CHARACTERIZATION OF ODOURS EMITTED BY LIQUID WASTE TREATMENT PLANTS (LWTPs)

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ABSTRACT

Odour emissions from liquid waste treatment plants (LWTPs) generally cause significant effects on the environment in terms of nuisance to exposed population. The particular and complex nature of the mixture of the volatile substances, its variability in time and the strong influence of the atmospheric conditions, are the elements that delayed their regulation and relative management.

Limited data are available in the technical and scientific literature, regarding the odour emissions characterization from liquid waste treatment plants. Moreover there isn't a common strategy from the different European Countries in the regulation of their emissions.

Different methods can be used to measure odour emissions from environmental engineering plants, and currently, in Europe, the most used techniques for odour emissions characterization and quantification is the dynamic olfactometry, according to EN 13725:2003.

The aim of this study is the characterization of the odour emissions from different liquid waste treatment plants (LWTPs), trough a case study of two large real LWTPs, in order to identify the principal odour sources and to define their related odour emissions.

Concentration Index (CI) is proposed as a useful and simply odour management tool for the identification of the priority actions necessary to identify and control the main odorous sources. Relationship between the measured odour emissions and the types of treated liquid waste is also discussed.

Results shown that the influent collection tank is the source with the highest detected odours emissions. CI results are useful for the definition of a clear priority action for odour control, similar for both investigated plants. Between the characterized types of liquid waste treated by LWTPs the leachate (EWC 190703 code) show the maximum odour emissions.

Keywords: dynamic olfactometry, European Waste Catalogue (EWC) code, leachate, odor impact, odor monitoring.

1. Introduction

In recent years the need for treatment of liquid waste, coming from the most varied industrial activities, has grown considerably (Belgiorno et al., 2012). Their treatment generally occurs in authorized wastewater treatment plants. Liquid waste, in terms of EU regulations, are identified and disposed in authorized treatment plants according to EWC code (European Waste Catalogue).

In the technical and scientific literature regarding the issue of odours emitted by liquid waste treatment plants limited data are available. Moreover there isn't a common strategy from the different European Countries in the regulation of their emission (Stuetz et al., 2001; Zarra et al., 2008).

Currently, in Europe the most used techniques for the characterization of odour emissions and quantification is the dynamic olfactometry, according to EN 13725:2003 (Nicell, 2009, Zarra et al., 2014;).

The aim of the study is the characterization of the odour emissions from different liquid waste treatment plants (LWTPs), trough a case study of two large real LWTPs, in order to identify the principal odour sources and to define their related odour emissions. Relationship between the measured odour emissions and the types of treated liquid waste, in terms of EWC code, is also discussed.

2. Materials and methods

2.1. Liquid waste treatment plants (LWTPs)

Research studies were carried out at two large real liquid waste treatment plants (LWTPs), located in the municipality of Buccino (B) and Palomonte (P), in the Salerno Province, in the Campania Region (Italy). Both plants were initially designed for the treatment of industrial wastewater and only in the recent years they were adapted and authorized also to the treatment of non-hazardous liquid waste. The principal design characteristics of the investigated LWTPs are shown in Table 1.

The main treated liquid waste types of both plants are leachate from landfill (EWC 190703), sludges from dairy waste (EWC 020502) and leachate from refuse derived fuel (RDF) plants (EWC 161002).

Table 1. Design characteristics of the investigated LWTPs.

Parameter	LWTP	
	Buccino	Palomonte
Average daily flow	6600 m^3/g	108 m^3/h
BOD_5	3600 kg/g	1690 kg/g
COD	7200 kg/g	3380 kg/g
max treatment capacity of non-hazardous liquid waste	300 t/g	200 t/g

2.2. Sampling program

Odour samples were taken every month at 6 different treatment units in each LWTP for a period of 12 consecutive months, from January 2014 to January 2015. Figure 1 shows the identification of the investigated treatment units for both plants.

