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# COMPLIANT *VERSUS* NON-COMPLIANT PRACTICES IN THE POULTRY SECTOR AND THE INFLUENCE OF DISCREPANCIES ON THE QUALITY OF LIFE. CASE STUDY – POULTRY FARM SC AVICOM SA, VASLUI COUNTY

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*Abstract*

This paper briefly presents some theoretical approaches regarding the compliant and non-compliant practices in the poultry sector, and the case study: Poultry farm SC AVICOM SA in Vaslui County. The purpose of this paper is to assess the changes to the air environment factor, caused by the pollutants originating from the zootechnical activities of an integrated poultry facility of SC AVICOM SA poultry farm in Vaslui County. The status of current environmental problems for air is presented from the perspective of the analysis of pollution management methods, approached at a general level.

This study focuses on air pollution caused by the activity of zootechnical branch, presenting current issues related to the activity of intensive poultry rearing. The study deals with the analysis of the evolution of odorous pollutants generated by this activity, the impact on the environment generated by the emission and concentration of ammonia NH3. The conclusions include recommendations for the application of BAT rules to reduce ammonia emissions and protect air quality.

***Keywards:*** poultry farm, pollutants, air quality, poultry manure.

## 1. Introduction

This paper details the analysis of the evolution of pollutants generated by the poultry activity – with special regard to the environmental factor –

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air, the monitoring methods and methods to reduce emissions, impact of the activity on environment and people, while also proposing solutions to improve air quality, by applying BAT rules. Defined as "a form of orientation and organization of the complex activity of environmental protection, called to establish the strategies, methods and means used in the actions carried out on a national and international level, to prevent and control pollution, to improve environmental conditions", the environmental policy tries to reconcile economic and social development with environmental protection (Lupan E., 2009).

Along with the great scientific advances, the amount and nature of residues has fundamentally changed. In the last decades, the process of degradation of the environmental factors on our planet has had an increasingly worrying evolution, the amount of pollutants reaching figures that exceed the most pessimistic estimates, and solving the pollution issue has become a complex problem of correcting the errors that cause it. Human activities, whether industrial or agricultural, have the greatest impact on the environment, all abiotic and biotic environmental factors being affected due to air, water, soil pollution, respectively through the generation of waste or overexploitation of natural resources. Along with the other environment components, atmospheric air is vital to nature, including organisms and humans. However, the development of human society led and leads to pressure on this environmental component, the impact on the air and its quality always being profoundly negative. In addition to urbanization and the development of transport, the branches of industry and agriculture cause emissions with high concentrations of polluting substances into the atmosphere. These emissions have harmful effects on the health of all living organisms. In this sense, the field of ecology focuses on studying the relationships established between the biotic part and the environment, with an emphasis on the protection of atmospheric air, as its pollution causes negative consequences both on local and global scale (Copacinschi Gh., et al., 2015).

While the organoleptic pollutants resulting, in general, from the industrial activity do not cause discomfort to human settlements in the immediate vicinity of the sites (provided the distances imposed by the legislation are observed), the emissions/odors from livestock farms,

respectively from poultry farms, are easily noticeable. Some of the emissions resulting from the poultry rearing activity are non-polluting, such as water vapor or carbon dioxide ($CO_2$) from breathing, or those from the decomposition of manure. Others, on the other hand, have a negative impact on the environment, including abiotic factors: ammonia $NH_3$, nitrous oxide $N_2O$, dust (Benciu F., 2009).

In 2017, in the United Kingdom of Great Britain, at the University of Cambridge, a group of specialists carried out an analysis on poultry rearing, Growth Curve Analyzes in Poultry Science, through which it was highlighted that the pattern of growth and modification of the body of poultry per unit of time are influenced by genotype and environment. The research results were grouped on three levels: determining the most suitable growth model, comparing the development of poultry vs. groups of experimental poultry and development of a growth curve based on estimates of genetic growth parameters (Narniç D., Narniç Ö., Aygün A., 2017).

