

Investigation of the Perception of the Population around a Chemical Industry in Relation to the Odor Generated by H₂S

Olimpio Gomes da Silva Neto^{*a}, Christian Alberto Lopes Burrone de Freitas^b

^aInstituto Federal Sul de Minas, Estrada do Aeroporto, 1.730 - Jardim Aeroporto - 37550-000 - Pouso Alegre/MG, Brazil

^bCentro Universitário das Faculdades Associadas de Ensino-FAE, Largo Engenheiro Paulo de Almeida Sandeville, 15, 13870-377, São João da Boa Vista/SP, Brazil
olimpio.neto@ifsuldeminas.edu.br

The odorous air emissions are increasingly less tolerated due to their effects on quality of life. Nuisances caused by odors in industrial emissions are a problem with high frequency of complaints of communities along the oversight agencies. Small concentrations of odoriferous substances are very likely to be issued in industrial activities and are often sufficient to affect the human olfactory system, which is highly sensitive. The present study aimed to investigate the perception of the population in the vicinity of a chemical industry with regard to odor generated by H₂S. This perception was quantified by applying a questionnaire to assess the understanding of the link between odors and air pollution, and identify the main source of odors. From the results obtained it was found that the industry is primarily responsible for the emission of odorous compounds. It was found that the population perceives the presence of hydrogen sulfide gas emitted by industry, however, despite feeling uncomfortable with the odor, individuals realized that this is less than time ago, implying that the actions taken by the industry eased the problem.

1. Introduction

The odorous air emissions are less and less tolerated because of their effect on quality of life (Lisboa et al., 2009). Awkward caused by odors in industrial emissions are a problem with high frequency of complaints from communities along the regulatory agencies. Small concentrations of odoriferous substances are very likely to be issued in industrial activities and are often sufficient to affect the human olfactory system, which is highly sensitive (Schwab, 2003).

Alongside the odorant problem, one must consider that the population is aware of the need for actions and measures to address the problem. Palliative actions and minimizing situations that cause discomfort and conflict between industry and the population are no longer acceptable. A solution which should be based on the study of data on air quality is required, the concentration of pollutants, weather forecasts, in order to prevent or avoid that pollutants may accumulate and cause nuisance or health problems.

The present study aimed to investigate the perception of the population in the vicinity of a chemical industry with regard to odor generated by H₂S. This perception was quantified by applying a questionnaire to assess the understanding of the link between odors and air pollution, and identify the main source of odors.

2. Materials and methods

2.1 Characterization of the study área

The industry focus is characterized as a chemical company that converts part of oxhide, which is not used by tanneries in gelatine and hydrolyzed collagen. It has a total area of 69,270 m² with 12,000 m² of built area. The municipality to which the industry is inserted has a population of 66,290 inhabitants, with a population density of 77.70 inhabitants/km² (IBGE, 2010), little rugged, with hills and massive tabular and gently sloping

hillsides. Its climate is temperate rain with dry winters (Aw in Köppen classification), with an average annual temperature of 23.1°C. Its location is north of the city, bordering the São Domingos Garden, located southwest of the company (Figure 1).

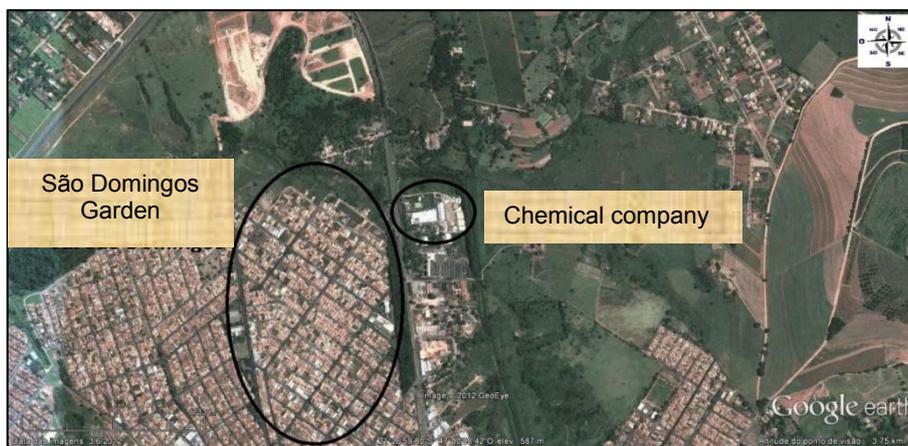


Figure 1: Location map chemical industry. Source: Google Earth (2013)

2.2 Evaluation of the impact odorant via questionnaire

The use of questionnaires for interviews is an excellent procedure in the evaluation of environmental perception of odors, especially in urban areas.