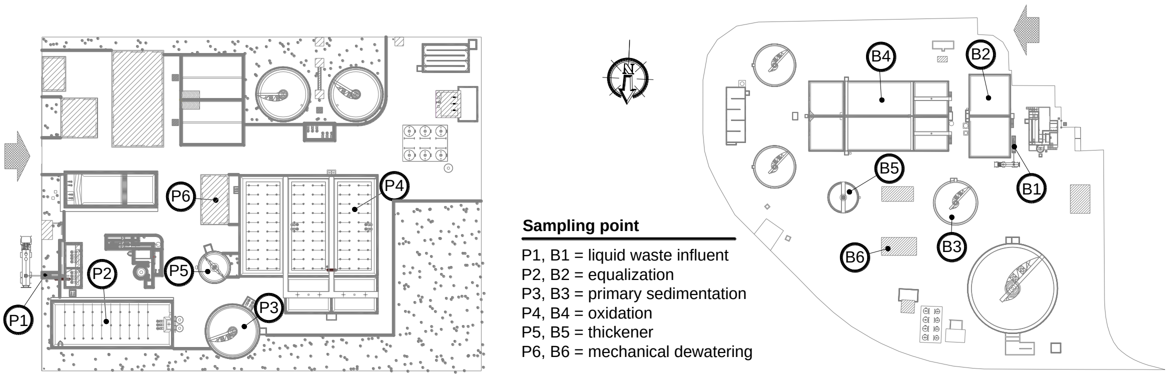

Figure 1. Sampling points at investigated LWTPs (Palomonte (P), left; Buccino (B), right)

Lung technique was implemented for the air sampling at selected emission points, using a vacuum pump in accordance with EN 13725:2003. 10 L volume of Nalophan® bags were used for the sampling. Passive areal sources are sampled using the SF450 flux chamber (Scentroid, CDN).

In order to investigate the relationship between the emitted odour concentration and the types of liquid waste, were also monthly collected the liquid waste samples of the main three abundant waste types at the influent point and its relative odour emission. Liquid waste samples were collected according to the APAT IRSA CNR 1030 MAN 29/03 method, taking a sample of 10 L in an amber glass container.

A total of 216 air samples and 72 liquid waste samples were collected of both plants in the investigated period.

2.3. Analysis

Collected air samples were characterized by dynamic olfactometry according to EN 13725:2003, determining the odour concentration in terms of OU/m^3. Olfactometric analyses were conducted at the Olfactometric Laboratory of the SEED (Sanitary Environmental Engineering Division) at University of Salerno using the olfactometer model TO8 by ECOMA. All samples were analysed within 30 h after sampling, relying on a panel composed of 4 trained panelists and applying the ‘‘yes/no’’ method. Odour Concentrations (Cod) were also compared in terms of Odour Index (OI) calculated with the following equation:

$$OI = 10\ Log(Cod)$$

Liquid waste samples were characterized in terms of COD and ammonia ($NH4^+$) following the Standard Methods APAT IRSA CNR MAN 29/03 respectively according to Section 5130 and Section 4030.

2.4. Concentration Index (CI) of odours sources

For the comparison of the results was introduced the Concentration Index (CI) and the Priority Action for odour Control (PAC) of odours sources.

CI at the source S_i is calculated with the following equation:

$$CI_{Si} = [75°p(Cod_{Si}) / Cod_{am}]$$

were:

- $75°p(Cod_{Si})$ is the 75° percentile of Odour Concentration (Cod) measured at the source S_i
- Cod_{am} is the admissible concentration at emission point, that in this study, in absence of national limit, was fixes at 300 OU/m^3 according to Lombardia Region Law that limit the odour emission from biofilters.

CI define the ranking between the different sources in terms of odour emission and give strategic information for odour control and management in the plant.

Priority Action for odour Control (PAC) is the ranking order of each odorous source according to calculated CI.

3. Results and discusion

3.1. Odour emission characterization

Variability of odour concentrations at investigated treatment units over the monitored period was reported in Figure 2. Results show that at the LWTP of Buccino the highest odour concentration (C_{od} = 92’682 OU/m^3) was detected at liquid waste influent (B1), while the lowest (C_{od} = 29 OU/m^3) at the sludge treatments (B5, B6). Similarly at the LWTP of Palomonte the liquid waste influent point has registered the highest odour emission concentration (C_{od} = 73’562 OU/m^3), while the lowest odour concentration was detected at the mechanical dewatering and the oxidation treatments (C_{od} = 23 OU/m^3). The source that highlights the major variability was in both plants the influent liquid waste thank, while the thickening in the Buccino LWTP and the mechanical dewatering in the Palomonte LWTP were the sources with more stable emitted concentrations of odours.

