CHEMICAL ENGINEERING TRANSACTIONS
VOL. 85, 2021
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.cetjournal.it
Guest Editors: Selena Sironi, Laura Capelli

ISBN 978-88-95608-83-9; **ISSN** 2283-9216
DOI: 10.3303/CET2185014

From Nose to Nuisance: a Collaborative Approach to Assess The Odour Problem in an Oilseed Plant

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Odour nuisance is an ignored environmental problem, an invisible face of air quality analysis and monitoring in Portugal. Local and governmental authorities have been receiving odour complaints, but only in recent years this issue is seen as a growing concern and not just a matter of licensing and inspection. This fact and the lack of specific ambient air odour regulation in Portugal originated a bottom up approach focused on citizens and their contribution to a more comprehensive analysis.
Despite the existence of odour measuring instruments, the human nose is a universal sensor with higher sensitivity that allows to assess the impact of discomfort on sensitive receptors. From this point of view, a sensorial method has been conducted with community neighbours of an odour emission source as an integrative approach to the problem and a complementary vector to a quantitative analysis. The human nose used as a "tool", allows to address the issue instantly and at a local level, which is not always possible with other methodologies, even in situations where the detection limit is reduced and therefore not measurable with certain equipment. It should be noted that this olfactory evaluations are the ones responsible for triggering formal complaints to the authorities whether it is the National Guard, the municipality or the environmental regulators. But the lack of a unified form to register the complaints is a mandatory issue to help addressing the correct odour sources and better understand the problem. So, this sensorial approach also aims to develop a tool to aggregate the needed elements to a valid form, to ensure that the complaints can be verified and validated. This would help to make a comparison and create a record history database, at the odour emitter level or at local and national scale.
The results obtained with this approach have led to the application of several actions such as the real knowledge of the problem from an industrial operator perspective, inclusion of public stakeholders, and the design and implementation of an odour management plan with the purpose of the establishment of mitigation measures.

1. Introduction

The interoperability of the civil society in scientific research projects is an integrative way for, in addition to co-creating essential data for analysis, promote the inclusion of elements that, through their experience, can assist in the mechanisms of data collection and in the development of measures to improve the context that surrounds them. In environmental assessment and monitoring projects, the inclusion of citizens promotes a more active role for individuals and, above all, the strengthening of the triangulation relationship between community, academia and institutions. The approach of non-scientists participation in the resolution of emergent environmental issues is a way of besides empowering the citizens, promote transformative social innovation, discussing the matter between citizens and stakeholders.
Having groups of people with the ability to register odour complaints in standard forms is an added value for the study of emission sources and the causes that led to the nuisance impacts, such as industrial activities, meteorological conditions, or atmospheric dispersion.
This sensorial approach was the trigger to evaluate odour nuisance and to develop a strategy to the odour monitoring but other techniques were also applied, particularly, field inspections with the use of a portable olfactometer and meteorological analysis.

Paper Received: 20 December 2020; Revised: 15 March 2021; Accepted: 11 April 2021
Please cite this article as: Teixeira S.A., Pereira P.D., Ferreira F.C., 2021, From Nose to Nuisance, Chemical Engineering Transactions, 85, 79-84 DOI:10.3303/CET2185014

2. Collaborative data creation: observers panels

The objective of the formation of observers panels (OP) is to create a net of voluntary citizens without connection between them besides the odour nuisance, without direct connection with any industrial operator that can be odour emitter and with the particularity of perceiving ambient odours in their homes or workplaces. This way it is possible to empower the citizens by giving them means to be heard and to make them part of the environmental problem awareness (Bonney et al., 2016).

Forming an Observers Panel can endorse a longer and more diverse measurement period in contrast to other techniques normally used in this type of assessment. It can also provide independent instant evaluations at several locations at the same time addressing the problem. Simultaneously, this approach tries to promote the engagement of the community by boosting their citizenship with the aim of resolving potential emerging conflicts between industrial emitters and neighbours, in order to decrease the nimby (not in my back yard) effect (Dettori, 2020). This way, on one hand, the data created by the Observers Panel makes the odour emitter gain awareness that its industrial activity may cause impacts on sensitive receptors, and in the other hand, on a long term, the group may better understand the characteristics of the odour emissions and in case of harmless effects, monitor the situation.

It must be taken in to account that this kind of data production cannot be just a form to have free manpower, because the idea is to engage the community in the science process in a way that they don't feel used, but part of the solution achievement (Senabre, 2021). The use of a guidance strategy is required so that the researcher's team may motivate the data production continuously in time. Also, a data disclosure policy is needed to give information to the elements of the achievements of the monitoring to make them a real part of the process.