Odor perception by the surrounding population odorant source, through the use of two questionnaires was investigated:

- Questionnaire 1 - Socio Demographic, with the objective of providing certain knowledge the researcher about the sample. This had a starter question for the 2nd Questionnaire;
- Questionnaire 2 - Investigations of Awkward Caused by Bad Odors - UFSC/ENS/LCQar - Validated. The questions in this questionnaire have as principles: to evaluate the understanding of the link between odors and air pollution; verify the adaptation to odors; identify weather conditions (temperature, wind direction, time of day and year) for the analysis of possible associations with odors; identify the main source of odors; relate some symptoms of diseases to odors (Lisboa, 2010).

In determining the total number of questionnaires, first, it was defined as the application area São Domingos Garden surrounding the industry, limiting the area for a distance of 1 km surrounding the industry. As the neighborhood has 1,456 households (SEADE, 2013), came to a minimum sample of 211 questionnaires to be applied, only one for each household.

In order to ensure a good representation of homes, the neighborhood was divided into a grid of 16 points. As each point of the grid had an area of 200 x 200 m, being occupied by approximately 90 residences, it was used a questionnaire every six households, a total of 15 questionnaires at each point, reaching a total of 240. It happened that, in points 1 to 5 there were 15 residences, reducing the sample to 215.

Using the positive responses to the perception of odor, it was generated a map of the São Domingos Garden, identifying the percentages of subjects reporting that perception. For this, it was used the software SURFER 8.0.

Finally, in order to perform a white field, an area that probably would not be affected by industry odors in question, the same questionnaires were applied in Aparecida neighborhood, located south of the city, in an oblique direction to the direction of predominant winds, distant 3 km from the industry in question. This tool allowed safeguard the quality of the evaluation of the responses for the São Domingos Garden.

According to Sesi (2007) for the application of field white should be applied 10 % of questionnaires for 215 applied in São Domingos Garden, but it was opted for the larger sample, increasing the sample of 22 to 30 questionnaires.

3. Results and discussion

3.1 Study of the winds

The historical data obtained from the Agronomic Institute of Campinas (IAC), monitored from 1960 to 1991, shows the dominance of the North/Northeast winds, corresponding to geographical position of the industry in relation to São Domingos Garden. The historical monthly average speeds recorded from 1961 to 1990 are consistent with the year 2013. The average wind speed calculated from 1 January to 23 August 2013 was 2.0 m/s.

3.2 Perception of odors via questionnaire

Through the analysis of the field of white applied in Aparecida, it was found that place does not suffer from the odor problem, as only 10 % of respondents said they note some kind of odor, however, none of them could not inform their origin. Also it could notice that among those who said they not some kind of odor, most do not know to identify your character; do not bother or feel little uncomfortable; found that the odor is too weak or weak and rarely feel odors.

The constant questions in the questionnaire were as principles: to characterize the respondents while maintaining anonymity; verify the possibility of adaptation to odors and the notion of pollution; general questions about the weather conditions (temperature, wind direction, time of day and year) for the analysis of possible associations with odors; identify the main source of odors; relate some symptoms of disease; and check the degree of unpleasantness of perceived odors. Was avoided any induction or influence of the responses.

In Santo Domingo neighborhood was observed that 43.26 % of the 215 respondents are men and 56.74 % are women. Half of the respondents (47.44%) have over 50 y of age, with a relative degree of education (67.91 %), as had at least completed high school. This may mean having a certain degree of experience, conscience and instruction.

Regarding professional activities, one in three respondents (33.02%) work at home and therefore spend most of the day in their homes, meaning they have a greater insight into the daily life of the neighborhood, giving the survey a more reliable character. By family income of respondents, it is clear that the majority belong to social classes D and E (low-income), as 75.82 % said up to 4 minimum wages. For the conditions of basic sanitation district, the responses indicate that virtually all realize these services and they are essential.

With respect to selective collection and separation of household waste for disposal, 66.51 % said that the selective collection is carried out by waste pickers and 80.47 % think it is important to separate the waste for disposal. However, the municipality does not have a selective collection program.

The main issue of the sociodemographic questionnaire was to assess the existence of the odor problem in the neighborhood. This question was eliminatory character, that is, if the respondent answered "no" to this question, he would not answer the next questionnaire, because the questions were related to their experience with the odors. From the 215 questionnaires, 106 were affirmative in relation to the perception of odors (49.30 %) and 109 were negative (50.70 %). It concludes that half of people perceived an unusual smell, a problem which was analyzed by Awkward Research Questionnaire Caused by Bad Odors, applied to these 106 individuals.

