

# Characterization of Volatile Organic Compounds and Odour Pollution in Atmosphere at Oil and Gasoline Handling and Processing Impact Zone

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**Abstract**—Air quality pollution problem is still one of the crucial points for citizens in Europe for already receiving increasing attention, particularly because of the major European cities 10 and more years. Although the EU's long-term goal is to achieve levels of air quality that do not impact and risks to human health and the environment, many of member states still didn't reach stated goals. Additionally, to gaseous pollutants, recently specific type of pollution, - odour, seems to become more important. Usually in order to determine pollution levels, national, municipal and private monitoring equipment is used. For this research municipal monitoring site in Riga (Latvia), at Milgravja Street 10, controlling gaseous pollutants (SO<sub>2</sub>, O<sub>3</sub>, BTX, PM<sub>10</sub>) and airborne particulate matter, and private monitoring results from Riga, Milgravja Street 16, where odour pollution was obtained, are analysed. Distance between both stations are just 500 m. Measurements at municipal monitoring site is obtained by DOAS and gravimetric sampling, while at Milgravja 16 by photoionization method or so-called "electronic nose". Monitoring results in municipal station show that in 2017 the average benzene concentration was 4,87 ug/m<sup>3</sup>, toluene – 8,89 ug /m<sup>3</sup> and xylene – 5,07 ug/m<sup>3</sup>, while the odour pollution level does not exceed 5 odour units. In general estimation of pollution averaged annually do not show and explain variability of pollution levels. It's well known that high BTX and odour pollution episodes occur in shorter periods, thus short term limit values would be useful in order to characterize short term effects on human health and well-being.

**Keywords**—air quality, gas analysis, odour.

## I. INTRODUCTION

More and more scientists are paying attention to research on emissions of different pollutants and odours. Several researchers have conducted odour emissions studies directly in agricultural areas [1] – [3] other researchers have focused on emissions of waste water treatment plants [4] – [6]; others, while industrial emissions [7].

According to public available information, over

the past 30 years there has been a tendency to issuing of various judgments, but instead rely on quantitative measurements of odour [8].

In order to perform an economic activity, which is related to air pollution and odour emissions, in conformity with the requirements of regulatory enhancements, the performer of polluting activity (company) must receive a permit issued by the competent authority. Oil Transshipment Company must obtain a category B polluting activity permit depending on level of activity (amount of handled and processed oil products). Before issuing an authorisation, modelling of the distribution of pollutants should be carried out and a draft emission limit for odours should be developed, thereby forecasting emissions of pollutants and odours within and outside the work area of the company [9].

The project for the odour emission limit for company in "Riga-Milgravis" - has been developed taking into account emissions from transshipment of petroleum products (processes) - from transshipment of all products in reservoirs, tankers, road tankers and railway tanks, as well as from storage tanks. The results of the modelling of the distribution of pollutants indicate that the impact of company on air quality does not exceed the limit values specified in regulation No 1290 of MK 03.11.2009. in the area where compliance with air quality standards is assessed [10].

On the other hand, the calculation of the odour distribution shall indicate that the target value of the odour 5 ouE/m<sup>3</sup> specified in regulation 25.11.2014 of the MK No 724 "Regulations regarding the methods for determining odours caused by polluting activity, as well as the procedures for limiting the spread of these odours", shall be not exceeded, where compliance with the target value of the odds in accordance with paragraph 3 of this Regulation [10].

The above points to the fact that a company cannot

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produce concentrations and odours of pollutants, which would affect human health and well-being, while working with maximum load and adverse weather conditions. However, despite this, the national controlling authorities concerned still receive relatively many complaints, in autumn 2017 the number of complaints per day even exceeded 400 [11].

In view of the installation of monitoring stations in the most which continuous measurements of concentrations of pollutants and odour are obtained, the data of the two monitoring stations can then be analysed, the relationship between odour emissions, concentrations of polluting substances, meteorological conditions and the impact of the economic activity of the company on humans may be clarified.

## II. MATERIALS AND METHODS

For all company whose performance may require the development of draft odour emission limit projects in the environment, the emission limit projects shall also be based on the direct measurement of odour emissions at the emission sources. Thus, data were obtained, both on actual emissions from the emission source and on the emission source parameters, on the possibility of determining the emissions of odours outside the place of performance of the polluting activity, as well as the possibility of identifying and modelling odours flows at meteorological conditions and the duration of the emissions of odours. The calculation of odour spreading mainly uses the ADMS computer program, which is applicable to the calculation of the spread of air emissions and odours of industrial sources, taking into account the characteristics of the surroundings, i.e. terrain and building, as well as meteorological conditions. In order to identify the emissions of odours from company outside the boundary of the company and potential emissions in residential and public building areas, an analysis of the draft emission limit for odours of Category B polluting activities was carried out.