Pollution generated by this poultry sector finds its solution can be solved by applying the best available techniques and practices regarding feeding, rearing poultry and managing manure, as well as the wider use of conventional energy saving technologies by using biogas generators. (Benciu F., 2010) In this context, on an international level, numerous specialist studies have been carried out regarding the assessment of the impact of pesticides on human health and ecosystems. For the present study, is relevant the work of Swiss specialists of EPFL – Swiss Federal Institute of Technology, Institute of Ecosystems Management, CECOS, CH-1005 Lausanne, Switzwerland, who found that by applying the best environmental management practices, it can be avoided the transmission of agricultural toxicity caused by pollution of environmental factors on the human body. The paper describes a method of assessing the pollutant circuit by which is determined the harmful impact on the air environmental factor, on ecosystems and implicitly on human health (Margni M., et al., 2002).

It is also worth noting the specialist works from the Islamic Republic of Iran developed within the framework of university research on the application of new methods (the DRASTIC Model) to identify the vulnerability of groundwater and underground water table to nitrate pollution from the agricultural areas of northern Iran. Specialists refer to the fact that, for a more accurate assessment, the values of DRASTIC

parameters that reflect the potential for aquifer pollution must be related to the DRASTIC index. This correlation (Pearson Correlation) is applied to identify the relationship between the index and pollution measured at each observation point, finally being able to get more accurate assessments of the risk of nitrate pollution from agricultural sources (Javadi S., et al., 2010).

## 2. Methodology

In the current understanding of scientific research, detailed studies found that the analysis of the knowledge of a phenomenon that constitutes a case study should follow several stages of the research, such as: to demonstrate in what form the knowledge of established objective is available; to establish the methods of critical analysis of knowledge of the phenomenon; to formulate and present the minimum conditions necessary to carry out critical analysis and to demonstrate by which specific methods this investigation is carried out (Iordache V., 2006).

In this research, we complied with the methodology and stages of drawing up case studies with environmental impact. In a first stage, the purpose of research was established, the knowledge of our goal and its identification on site. The official sources for obtaining public information and statistical data were selected from relevant institutions. Also, we developed the necessary documentation for carrying out field work: maps, laptop, Toolpack field distance measuring device with a measuring capacity of 10000 m and a tolerance of 5 mm/m. The information was collected by gathering an appropriate number of data, sufficient for the relevance of the study. In the next stage, we compiled and processed the numerical data, drew up the graphic part and finally, we created the material. For the graphic representation, we used a modeling program made available to the public by the United States Environmental Agency: Screen Model – Lakes Environmental Software, which provides a pollutant concentration estimation method for ammonia emissions to air. The research was completed by obtaining the results, establishing the conclusions and suggestions regarding the improvement of the air quality. For immediate results, we recommended to apply the best practices available for air, agreed by national and European legislative norms for air quality management.

### 3. Case study: SC AVICOM S.A. Poultry Farm, Vaslui County

The SC AVICOM SA poultry farm is located in the suburbs of Muntenii de Jos, in the southeast of Vaslui city, on the left bank of the Vasluieț river - a tributary of Bârlad river (Figure 1). The poultry farm's business activity is the rearing of meat birds (NACE code 0147 Poultry rearing) for consumption through the "ground" raising method and is the oldest of the poultry farms in Vaslui County.


*Figure 1.* Geographical location of the study area
(*Source:* Google Earth, 2020 https://www.google.ro/intl/ro/earth/)

Geographical features. The relief on which the site is located is typical of a smooth plateau, with well-developed terraces along the main Bârlad and Vasluieț watercourses (Ienenicz M., 2005). The local hydrographic network formed three terrace levels: the upper terrace of 70-80 m, the middle terrace of 40-50 m and the lower terrace of 10-20 m. The slopes are smooth, and the interfluves have small slopes that stimulate swamping and clogging of lands, especially in the areas of water convergence (Pișota I., Zaharia L., 2001-2002).

The climate is transitional temperate-continental with continental patches of aridity, where the circulation of air masses is mostly from the southeast. Depending on the speed and direction of the wind, they are of particular importance in the atmospheric dispersion of noxious substances and pollutants originating from human activities (Bordei-Ion E., Taulescu G., 2008).

The zonal soils are specific to the low plateau and plain relief that are part of the mollisol and clay loam classes, and the azonal soils belong to the alluvial soils, widely distributed in the meadow. The natural vegetation is typical of the steppe and silvosteppe, but it has mostly been replaced by agricultural crops or removed by the expansion of urban development (Radu Al. T., 2003).