Figure 2 reflects disturbances produced by odors, who were questioned. Among the options presented to unrest (38.68 %), irritation (22.64 %), nausea (13.21 %) and headache (11.32 %) were the most frequent. This can be caused by the presence of hydrogen sulfide, which also causes eye irritation and lung airways (Lisboa, 2010). Then compared the odor perceived by the interviewed with other odors known for, well, the source of the odor could be identified (Figure 3). The results showed that the odor of rotten egg and sewage, which are commonly associated with the presence of hydrogen sulfide in the air were the most answered, with 52.83 % and 66.04 %.

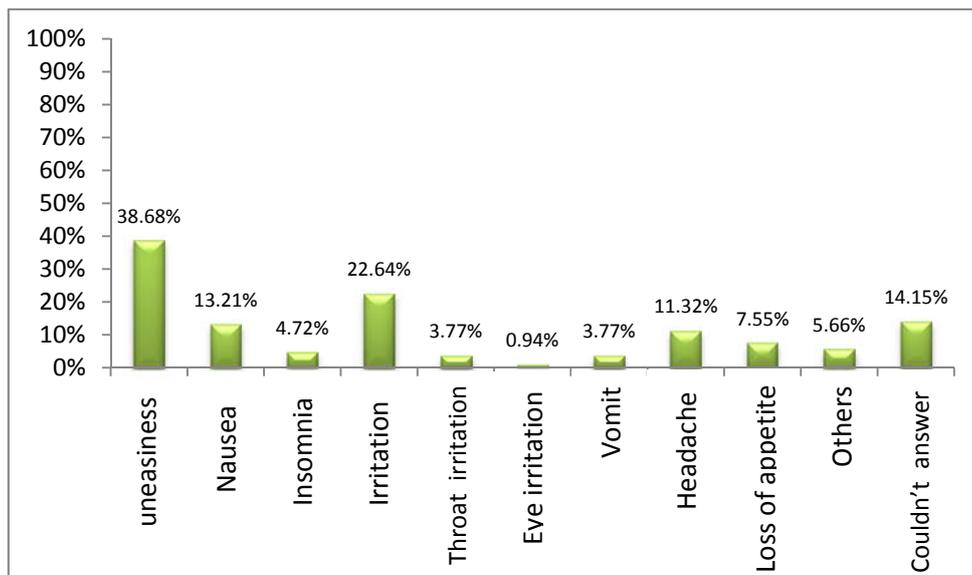


Figure 2: Nuisance versus odor

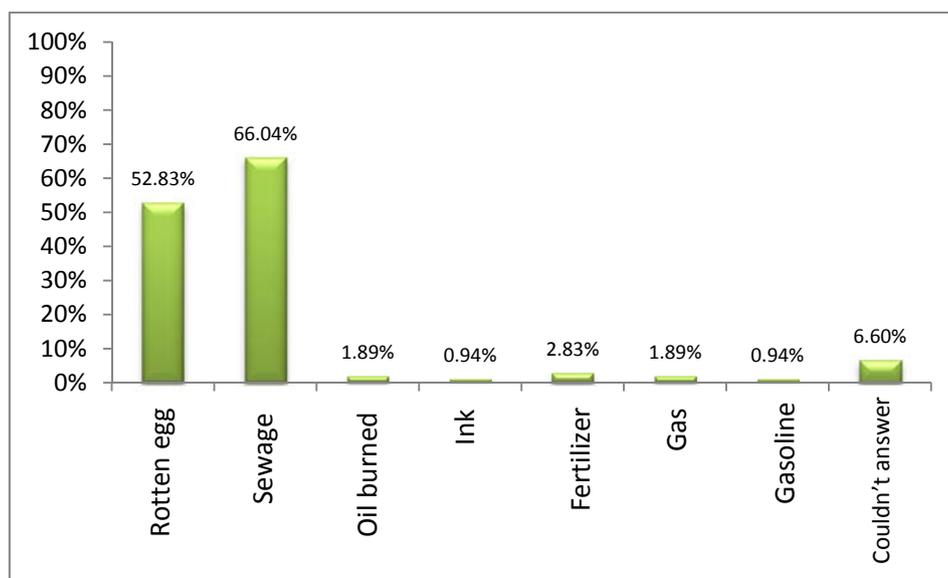


Figure 3: Odor perceived by the interviewed compared with other odors known

The degree of discomfort caused by odors was calculated as a weighted average of the results obtained, reaching a value of -51.41, concluding that the olfactory discomfort index is very close to those people who feel uncomfortable with the odor.