Data from the air monitoring station of the type of continuous activity installed by the local government, which is located on the Street Milgravja 10, Riga, were used for the analysis and processing of pollutant data. The monitoring station is operated at continuous mode, new measurements averaged for every 10 minutes are collected automatically in the Housing and Environment Department of the Riga City Council via mobile communications and ftp servers [12]. This monitoring station shall also ensure the acquisition of meteorological data, i.e. information on wind speed, direction and air temperature.

The aim of the study is to establish relationship between emissions of air pollutants and odour emissions, as well as the release of volatile organic compounds by nearby located companies, analysis of the continuous measurement data of benzene, toluene and xylene from the DOAS type air monitoring station was carried out in the study. Direct non-validated data were initially obtained, which serves as an indicative assessment of the level of air pollution in the monitoring sites, which are

further recalculated in the air quality index and 1 day cut.

Outside the business area, i.e. in the public building area, the company has installed an electrochemical, metal oxide and photoionization detector or “electronic nose”. This “electronic nose” is subjected to continuous measurements of the odour concentration. The results of the measurements shall ensure the possibility of obtaining information on the odour concentration, expressed in the odour units (ouE). This monitoring station shall also ensure the acquisition of meteorological data, i.e. information on wind speed and direction.

Data from the two continuous monitoring stations were analysed and compared with each other in MS Excel.

## III. RESULTS AND DISCUSSION

Testing results of accredited laboratories show that from emission sources the odour concentration can be higher than 40000 odour units (ouE/m<sup>3</sup>). The results of odour spreading modelling show that the maximum concentration of odours from the location of the polluting activity is not significant, i.e. up to 3,58 ouE/m<sup>3</sup>. Such emissions of odours from company are not relevant, although the perception of odours in humans is already from 1 unit of odours (ouE/m<sup>3</sup>).

Modelling results show that peak odour concentrations are at very low air mass mixing cold and low wind rates, thus identifying the most vulnerable weather conditions for contamination, i.e. stable atmospheric conditions.

Monitoring station for the measurement of continuous odours concentration is installed in the area of the pellet golf area, which is currently the only such type of equipment in the administrative territory of Riga, located in accordance with Republic of Latvia Cabinet Regulation No. 724 „Regulations Regarding the Methods for Determination of the Odours Caused by Polluting Activity, as well as the Procedures for Restricting the Spread of such Odours” in Paragraph 3. The monitoring station shall record actual emissions. According to the data of the monitoring station, the target value of the smell has been exceeded 281 times (hours; the target value of the odour shall be determined for the hour period) in the area of sport and recreation with plants (AS) where the monitoring station is located. In accordance with Cabinet Regulation No. 724, the target value of the odour of paragraph 8, determined for an hourly period (5 ouE/m<sup>3</sup>), may not exceed more than 168 hours per calendar year. It is thus apparent that the monitoring station has detected peak of 213 hours (sometimes), as permitted by the regulatory enactments. In this case, there are significant meteorological conditions, i.e. wind direction, since the analysis of wind direction leads to the conclusion that the impact of the oil terminal could have been 183. However, regardless, the target value of odours is exceeded by 15 times (hours) more than permissible. In the analysis of odours emissions, the intensity and duration of odours are essential, so that the five figures “Fig.1” – “Fig.5” reflect the longer-lasting odour episodes with higher odour concentrations.

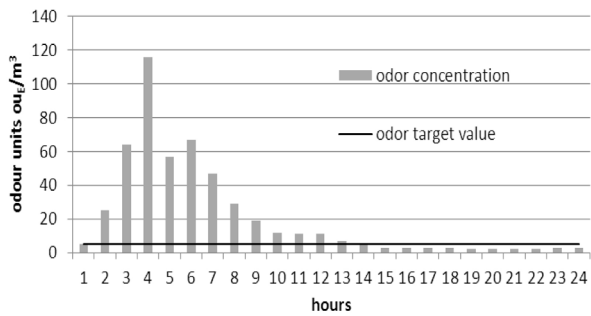


Fig.1. Odour concentration on July 29, 2017.

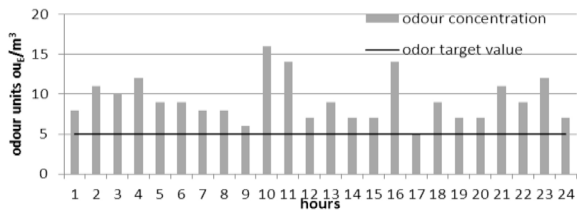


Fig.2. Odour concentration on September 4, 2017.

