no complaint arrived at the plant from the neighbours.

In two years of operation, some erratic complaints arrived at Etaples-Le Touquet WWTP. The Alizair biofilter complied most of the time with the requirements of the Collectivity, the Water Agency and most of all neighbours and tourists.

The Alizair inorganic bed biofilter demonstrated a good adequacy at removing odours in a small WWTP whose operation is strongly influenced by the tourist season.

Operation of the Alizair biofilter

1. The operation and maintenance tasks are quite simple as follows:

Daily:

- the overall efficiency of the system is checked by the operators as the filter is located by the parking area and the air outlet if directed downward
- pressure loss through the filter control
- depression ahead of the main blower control
- filtrate pH control

Twice a month:

- spray nozzles check and cleaning
- water filter cleaning
- filtrate analysis

2. Manual regulation with the filtrate pH (ideally within 1.8–2.6):

- low = > increase water
- high = > decrease water

3. Reagents

Apart from the commissioning period where KOH solution was used to help develop biomass, no reagent has been used.

4. Dysfunction

The sole disorders encountered were related to defective spraying with a clogged water filter or a poor quality of sprayed water. The outgoing air rapidly smells. A good function is recovered within a few hours by continuous spraying with drinking water.

Conclusion

Before the installation of the Alizair biofilter at Le Touquet WWTP, the local authorities' attention was focussed on the odour problems. The plant required an upgrade but undertaking it at the same location was in question due to odour nuisances.

An evaluation of the air flow to be treated with a full coverage of the plant indicated 21,000 m^3/h. The Alizair system treats 2,500 m^3/h. Now, with the main odorous sources controlled, the nuisance has been greatly reduced at low cost.

The permanent population of Le Touquet as well as tourists are satisfied with the odour disappearance.

The local Authorities are now convinced it is possible to upgrade Le Touquet WWTP at the same location. The Water Agency is convinced it is possible to implement a small WWTP with minimal odour nuisance. Such a biofilter with an inorganic media is compact and well adapted in the case of old WWTPs that cannot be upgraded. From its point of view, such a biofilter can also be recommended for large pumping stations, inlet of wastewater storage vessels before treatment.

The study before the installation and the close monitoring following enhanced the awareness of the plant operators to the cause and the remedies for the odours. For instance, the night soil tank was connected after the first monitoring period whilst it was not expected to be connected at the beginning. Every three months, a complete survey of the air flows to the filter is undertaken, which is not common on a WWTP.

The inorganic bed biofilter appears to be more compact than a peat bed biofilter. It is also easier to operate and maintain than a wet scrubber.

The operators are very confident with such a simple and effective system.

On the whole, local authorities, the Water Agency and the operators were fully satisfied with an odour control unit they found adequate to fulfil their objectives for installing an odour control unit:

- effective even with sudden high loads in wastewater,
- economically viable for small size WWTPs
- simple to operate and maintain,
- compact.

In conclusion, the Alizair trickling filter appears an appropriate odour control process for small sized wastewater treatment plants, easy to operate and efficient even in areas where tourism seasons have a great impact on the pollution load arriving at the plant.

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