Ecological features. The purpose of study Compliant practices *versus* non-compliant practices in the poultry sector and the influence of the discrepancies for the quality of life is related to the fact that the dispersion of polluting substances in the atmosphere is influenced by the geographical characteristics of the location of SC AVICOM SA poultry farm in Vaslui County. The concentration of pollutants is influenced by meteorological factors such as: wind speed, direction of movement of air masses, temperature and precipitation, and their variation during a day or from one day to another leads to short or long-term variations in their concentration and their persistence in air (Benciu F., 2010).

In Romania, the concentration of atmospheric pollutants is monitored by the National Air Quality Monitoring Network (R.N.M.C.A.). The study area is within the scope of the automatic air quality monitoring station VS1, which is part of the R.N.M.C.A. As a type, it is an urban base station providing field coverage up to a distance of 5 km. The VS1 station is located in the central-southern part of the Vaslui city, and the SC AVICOM SA poultry farm is located 1.6 km from it in the southeastern part.

According to public information from the County Report on Environment Condition in Vaslui County 2020, carried out by the Vaslui Environmental Protection Agency, animal farms (livestock and poultry) fall under the scope of Directive 2010/75/EU on industrial emissions, known as the IED Directive to which the animal farms that are inventoried in the E-PRTR (European Pollutant Release and Transfer Register – refers to the water environmental factor) are also added.

In the technological flow of SC AVICOM SA poultry farm, the sheds with various population/raising/depopulation purposes have an important role in ensuring an environment conducive to the optimal development of poultry. The main role is to comply with sanitary rules and maintain cleanliness. The sheds are permanently sanitized at each end of the poultry raising cycle, the process consisting in the mechanical

removal of the previously dry bedding (consisting of sawdust, sunflower stalks, animal droppings); and the substances used as disinfectants must be approved by the competent institutions regarding toxicity and environmental impact. The sanitization procedure of the halls must observe the sequence of execution stages: wash the walls and floors with a turbo jet with a concentrated solution of 3% sodium hydroxide, rinse with water and ventilation. Disinfection is done with substances with virucidal, bactericidal and fungicidal action, after which the halls are closed for a period of 6 to 10 days, followed by their ventilation. The following raw materials of a polluting nature are needed for the activity of raising broiler chickens at the poultry farm in Vaslui County: combined feed, vitamins, vaccines, medicines. Depending on the population capacity of the poultry farm, the quantities of raw materials are variable. The waste water from the sanitation of the premises during the sanitary vacuum period is discharged through sewerage networks and directed to the city's sewage treatment plant.

The SC AVICOM SA poultry farm in Vaslui County uses entirely the water and sewerage network in the area, the waste water being purified in the municipal treatment plant according to NTPA001/2002 and NTPA002/2002 standards; thus complying with the provisions of GD no. 352 of April 21, 2005 for the approval of certain rules regarding the conditions for discharging waste water into the aquatic environment (completion and amendment of GD no. 188/2002) published in the Official Gazette no. 398 of May 11, 2005.

In the production flow of the SC AVICOM SA poultry farm, the management of animal waste falls under the final procedures, Figure 2. The site has a storage platform for manure from the chicken rearing sector. This construction is concreted, waterproofed, and provided with a drain through which the leachate is directed to the concrete waste water storage basin. From here, the manure can be taken over and used (along with cattle manure and cereal stillage) in the local biogas production process.

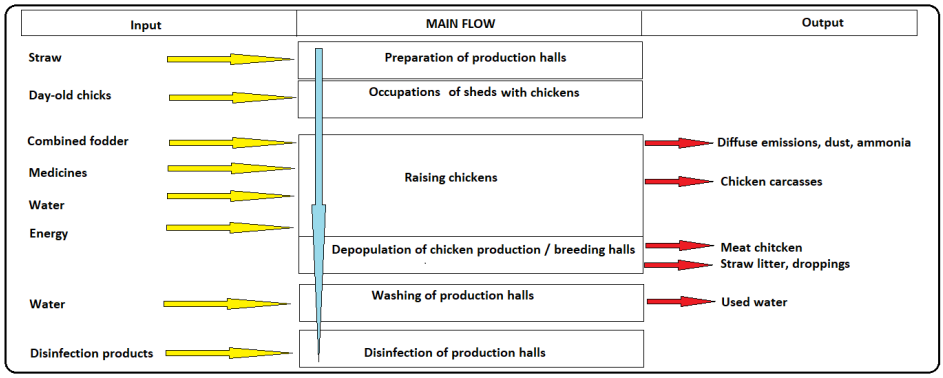


*Figure 2*. Technological flow diagram for SC AVICOM SA Poultry Farm, Vaslui County