The average intensity of the perceived odor was 59.67, being indicated between an average and strong intensity. Continuous exposure to a constant odor can result of the adaptation phenomenon. Some interviewees (7.55 %) perceived the odor, but they considered weak. They may be experiencing changes in odor perception, in other words, olfactory adaptation.

There is also another phenomenon called olfactory fatigue. The olfactory fatigue can be defined as the inability of an individual to perceive a near odor perception limit, and even when subjected to even higher concentrations of odor. The phenomenon explains the absence of olfactory reaction of many individuals face to odors they encounter in the workplace. Fatigue can be a dangerous variable in the case of inhaled odors are toxic risk.

It was also found that the majority of respondents (63.21 %) said perceive the odor with some regularity. It was evident that periods of increased perception of odor were afternoon and evening, corresponding to 88.68

% of interviewed. This can be explained by the fact that, in the evening, usually the temperature drops quickly, stratifying the atmosphere, reducing the height of the mixed layer, making the most noticeable odors (Lisboa, 2010).

In order to assess the merits of the odor and its perception in the past between individuals of the searched area, was first rated the residence time of these individuals for the purpose of verifying the quality of the responses in terms of the origin and perception of odor in the past. It was found that 75.46 % of interviewed living in the neighborhood for more than five years, long enough so that citizens know their habitat. Comparing the perception of odor from the past, 8.49 % of interviewed said that the odor increased, while 43.40 % said it was the same times ago and 48.11 % indicated that the perception of odor decreased compared the past. Almost half of the interviewed indicated that the odor is lower nowadays, suggesting that actions were taken by the company, and the problem was minimized.

It was also found that 77.36 % of interviewed indicated that the chemical industry is the likely source of the odors perceived, while 22.64 % said it would be another source responsible for the generation of odor or could not tell the origin. This question relates to the chemical industry as likely issuing of odorous compounds. The perception of smell is directly related to atmospheric dispersion of the pollutants, in turn, depends on the emission source, meteorological factors and the receiver. Figure 4 lists the quantities of affirmative answers of interviewed about the odor with the distance of the likely emission source (chemical industry), dividing the Santo Domingo neighborhood in a grid of 16 points. Through a visual analysis it can be seen that the closer the industry, the greater the percentage of individuals claiming notice the odor, unlike most distant points in which the percentage of claims nears zero. Highlights the presence of the green belt, which also functions as breaking tree winds. It can influence the dispersion of pollutants and thus the perception of the population about the odor. It is observed that at the bottom of mesh (points 9-16) the percentage of positive affirmations to the odor is less than at the top (points 1-8), where the belt appears to have a minor influence by its location.