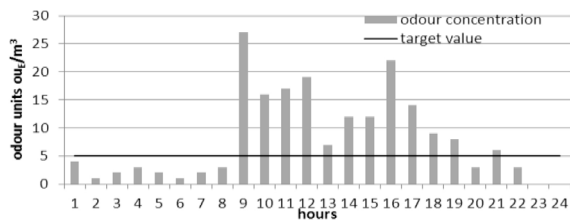


Fig.3. Odour concentration on October 21, 2017.

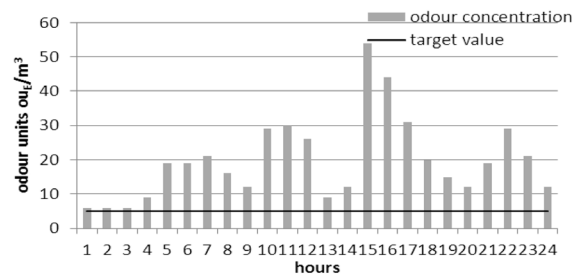


Fig.4. Odour concentration on April 1, 2018.

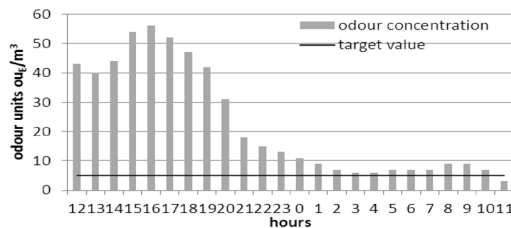


Fig.5. Odour concentration on April 20-21, 2018.

Concentrations of polluting substances, i.e. air quality standards for polluting substances shall be determined at 03.11.2009. Cabinet Regulation No. 1290 "Regulations regarding air quality, according to which the annual average concentration of benzene must not exceed  $5 \mu\text{g}/\text{m}^3$ , the target value of toluene week shall be  $0,26 \text{ mg}/\text{m}^3$ . However, the concentration of xylene is not determined by normative measures.

Data from the monitoring station indicate that the

average concentrations of the pollutants in the water in 2017 are as follows: benzene concentration –  $4,87 \mu\text{g}/\text{m}^3$ , toluene –  $8,89 \mu\text{g}/\text{m}^3$  and xylene –  $5,07 \mu\text{g}/\text{m}^3$ .

Although the annual average concentration of benzene in 2017 in Milgravis is lower than in the city centre, the peaks of individual air pollution episodes are more pronounced.

In the analysis of the 2017 data, the largest 1 hour concentration of benzene was observed on 1 August when it reached  $97,04 \mu\text{g}/\text{m}^3$ , with a maximum concentration of toluene of  $51,11 \mu\text{g}/\text{m}^3$  fixed on 23 December, while the maximum hourly concentration of xylene was observed on 9 June at  $44,22 \mu\text{g}/\text{m}^3$ .

On the evening of September 12, 2017, both the State Environmental Service and the State Fire and Rescue Service received complaints from more than 400 residents over a short period of time (a few hours interval) about disturbing smells from several districts of Riga, i.e. Sarkandaugava, Milgravis and Vecmilgravis [11]. Therefore, Fig.6 summarises the information from the two monitoring stations located in Milgravis, both concentrations of pollutants and odour emission concentrations.

Data from monitoring stations do not indicate increased odour emissions or concentrations of pollutants, although benzene, toluene and xylene concentrations exceeded  $5 \mu\text{g}/\text{m}^3$  in individual hours. During this period there was a SPC wind at a speed of up to  $2 \text{ m}/\text{s}$ , which means that due to meteorological conditions, true emissions from oil terminals could not be identified.

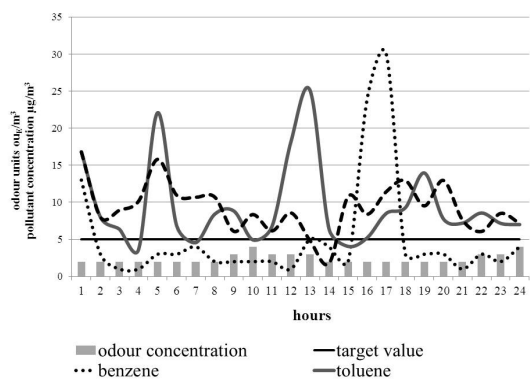


Fig.6. Odour and pollutants concentrations on September 12, 2018.

Although performers of polluting activities, perform the development of draft odour emission limit projects, perform modelling of the odour concentration, as well as the State Environmental Service, when issuing permits for polluting activity, shall determine the conditions regarding the operation of plants in conformity with the requirements of regulatory enactments, regardless of which there are problems with the emission of odours in individual districts of Riga. The assessed draft emission limits for odours and the results of modelling the odour concentration shall indicate the hours in the annual cut of the average and maximum concentration, as determined by regulatory enactments. Calculated emissions in

emission limit projects are less than actually in nature.