## 4. The impact on the environmental factor – air generated by the Poultry Farm SC AVICOM SA, Vaslui County

According to the legislation in force, intensive poultry facilities with more than 40,000 places have the obligation to protect the quality of environmental factors by complying with Law no. 278/2013 on industrial emissions, published in the Official Gazette no. 671 of November 1, 2013, whose purpose is the prevention and integrated control of pollution resulting from industrial activities. This document establishes the conditions for the prevention or, if it is not possible, for the reduction of emissions to air, water and soil, as well as for the prevention of the generation of animal waste, so as to achieve a high level of environmental protection. Operators that carry out activities of this type will only operate after obtaining the Integrated Environmental Permit from the relevant institutions.

### *Air quality*

The internal activities of agricultural farms are generating sources of pollutants and odors in the atmospheric air. They fall under pollutant emissions and immissions as follows:

***A*** – Non-directed point sources identified by: the ventilation system of poultry rearing halls that cause emissions of burnt gases, ammonia ($NH_3$), non-methane organic compounds and dust; fugitive emissions from the leachate storage basin and from the waste platform containing ammonia, non-methane organic compounds; vehicle traffic on the premises of the farm that generates exhaust gases containing carbon monoxide (CO) and carbon dioxide ($CO_2$), nitrogen oxides ($NO_x$).

The broiler chickens are raised on the ground at the SC AVICOM SA with adequate ventilation and frequent sanitation, which has led to a decrease in the level of pollutants generated in the atmosphere. Ammonia and non-methane VOC result from both the metabolic growth reaction of the birds and their droppings. Ammonia and dust emissions discharged with the ventilation systems equipped with exhaust fans are below the limits imposed by the regulations in force. By humidity control, fermentation of manure in the hall is reduced. The noxious emission exhaust systems in the hall are located at height and due to the location in an open area, a dilution of the emitted pollutants is achieved.

### *Odors from the leachate storage basin and the manure platform*

The odor is a local problem of discomfort, which is generated by stationary sources such as: storage basins, technological waste water, household water and the storage platform. The intensity of the odors is due to the fugitive emissions of ammonia NH3 and non-methane volatile organic compounds. The storage of manure on the concrete platform is a source of emissions of ammonia and other foul-smelling components. Emissions from manure storage depend on their chemical composition, as a result of diet and feeding level applied, climatic conditions – temperature, ambient, precipitation, as well as the nature of the feed composition. The animal waste storage platform is located within the premises of the poultry farm and is set up in compliance with the technical conditions to avoid soil, subsoil and water table pollution in the farm area.

Starting from the premise that of the four parameters monitored between 2013 and 2018: ammonia, non-methane VOC, $PM_{10}$ and $PM_{2.5}$, the highest values of release into the atmosphere are of ammonia $NH_3$

(Figure 3). This study focused on the detailed research of this parameter. In parallel, it is stated that the odors generated by ammonia were periodic and persistent.

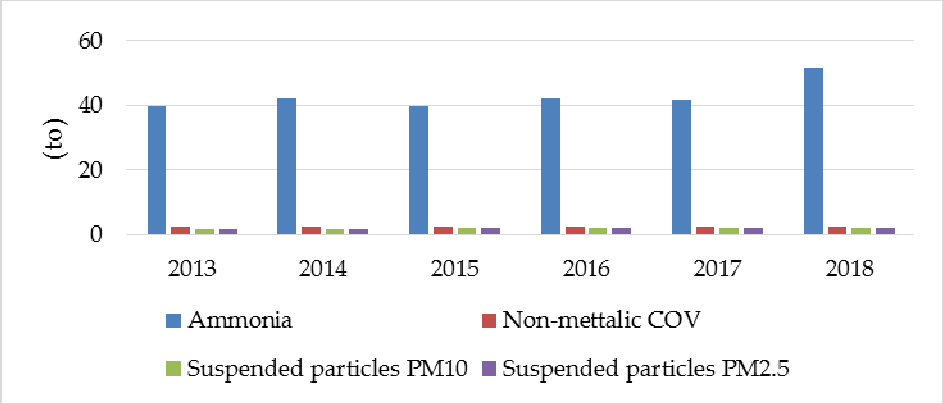


*Figure 3*. Annual evolution of $NH_3$, VOC, $PM_{10}/PM_{2.5}$ pollutant emissions (*Source:* primary data of SC AVICOM SA Poultry Farm, Vaslui County)