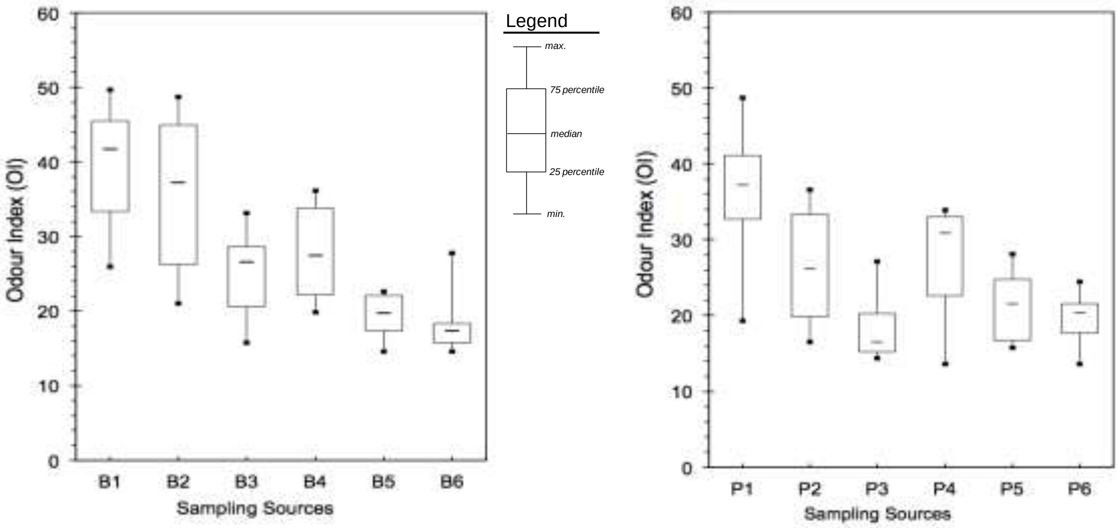

Figure 2. Box-Whisker diagrams on measured odour concentrations at Buccino LWTP (*left*) and at Palomonte LWTP (*right*)

Figure 3 shown the relation of COD and $NH4^+$ versus odour index (OI) for each liquid waste, identified in terms of ECW code, investigated in both plants at influent point. With reference to ammonia content, leachate from landfill (EWC 190703) have high variability and high content of ammonia. On other hand sludges from dairy waste (EWC 020502) and leachate from refuse derived fuel (RDF) plants (EWC 161002) have limited variability of ammonia and generally lower odour concentration at emission sources.

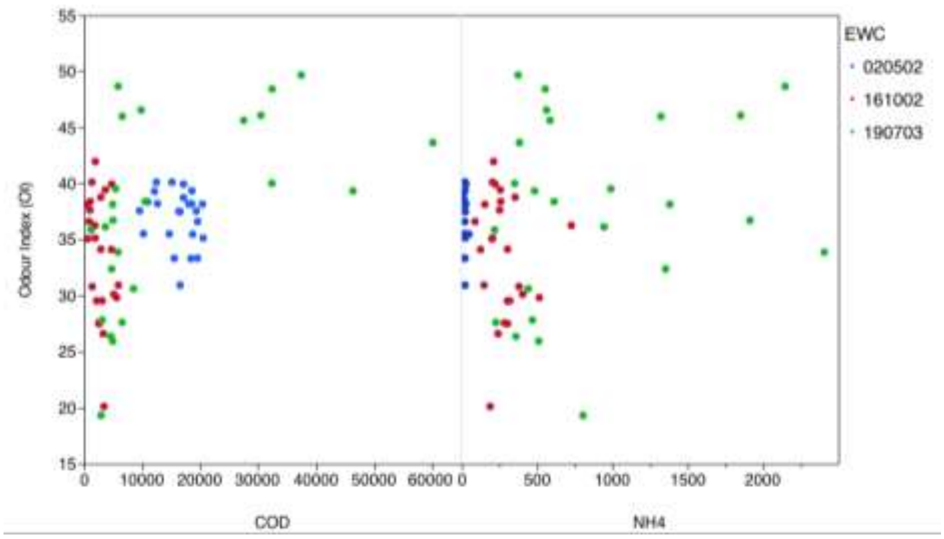

Figure 3. Characterization of Odour Index (OI) versus COD (mg/L) and Ammonia (mg/L) for each investigated EWC code in both plants.