A conceptual pyramid framework of four dimensions of analysis was used to understand the collaborative data creation process as a guide to achieve the results step by step. The intent of participate is on the base of this methodology because it's a reaction motivated by the desire of communication of an environmental issue. On the second level, the knowledge of the theme (in this case, of ambient air odours) promotes a learning of the issue given by the researchers. On the third, the action, which promotes the sensorial evaluation and record of the odours in ambient air by the volunteers. Finally, on the top of the pyramid are the results produced by the OP elements, validated by the researchers, shared with all the group. This results should led to an odour records map of a given area with the most affected locations highlighted.

2.1 Material and methods

How to reach people? Can anyone participate? How to start? First it is essential to define criteria of participation to target the right people. In the odour case, for the selection of the human panel sample, a survey is applied to ascertain some essential criteria (namely the olfactory sensitivity; residence area/workplace, odour perception, health condition) for the analysis. Then it is important to disseminate the activity through flyers, social media, environmental associations, face-to-face interactions, mailing-lists, snowball techniques and in case of a list of complainers invite them to collaborate. The participants have to have availability, and make a pre-registration. Subsequently, a monthly form of odour records is distributed to the selected elements or a link to a google form in a smartphone can be used (Figure 1). This two options evaluates some odour characteristics, namely: type, frequency, duration, intensity, location (FIDOL factors, Nicell, 2009), as well as the perceived weather and wind. The intensity and the hedonic tone categories are quantified by a Likert scale of 6 levels (from very week to extremely strong). Subsequently, these data are subject to validation through complementary analysis methodologies developed by the researcher's team. This should be developed with a defined timeline and in two different meteorological periods so that the participants don't be unmotivated and to see the impact of some weather conditions in the analysis (e.g. 3 months in winter time and 3 months in summer time).

To manage the collaborative work it is important to implement some key actions such as: establish communication between the researchers and the OP members (e.g. phone calls, sms, chat apps, e-mail) keep them informed of the project by giving them some feedback of the group results and be available for any doubt along the monitoring.

Figure 1: Tools to record odour perceptions of the observers panel

2.2 Combine to validate

This collaborative method, with a bottom up approach has to be combined with an analytic one (top down approach) (e.g. quantitative assessment with field inspections) to accomplish a mutual validation of the data produced by this different strategies. In this sense, after the data collection (which can be automatically when using an online form) the validation process in mandatory. It takes in account several dimensions such as meteorological analysis, the existence of more than one record at the same time in different locations, the data collected by a control group (research team) throughout field inspections with a portable olfactometer according to the VDI 3940: 2nd part standards and the record of the industrial operator activities (e.g. number of days working or in technical shutdown). With this combined strategy it is possible to assure data quality and thus, the replicability of the adopted methodology in different case studies.

3. Results of the OP approach: a case study of an oilseeds industry in Lisbon Metropolitan Area.

An odour monitoring program was conducted in 2019-2020 in the surroundings of an oilseeds processing plant located at the south bay of Lisbon Metropolitan Area. Besides the collaborative approach, the monitoring strategy was composed by a meteorological evaluation, field inspections with a portable olfactometer within the surrounded area and inside the industrial perimeter. Focusing only on the OP, in this case, it was formed with a total of 45 citizens (of which 5 elements from municipality authorities) distributed in the municipality (Figure 2). This OP monitored the ambient air during 213 days (July to September of 2019 and February to May of 2020) even with the pandemic COVID 19 conditions. The most used record tool was the online form (60%), followed by the paper form (40%).

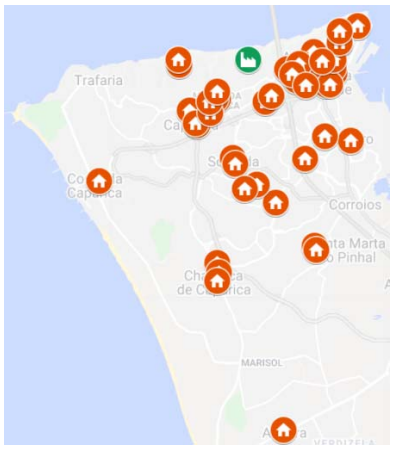

Figure 2: Distribution of the OP elements in the surrounding area of an oilseeds industry

The results showed 87 odour records, 75 concerning the type of odour “cereal/flours/feeds” (assigned to the activity of the industry under analysis) (Figure 3 a). In this case, in 77, 5% of the time no odour was perceived.