The above diagram shows that the evolution of the quantity of ammonia has increased, exceeding 40 tons/year in the period 2013-2017, so that in 2018 the quantity exceeds 50 tons/year.

The calculation of ammonia emissions resulting from the poultry rearing activity was carried out during the Local Emission Inventory stage carried out by the environmental authority of Vaslui County. There were used the indicators of emission factors provided by the EMEP/EEA Air Pollutant Emission Inventory Guidebook, with the changes made in 2013 and 2016. According to the European Pollutant Emission Register and the Local Emission Inventory the amount of pollutants released by the SC AVICOM SA poultry farm in the period 2013-2018 had the following evolution (Table 1):

*Table 1*

**Amount of pollutants generated by SC AVICOM SA Poultry Farm, Vaslui County**

| Pollutant released t/year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Broiler chicken population | 2.033.715 | 2.164.614 | 2.035.600 | 2.148.440 | 2.137.650 | 2.044.464 |
| $NH_3$ | 39,8 | 42,3 | 39,8 | 42,0 | 41,8 | 51,8 |
| Non-methane VOC | 2,34 | 2,49 | 2,34 | 2,47 | 2,45 | 2,35 |
| $PM_{10}$ dust | 1,6 | 1,7 | 2,1 | 2,2 | 2,2 | 2,1 |
| $PM_{2,5}$ dust | 1,6 | 1,7 | 2,1 | 2,2 | 2,2 | 2,1 |

*Source:* primary data of SC AVICOM SA Poultry Farm, Vaslui County

**B –** Directed point sources. The thermal plant of the administrative pavilion of the SC AVICOM SA poultry farm operates on the basis of methane gas and generates burnt gases such as: carbon monoxide, nitrogen oxides, sulfur dioxide, dust. Following the observations made on the directed emissions from this plant, they were considered to be insignificant emissions. The permitted limit values for pollutant emissions from the combustion of natural gas, respectively those resulting from the biogas production facility through anaerobic fermentation are established by Order no. 462/1993 for the approval of the Technical Conditions regarding the protection of the atmosphere and the Methodological Norms regarding the determination of emissions of atmospheric pollutants generated by stationary sources, as presented in Table 2.

Operator is obliged to monitor annually the emissions from the biogas production facility through the anaerobic fermentation of waste. Starting with the start-up year of the installation - 2014 and up to 2018 (Table 3), the values obtained in the monitoring activity fell below the allowed limit value provided by Order no. 462/1993 for the approval of the Technical Conditions regarding the protection of the atmosphere and Methodological norms regarding the determination of atmospheric pollutant emissions produced by stationary sources (Figure 4).

*Table 2*

**Limit values allowed for pollutant emissions from natural gas combustion**

| Emission | Source description | Pollutant | Order 462/1993 (mg/cbm) | Evacuation |
|---|---|---|---|---|
| Permissible | Thermal plant – methane gas | Dust | 5 | Evacuation chimney |
| | | CO | 100 | |
| | | $NO_x$ | 350 | |
| | | $SO_2$ | 35 | |
| Directed | | Dust | 5 | Evacuation chimney |
| | | CO | 100 | |
| | | $NO_x$ | 350 | |
| | | $H_2S$ | 5 | |

*Source:* Order no. 462/1993 for the approval of the Technical Conditions regarding the protection of the atmosphere and the Methodological Norms regarding the determination of the emissions of atmospheric pollutants produced by stationary sources