The above does not indicate that non-compliant emission limit projects are being developed for the performance of polluting activities, the problem is that odour emissions are assessed on an annual basis, but the activity of companies or the work area does not operate for the full annual cycle, i.e. the number of hours per year is significantly lower. By offsetting working hours in the annual section, even when no polluting activity is carried out, the concentration of odours will be reduced by analogy. Similarly, the average concentration of the hour may also meet the requirements of the regulatory enactments in cases where there has been a strong smell for 30 minutes and the smell has not been at all or has been minimal for 30 minutes. It is logical that, within 30 minutes, even serious health problems may arise for a particularly sensitive group of people, so it is necessary to think about both spatial planning and legislative developments.

If the emission limit projects developed also show the actual maximum possible emissions as well as the total actual emissions of several companies, this would not solve the problem in the areas affected by the odour of petroleum products, i.e. significant measures should be taken to reduce odour emissions. This does not mean that it is necessary to shutdown firms in order to preserve the quality of the environment, but the economic situation in the country must also be promoted, but a new regulatory framework is currently needed to carry out polluting activities, which would require stricter requirements to install polluting gas collection plants.

#### IV. CONCLUSION

The results indicated that concentrations of pollutants are not always high during periods when odour emissions are higher. The results obtained show that odour emissions exceed the number of hours when the odour concentration is above  $5 \text{ ouE/m}^3$ . On the other hand, the annual average concentration of odour shall not exceed  $5 \text{ ouE/m}^3$ , nor shall emissions of pollutants be within the limits of regulatory enactments.

#### REFERENCES

- [1] Traube S., Anhalt J., Zahn J. "Bias of tedlar bags in the measurement of agricultural odorants", *Journal of Environmental Quality*, 35, 1668-1677, 2006.
- [2] Parker D., Perschbacher-Buser Z., Cole N., Koziel J. "Recovery of agricultural odors and odorous compounds from polyvinyl fluoride film bags". *Sensors*, 10, 8536-8552, 2010.
- [3] Henry H., Schulte D., Hoff S., Jacobson L., Parkhurst A. "Comparison of ambient odour assessment techniques in a controlled environment", *Agricultural and Biosystems Engineering*, 54(5), 1865-1872, 2011.
- [4] Gostelow P., Parsons S.A., Stuetz R.M. "Odour measurements for sewage treatment works". *Water Research*, 35(3), 579-597, 2001.
- [5] Munoz R., Sivret E., Parcsi G., Lebrero R., Wang X., Suffet I.H., Stuetz R. "Monitoring techniques for odour abatement assessment", *Water Research*, 44, 5129-5149, 2010.
- [6] Dlugosz J., Gawdzik J. "Validation of the operations of municipal wastewater treatment plant in Piaseczno". *Archiwum Gospodarki Odpadami I Ochrony Środowiska*, 14(4), 31-40, 2012.
- [7] Čupas K., „Preparation of 3D digital city model development technology based on geoinformation systems”, *Geodesy and Cartography*, Vol XXIX, No 3., Vilnius: Technica, p. 90-97. ISSN 1392-1541, 2003.
- [8] Harreveld van A.P., Heeres P., Harssema H. "A Review of 20 Years of Standardization of Odor Concentration Measurement by Dynamic Olfactometry in Europe", *Journal of the Air & Waste Management Association*, 49:6, 705-715, 2015.
- [9] Republic of Latvia Cabinet Regulation No. 724 „Regulations Regarding the Methods for Determination of the Odours Caused by Polluting Activity, as well as the Procedures for Restricting the Spread of such Odours”, 2014. *Latvijas Vēstnesis*, No. 250 (5310), 16.12.2014., Adopted 25.11.2014.
- [10] A; B permit, 2017. State Environmental Bureau. URL: <http://www.vpvb.gov.lv/lv/piesarnojums/a-b-atlaujas> [Online], [Accessed: Jan. 22, 2019].
- [11] Smirde Vecmīlgrāvī: smakas avots nav uzņēmums brīvostā, secina policija, 2017. Delfi editorial. URL: <http://www.delfi.lv/news/national/politics/smirde-vecmilgravi-smakas-avots-nav-uzne-mums-brivosta-secina-policija.d?id=49240809> [Online], [Accessed: Jul. 31., 2018].
- [12] Air monitoring in Riga, 2017., Riga City Council Housing and Environment Department, URL: <https://mvd.riga.lv/nozares/vides-parvalde/gaisa-kvalitate/gaisa-monitorings-riga/> [Online], [Accessed: Sept. 12, 2018].