CHEMICAL ENGINEERING TRANSACTIONS Volume 23, 2010
Editor Renato Del Rosso
Copyright © 2010, AIDIC Servizi S.r.l., ISBN 978-88-95608-14-3 ISSN 1974-9791
DOI: 10.3303/CET1023020

An integrated approach to investigation and monitoring of odour emissions from composting plants: the experience of Provincia di Torino (Italy)

P.F. Ariano[(**)] , I. Davi [(*)], R. Martini[(**)],P. Molina[(**)] M. Morello[(*)], R. Romano[(**)]
[(*)] ARPA Dipartimento Provinciale di Torino Struttura Tutela e Vigilanza.
[(**)] Provincia di Torino – Area Sviluppo sostenibile e Pianificazione Ambientale.

In Provincia di Torino (Piedmont Region – Italy), odour emissions from composting plants became an important problem, so that it was necessary to carry out a methodological approach to assess the odour annoyance, causing people complaints, and to take an action on the plant.
This paper concerns with the preliminary results of the project named "Lend us your nose", developed by Provincia di Torino with the contribution of ARPA (Regional Agency of Enviromental Protection). This project started in 2009 and it is still in progress. The work focuses its attention on the area Mappano Borgaro Caselle, where a composting plant is settled.

1. Project development

The project "Lend us your nose" was devised for various purposes and its aim was to develop a method for odour investigation and monitoring, using different techniques. First of all, the project involved the local population: a few number of people, living or working in the investigated area, were asked to help local Authorities recording the odour perception and giving some details about the odour itself, such as its quality, its intensity and its duration. The panelists were also asked to record the weather conditions for each odour episode. All the data, collected by the panelists, were geographically located, recorded in a special database and then compared with the composting plant diary, to find possible relationships between the odour annoyance and single or multiple operations carried out in the organic waste treatment plant. At the same time, Provincia di Torino and ARPA carried out several inspections on the composting plant, to find some technical reasons connected with the odour generation and starting the systematic collection and analysis of the meteorological data.

1.1 Monitoring with a sample of local residents

According to the German Guidelines indications for the measurements of the odour impact by field inspections, the investigated area was divided into a theoretical grid of squares with 300 metres sides. The panel was composed by a voluntary sample of people living or working in the outlined perimeter. Each square was identified by a progressive number, which corresponded to each member of the panel. The panelists

Please cite this article as: Ariano P., Davi I., Martini R., Molina P., Morello M. and Romano R., (2010), An integrated approach to investigation and monitoring of odour emissions from composting plants: the experience of provincia di torino (italy), Chemical Engineering Transactions, 23, 117-122
DOI: 10.3303/CET1023020

were asked to record every odour episode by filling a provided form, which contained a list of four odour types, commonly known. The odour type “A” was defined as “garbage”, the odour type “B” was identified as “rotten wood”, the odour “C” was defined as “faecal/sewerage”, the odour “D” was identified as “cattle slurry/manure” and, finally, the odour type “E” was generically described as “other odours”. The odour type “A” and “B” could be related, respectively, to the pretreatment section or the ACT (Active Composting Time) phase and to the curing phase or to the final storage of the investigated composting plant.
The panelists were also asked to record the duration of the odour episode, the weather conditions and the intensity of the odour itself.

1.2 Monitoring with “Electronic nose”

Meanwhile, a sensorial analyser was installed for odour emissions monitoring.
The sensorial analyser was placed at the receptors, in the residential area, and its location respected the necessary criteria to obtain representative data about the wind direction and the ambient air quality. The location of the electronic nose was chosen through field inspections to find a suitable place with no distortion of airflow or other interferences.
An electronic nose with MOS (Metal Oxide Semiconductor) sensors was employed. The monitoring started with the collection of air samples in the waste treatment plant, to train the instrument to recognise the odour of the different phases. The data set obtained by sensors response curves were validated and processed by a chemometric analysis to obtain a reliable pattern to use to investigate the ambient air quality. After the training, the electronic nose was settled in the residential area for the analysis of the odour impact.
During the monitoring period the electronic nose analysed air for 100 seconds; between a measure and the other the instrument was cleaned with reference air for 10 minutes.
The data collected were processed by statistics and chemometric analysis, to find possible relationships between the air quality at the receptor and typical odour coming from single or multiple composting phases.