*Table 3*

**Emissions from the biogas production facility (2014-2018)**

| Year | CO (mg/cbm) | NOx (mg/cbm) | $SO_2$* (mg/cbm) | Dust (mg/cbm) | $H_2S$* (mg/cbm) |
|---|---|---|---|---|---|
| 2014 | 29 | 133 | <0,26 | 2,3 | <0,01 |
| 2015 | 29 | 135 | <0,26 | 2,5 | <0,01 |
| 2016 | 27 | 142 | <0,26 | 2,4 | <0,01 |
| 2017 | 28 | 138 | <0,26 | 2,5 | <0,01 |
| 2018 | 29 | 133 | <0,26 | 2,5 | <0,01 |

*Source:* primary data of SC AVICOM SA Poultry Farm, Vaslui County

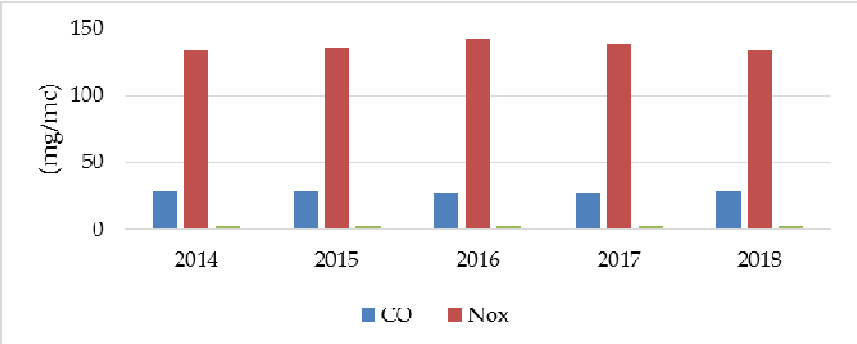


*Figure 4*. Annual evolution of pollutant emissions $NH_3$, $VOC_s$, $PM_s$ at the cogeneration plant (*Source:* primary data of SC AVICOM SA Poultry Farm, Vaslui County)

It is apparent that for all monitored parameters, the values of pollutant emission concentrations remained constant during the period 2014-2018 and fell below the maximum limit allowed by law.

The impact of noxious emissions and odors on neighboring areas, mostly residential areas, depends on several factors, such as: the way in which the operator manages the metabolic and fermentation processes of waste from birds; distance to receivers; the circulation of air masses through the direction, frequency and speed of the wind. It is obvious that weather phenomena cannot be controlled by humans, and the dispersion of unpleasant odors in the atmosphere can reach significant distances, causing discomfort when crossing inhabited areas. However, compliance with the conditions imposed by the best techniques available in the field (BAT Norms for maintaining air quality) can lead to minimizing the impact of unpleasant odors on sensitive receptors. The application of BAT rules aims to reduce the emissions generating disturbing odors through sustained actions such as: implement an adequate nutritional regimen in the birds' feed, the appropriate management of droppings eliminated by birds, transport of animal droppings in accordance with the local and daily weather conditions, so that they do not increase the dispersion of pollutants in the atmosphere.

Also, *pollutant immissions* (transfer of pollutants into the atmosphere to a receptor) must fall within the maximum limits allowed according to Law no. 104/2011 on the quality of the surrounding air for the pollutants CO, $SO_2$, $NO_x$, suspended dust, and STAS 12574 /87 regarding air quality conditions in protected areas for the indicator ammonia $NH_3$ and hydrogen sulphide $H_2S$, both sets of values being presented in Table 4.

Operator has the obligation to monitor the immissions from the poultry farm site and to draw up annual reports on the monitoring of the immissions. For the year 2019, pollutant immission values were recorded in the area of incidence of the cogeneration plant, at the boundary of the site, in the area of the flare of the biogas plant and in the area of the nearest sensitive receptors for the pollutants: carbon monoxide CO, $NO_x$, dioxide of sulfur $SO_2$, dust, hydrogen sulphide $H_2S$ and ammonia $NH_3$ (Table 5, Figure 5).