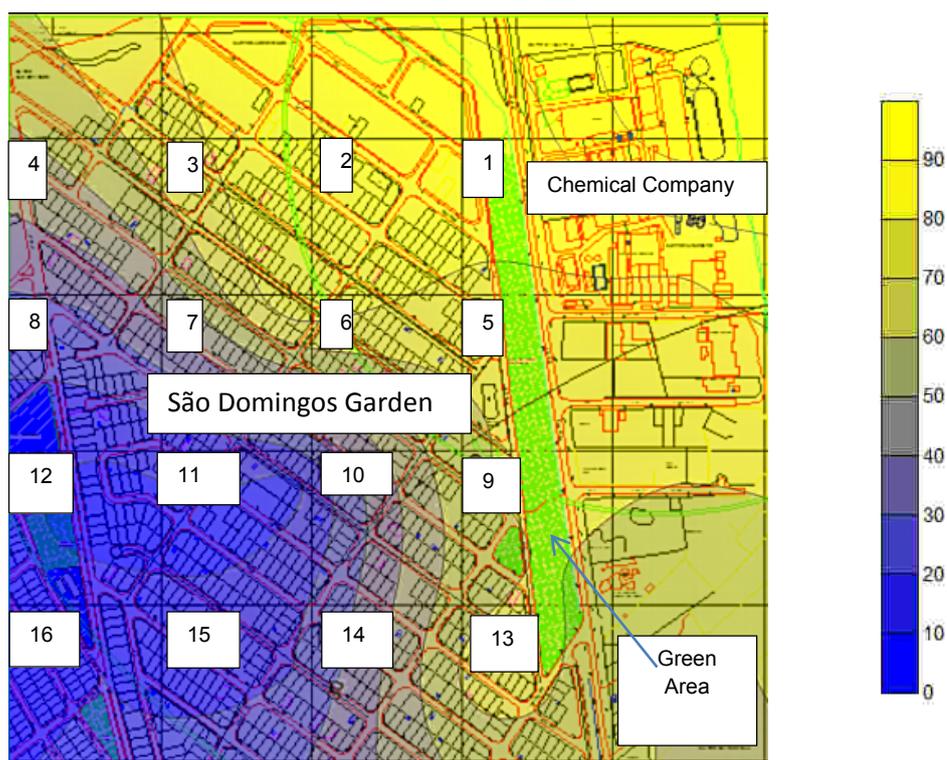


Figure 4: Odor perception of the distance from the industry

Through a linear regression, Figure 5, it can be seen that the odor perception is related to the inverse of the distance of the receiver relative to the emitting source. However, the olfactory capacity varies from person to person and it does not mean that a receiver over that distance (1000 m) could not feel the same, which can also justify the value obtained for Pearson Correlation ($r = -0.7967$). The model proved to be relevant to estimate the perception of residents regarding odor emitting source, in this case.

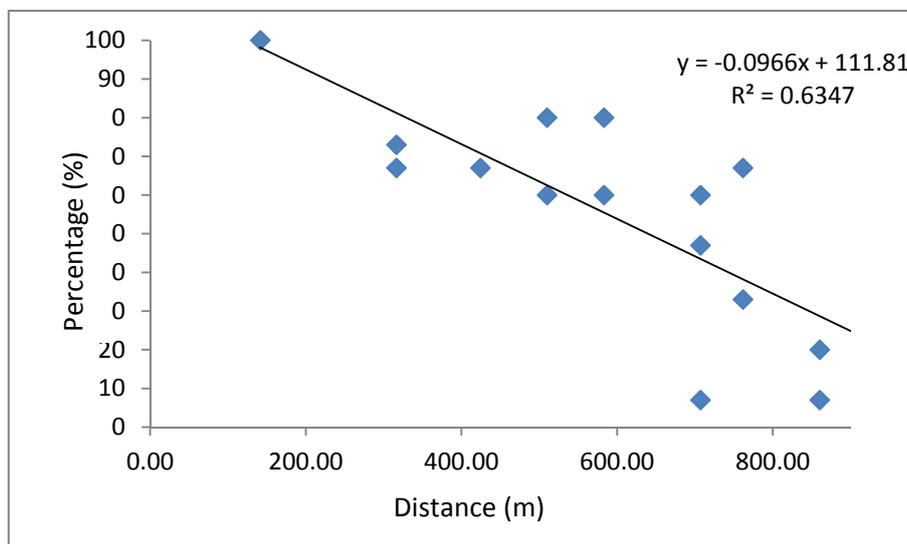


Figure 5: Scatter diagram: distance of the chemical industry and percentage of positive responses to the odor

4. Conclusions

The use of questionnaires for interviews proved to be an excellent tool in the evaluation of environmental perception of odors. According to the population, the industry is primarily responsible for the emission of odorous compounds. The weather, especially wind direction, contribute to this problem, as the wind blows in the direction of the industry to the neighborhood. The green belt proved to function as a tree barrier hindering the access of odor to the neighborhood. It can influence the dispersion of pollutants and thus the perception of the population about the odor. It was found that, despite being bothered by the odor, the interviewees realize that this is less than days ago, implying that the actions taken by the industry mitigated the problem.

Acknowledgements

This work has been supported by FAPEMIG and IFSULDEMINAS for the financial support to research and the UNIFAE, the possibility of carrying out the work.

References

- De Melo Lisboa H., Page, T., Guy, C., 2009. Odour Management: Electronic Nose Essentials, Sanitary and Environmental Engineering, 14 (1) 9-18.
- De Melo Lisboa, H., 2010. Olfactory methodologies for assessing the impact odorant. Florianópolis : UFSC/ENS/LQCAr <www.lcqa.ufsc.br/aula_met.php> accessed 05.12.2012.
- Google Earth, 2013. <maps.google.com.br/maps?hl=pt-BR&tab=wl> accessed 23.02.2013.
- IBGE – Brazilian Institute of Geography and Statistics. 2010 Population Census. <www.ibge.gov.br/home/estatistica/populacao/censo2010/default.shtm> accessed 23.02.2013.
- Schwab, F. C. C., 2003. Odor nuisance in industrial facilities: theoretical aspects, current practices and a case study in agrochemical factory. 3. 92 p. Thesis (Environmental Engineering) - UERJ, Brazil.
- SEADE – Foundation System Data Analysis of State. 2013. Municipal Profile. <www.seade.gov.br/produtos/perfil/perfilMunEstado.php> accessed 20.02.2013.
- SESI – Social Services Industry. 2007. Technical evaluation of environmental agents. Brasília, Brazil.