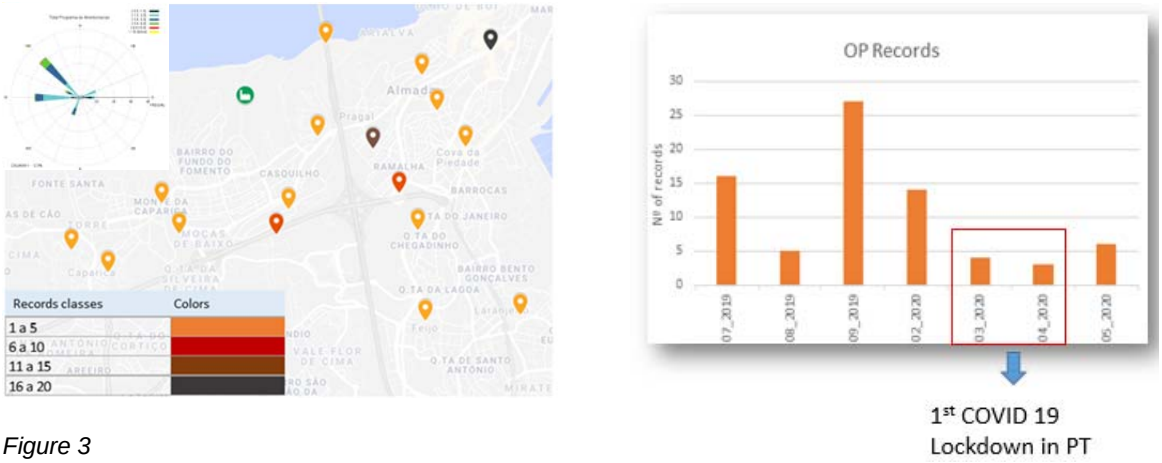

Figure 3

a) Geographic location of the “cereal/flours/feeds” odour records and wind rose of the monitoring period

b) OP odour records by monitoring month

The odour perceptions were made mainly in the afternoon period with meteorological conditions of winds from the Northwest and from the West of weak intensity. This conditions may have influenced a higher number of odour records in locations at east, south and southeast of the emitting source which is consistent with the OP locations. The intensity level detected was strong in a Likert scale of 6 categories. According to Figure 3 b), during the winter period there was a decrease in the number of records, despite the fact that the emitting source continued its normal operation during the first lockdown situation in Portugal due to COVID 19.

The OP data made it possible to make a comparison between the oilseeds industry operation (with two processing plants) and the number of odour records for “cereal/flours/feeds” (Figure 4). As it is showed, the operation of the plant one may had a bigger influence on the perception of the odour by the OP, because of the higher number of records made when it is “on” and because of the decrease of them when it is “off”. The absence of odour records when the plants were in shut down for technical reasons also validates the OP data gathered in the monitoring program (the OP didn’t had access to the information about the oilseeds operation).

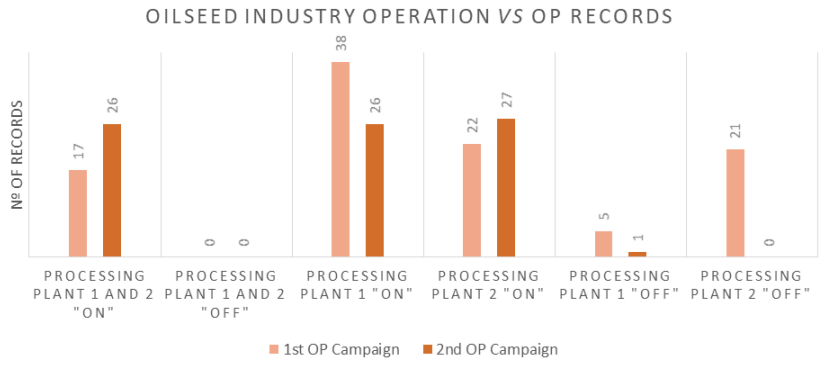

Figure 4: Comparison between the OP records and the oilseeds industry operation

The records made by the OP volunteers was also validated through 26 field inspections. The results were 51 positive measures of “cereal/flours/feeds” odour between 2 and 4 dilution by threshold. The locations with the higher frequency of positive perceptions are marked on the map (Figure 5) with the orange colour. These locations are influenced by the prevailing wind directions (as seen above) and are coincident with the locations of the majority of the OP records.