1.3 Inspections and plant diary

The inspections took place to verify the correspondence between the approved project and the plant realized. In particular, the inspections were carried out regarding waste management procedures, air capture and abatement systems, drainage and storage of leachate. All the possible sources of the odour emissions were investigated: the correct set up of the leachate sewer and the right working of the aeration systems. ARPA carried out several controls by chemical and physical analysis and airflow measures, to verify the efficiency and reliability of biofilters and scrubbers. Furthermore, in order to monitor the composting process, the waste mixture was sampled during the ACT and the curing phase for chemical and microbiological analysis. At the same time, a plant diary was filled by recording the operations carried out in the plant itself: this diary allowed to mark out every single operation giving some information about handling of wastes, refining of compost, air abatement system maintenance.
The analysis of the plant diary did not show a direct correlation between a single operation and the odour annoyance: anyway the systematic collection of the data

dealing with the composting plant activity, allowed to keep on studying the set up of different technical adjustments for the investigated waste treatment centre.

1.4 Meteorological data collection and analysis

The meteorological data confirm the overall weather conditions of the Region, with high percentage of calm wind. In particular, in the 85 % of cases, the wind speed is less than 2 m/s (see figure 1.4.1), concerning the evaluation of hourly average data of 2009. This situation causes odour stagnation all over the day and the movement of odour masses early in the morning or late in the evening, when there is a thermal inversion phenomena. As a matter of fact, odour annoyances mainly occur from 6 a.m. to 8 a.m. and from 8 p.m. to 10 p.m. Looking at the wind direction we can notice that the main one is NNW - N (see figure 1.4.2), that is the direction of the wind in the investigated area. Concerning the wind speed, the data collected show that it is mostly very low and not favourable to the odour dispersion. From a meteorological point of view, the area is not suitable to locate a waste treatment plant, although the distance between the village and the plant is almost 2-3 chilometers.

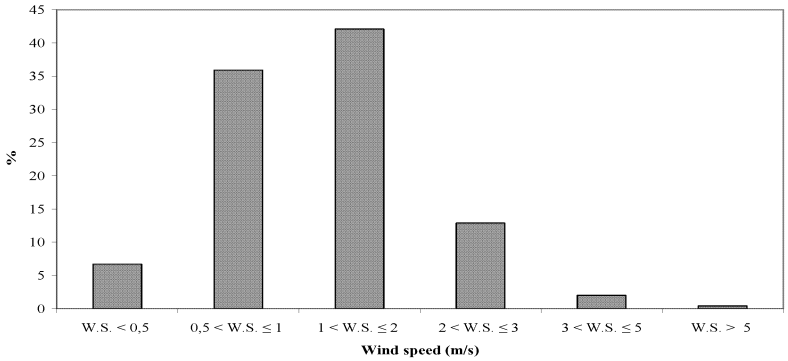

Figure 1.4.1 Relative frequency of wind speed range.

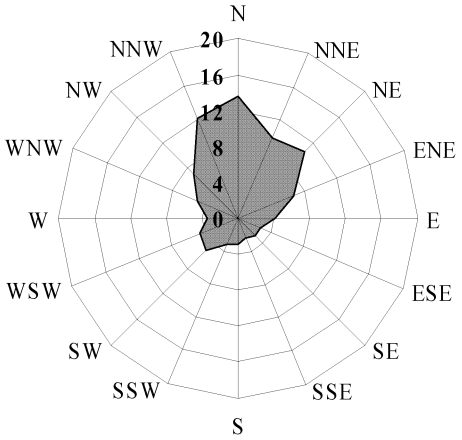

Figure 1.4.2 Annual wind rose. Percent frequencies of wind from various directions are indicated.