In terms of COD the results are more stable with exception of some points of leachate from landfill (EWC 190703) that have very high content of COD.

Comparing the results of odour emissions monitored in both LWTPs with the odour concentration generally emitted by conventional wastewater treatment plants (Zarra et al. 2008; Zarra et al., 2012), it can see how the emissions are higher.

3.2. Concentration Index (CI) of odours sources

Table 2 show the Concentration Index (CI) and the Priority Action for odour Control (PAC) for all monitored treatment units in both plants.

Table 2. Characterization of treatment units for both plants in terms of CI and PAC.

LWTP		Buccino			Palomonte		
ID	**Sampling point**	**75° p Cod [OU/m^3]**	**CI**	**PAC**	**75° p Cod [OU/m^3]**	**CI**	**PAC**
1	Liquid waste influent	35587	118,6	*1*	12894	43,0	*1*
2	Equalization	31661,5	105,5	*2*	2173	7,2	*2*
3	Primary sedimentation	724	2,4	*4*	107	0,4	*6*
4	Oxidation	2370,5	7,9	*3*	2006	6,7	*3*
5	Thickener	162,25	0,5	*5*	303	1,0	*4*
6	Mechanical dewatering	67,5	0,2	*6*	143	0,5	*5*

The results show that for both plants the liquid waste influent tank is the treatment unit that need some Priority Action for odour Control before all others units. In addition, according to calculated CI between all monitored treatment units, only 2 odour sources for each plant have odour concentrations, in terms of their 75% percentile, lower to fixed admissible odour limit.

4. Conclusions

Odours emitted by LWTPs generally are more higher of the odours measured at the conventional wastewater treatment plant. The proposal and the use of the Concentration Index (CI) highlights that only two sources for plant has a acceptable odour concentration at emission point.

In both investigated LWTPs the odour source with the highest detected odour concentration are localized in the initial treatment units (the liquid waste influent tank and the equalization basin). The Priority Action for odour Control (PAC) index give a clear priority list of actions needs in the plant for the implementation of effective odour control strategy.

Additional studies are needed to investigate the plants that treat different type of liquid waste and to analyze the possible correlation between the content of organic substance in the liquid waste versus the their odour emission capacity (OEC).

REFERENCES

1. Belgiorno, V., Naddeo, V., Zarra, T. (2012), Odour Impact Assessment Handbook, Wiley & Son. London. ISBN: 978-1-119-96928-0
2. Stuetz R., Frechen F.B. (2001), Odours in wastewater treatment: measurement, modelling and control, IWA Publishing, ISBN:1900222469.
3. Zarra T., Naddeo V., Belgiorno V., Reiser M., Kranert M. (2008), Odour monitoring of small wastewater treatment plant located in sensitive environment, Water Sci. Technol. **58(1)**, 89-94.
4. EN 13725:2003 (2003), Air Quality e Determination of Odour Concentration by Dynamic Olfactometry, Comité Européen de Normalisation, Brussels, 1 - 70.
5. Nicell J.A. (2009). Assessment and regulation of odour impacts. Atmospheric Environment, **43**, 196-206.
6. Zarra T., Reiser M., Naddeo V., Belgiorno V., Kranert M. (2014), Odour Emissions Characterization from Wastewater Treatment Plants by Different Measurement Methods, Chemical Eng. Trans. **40**, 37-42.
7. Zarra T., Giuliani S., Naddeo V., Belgiorno V. (2012), Control of odour emission in wastewater treatment plants by direct and undirected measurement of odour emission capacity. Water Science Technology **68(8)**, 1627– 1633.