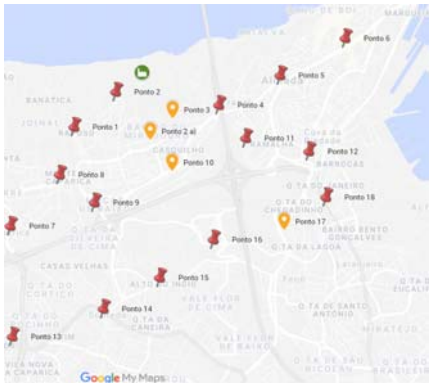

Figure 5: Locations with the highest number of positive measurements of "Cereals/Flours /Feeds" made with field olfactometer

3.1 The outcomes of having a collaborative approach

The results of the OP data and of all the approaches conducted in the odour monitoring program, led to the need of the oilseeds industry to implement some measures to decrease the impact of its activity on sensitive receptors. The most important measure with low cost- higher efficiency, short term implementation and with direct impact on the sensitive receptors was the implementation of an odour management plan. This plan is not a monitoring program with a defined timeframe but a group of procedures that will be permanently available by the operator. One of the elements of this plan is a tool for manage the reception of odour complaints and thus the complaint investigation by the operator with the aim of a response to the complainer. This tool is available for everyone (not only for the OP elements) who wants to make a complaint related to the activity of the operator either a citizen or a local power institution (parish, municipality local associations). This management is composed by a form according to the FIDOL approach so that the complaints assemble all the elements needed to be investigated. Then, a decision making tree was developed to guide the operator in the complaint investigation process (Figure 6). This procedure was also transformed in a guidance for intern support with all the steps in detail for employees and it has to have in account a response to the complainer (either the complaint is considered valid or invalid). In case of a valid complaint, a response will be given after an internal investigation and a meteorological analysis. For the invalid ones, a response will be send to ask for more elements (if the complaint lacks some information) or to address that the odour emission source could not be the one responsible for the nuisance.

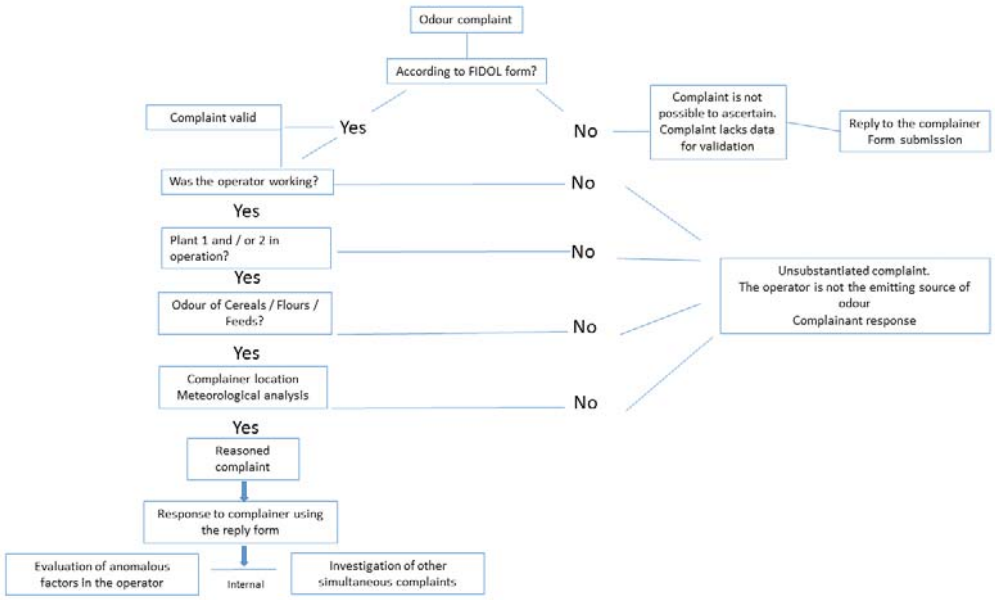

Figure 6: Decision making tree to evaluate odour complaints

This odour management plan is an innovation for the oilseed operator since there is no guideline for the odour matter in ambient air (only for emissions, shortly in the Best Available Techniques Reference Documents-BREF) in Portugal and it was an opportunity to implement a training tool for the use of the employees that could also have some knowledge on the odour issue for the first time. All the complaints will be integrated in to a data base, so that an historical record may be developed to assist further internal analysis.
It is to be set on place a defined joint strategy with local stakeholders (e.g. the municipality) and with the academia for the capacity building of a target of the population with some dynamization activities in schools.
The odour management plan has become also an opportunity for the operator to give a step further on the odour matter showing this developments to the Portuguese Environmental Agency.

4. Conclusions

The collaborative methodology with the OP has some advantages and disadvantages. The first ones are the possibility of public engagement with science, the scientific knowledge that can help on the decision making (e.g. formalizing or not an odour complaint), low cost to higher benefits, major data diversity and major closer to local reality. The second ones are to not consider at any time the volunteers as manpower only to collect data, the difficulties to maintain the enthusiasm and the accountability of the volunteers so they don't give up the task, and to assure the data quality through the application of validation methods. The validation process is as essential vector of the analysis in order to provide more consistency to the data provided by the citizens.
This bottom-up approach with the collaborative data creation of the OP has given the possibility of the development of some tools to manage the odour nuisance and to make some advances in the odours theme in Portugal, given we are one step behind other countries.

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