2. Results and data evaluation

A first evaluation of the data recorded by the panelists didn't show an unambiguous relationship between the data themselves and the plant diary: anyway a careful comparison of the duration of the annoyance, the weather conditions and the operations carried out in the waste center allowed to try some interesting considerations.

First of all the most part of the odour annoyance happens early in the morning or late in the evening: this fact seems not to be related to a specific operation in the composting plant. In fact, the treatment platform operates only during the day, from about 7 a.m. to 5 p.m.. However, the people complaints seem to be temporary shifted if compared to the waste center activity (see figure 2.1). This fact can be explained by the weather conditions of the investigated area: all over the day the prevailing condition of wind calm causes the odour stagnation, while in the early morning and in the evening the wind starts to blow slowly and it moves odour masses in the direction of the village of Mappano.

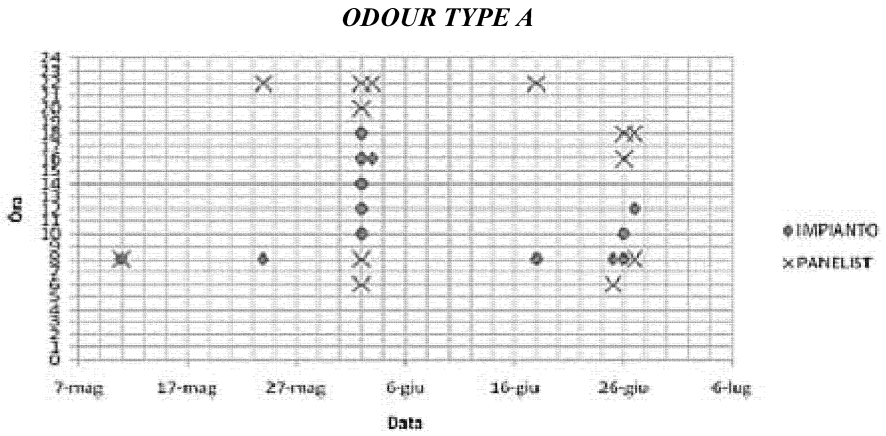

Figure 2.1 Odour annoyance compared with plant activities – Odour type "A"

The correlation described above can be tried not only for the odour A but also four the odour B and for the odour E: moreover, the episodes related to the odour E often happen at the same time of the odour annoyance due to the odour A and the odour B. Considering that frequently the odour E is described by the panelist as the "typical composting plant odour", we can suppose a superimposition of the odour A and the odour B to cause the odour E. (see figure 2.2). If we consider that the odour A was identified as the typical odour of ACT phase and the odour B was related to the curing phase, we can assert that the episodes of the odour annoyance recorded by the panelists were mainly due to the curing phase and, to a lesser extent, connected to the ACT phase.

ODOUR A+B=E

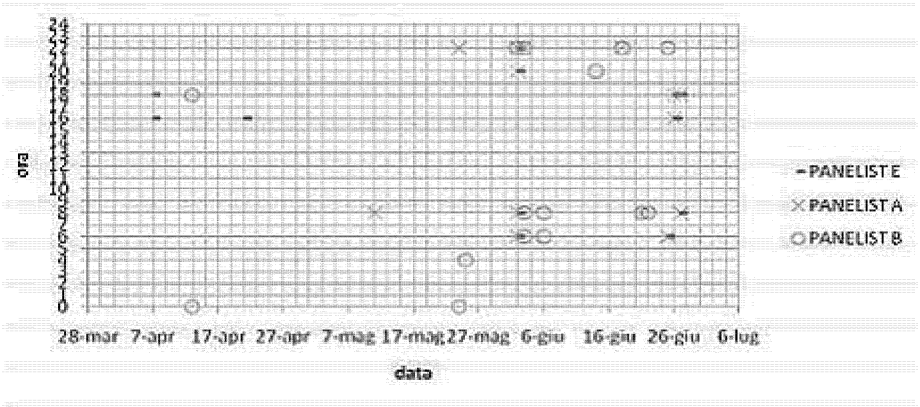

Figure 2.2 Relationship among odour A, odour B and odour E.

The monitoring with the electronic nose confirmed that the odour emissions were related to the composting plant. In particular the instrumental monitoring showed that the odour annoyance was mostly due to the curing phase, but also to a significant contribution of the ACT phase. Figure 2.3 shows the assessment of three different odour episodes: the data collected by the sensor analyser were considered only values of $UO/m^3 > 70$ and wind direction NW-NNW.

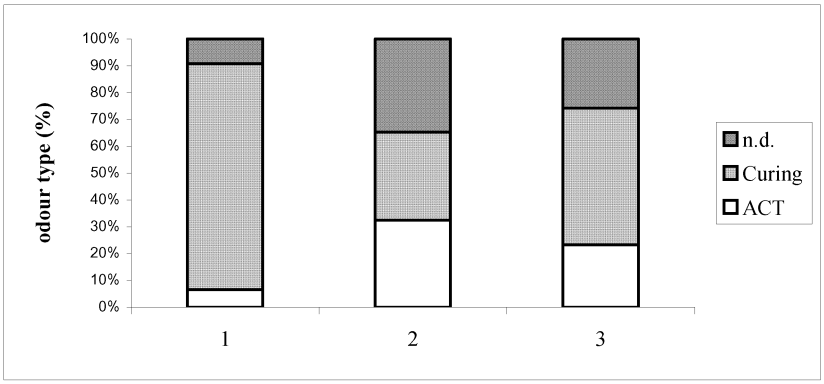

Figure 2.3 Type of odour recognized by EN during three different odour episodes.

The data evaluation permitted to focus the inspections on the last phase of the composting plant, that is to say, the section dedicated to the curing of the treated material. From a technical point of view, the inspections carried out in the composting plant identified some probable reasons for the odour generation such as:
- the movement of material not yet stabilized from the ACT phase to the curing phase;
- the bad working of the biofilter and scrubbers used for the treatment of the air coming

from the curing phase, and to a lesser extent, from the ACT phase.
The technical aspects, described above, are obviously connected with the main characteristics of the odours described by the panellists and seems to confirm a superimposition of the odour A and the odour B to cause the typical compost plant odour perceived by the ocal population. Actually, the movement of waste mixture not yet stabilized may produce an odour like ACT phase (odour A). On the other side, the inadequate air treatment may release odour emissions composed by the typical odour of the curing phase (odour B) and the typical odour of the ACT phase, since the system is dedicated to both areas.

3. Conclusions

The integrated approach used to investigate the odour sources and annoyance in the Area Borgaro Mappano Caselle gave good results. First of all the accurate analysis of the composting plant let local Authorities to identfy the most probable technical reasons of the odour generation. Thanks to the contribution of AMIAT (i.e. the management society of the composting plant), it was possible to carry out the necessary operations to bound the most critical areas of the waste treatment plant and then to suggest solutions to the problems.
The monitoring with the electronic nose identified as the most probable source of the odour annoyance the curing phase: the data recorded by the panelists confirmed that hypothesis. The monitoring with “human noses” was very useful to understand the causes of the odour annoyance dealing with the weather conditions: moreover this approach was recognized by the local population as an important instrument of participation in the control activities of local Authorities.
Generally speaking, the project “Lend us your nose” allowed Provincia di Torino to try out a method for the assessment of odour generation: this methodological approach seems to be successful so that it will be used for future investigations and maybe not only for waste treatment plants.

4. References

Various Authors , 2008 “Emissioni odorigene e impatto olfattivo prevenzione e trattamento” Geva Editions Rome;

Capelli L, Sironi. S., Snidar R, Rivilli S., Castellan A., Culos, B., Trovarelli A., Soldati A, 2008 “ Identification of odour provenance in presence in multiple sources” Proceedings of NOSE 2008, AIDIC ;

Valli L., Immovilli A, 2008 “Measurement of odour annoyance by integrated assessment methodologies” Proceedings of NOSE 2008, AIDIC:

5. Acknowledgments

The project was conducted with the contribution of AMIAT as the management society of the composting plant, regarding to the data collection of the sensorial analyzer and with the collaboration of Politecnico di Torino.