*Table 4*

**Legislative conditions regarding air quality in protected areas**

| | STAS 12574/1987 | | Legea nr.104/2011 | | |
|---|---|---|---|---|---|
| | **Pollutant** | **Short-term average value (30 min) mg/cbm** | **Pollutant** | **Hourly limit value** | **Daily limit value** |
| Sensitive receptor area | CO | 6,0 | $NO_2$ | 200µg/m$^3$ | - |
| | NOx | 0,3 | $SO_2$ | 350µg/m$^3$ | 125 µg/m$^3$ |
| | $SO_2$ | 0,75 | CO | - | 10 mg/m$^3$ |
| | Dust | 0,5 | - | - | - |
| | $H_2S$ | 0,015 | - | - | - |
| | $NH_3$ | 0,3 | - | - | - |

*Source:* Extract from STAS 12574/1997 regarding the conditions for protecting the air in protected areas and Law no. 104/2011 regarding the quality of the surrounding air for pollutants CO, $SO_2$, $NO_x$, suspended dust

*Table 5*

**Emissions from the site of SC AVICOM SA Poultry Farm in 2019**

| | **Pollutant** | **Short-term average value (30 min) mg/m2 according to STAS 12574/1987** | **Measured value (2019) mg/cbm** |
|---|---|---|---|
| **At the boundary of the site, the area of the biogas plant flare (approx. 4 m of flare)** | CO | 6,0 | 4,12 |
| | $NO_x$ | 0,3 | 0,26 |
| | $SO_2$ | 0,75 | 0,18 |
| | Dust | 0,5 | 0,16 |
| | $H_2S$ | 0,015 | 0,010 |
| | $NH_3$ | 0,3 | 0,11 |
| **Area of the nearest sensitive receptors** | CO | 6,0 | 1,8 |
| | $NO_x$ | 0,3 | 0,19 |
| | $SO_2$ | 0,75 | 0,22 |
| | Dust | 0,5 | 0,042 |
| | $H_2S$ | 0,015 | 0,008 |
| | $NH_3$ | 0,3 | 0,12 |

*Source:* primary data of SC AVICOM SA Poultry Farm, Vaslui County

As can be seen, the recorded values are below the limit values allowed according to regulations in force (STAS 12574/1997 regarding the conditions for air protection in protected areas).

The poultry rearing facility at the integrated level of the poultry farm with a population of more than 40,000 broiler chickens falls under the scope of Law no. 278/2013 regarding industrial emissions. In this sense, the provisions imposed by Commission Implementing Decision (EU) 2017/302 of 15 February 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the intensive rearing of poultry or pigs.

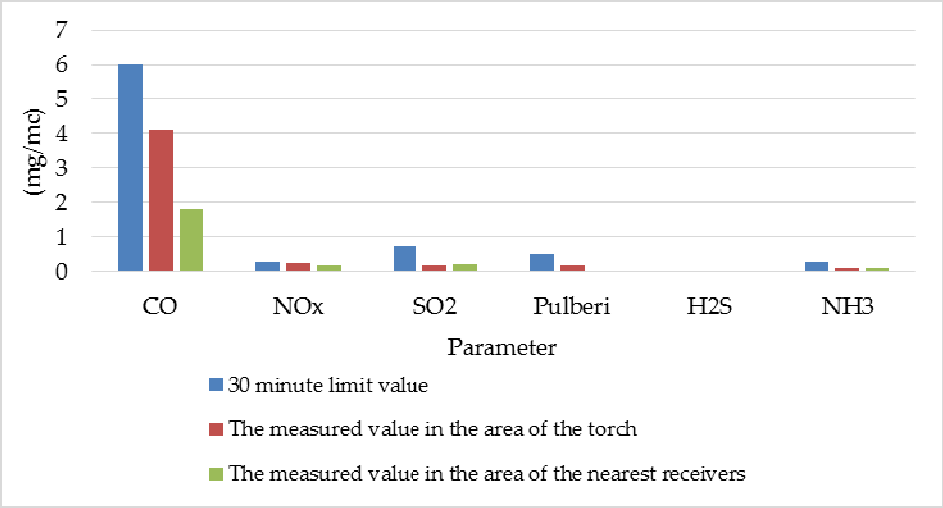


*Figure 5*. Values of pollutant emissions in the incidence area of the cogeneration plant, 2019 (*Source:* primary data of SC AVICOM SA Poultry Farm, Vaslui County)

The BAT norms and conclusions detail the techniques by which odor-generating immissions are reduced, details also observed by the operator: frequent removal of animal droppings; the use of forced ventilation in shelters; use of an adequate nutritional regimen; keeping the bedding dry thanks to the forced ventilation and the heating system; manure management depending on the weather conditions. Failure to comply with these rules does not ensure favorable conditions for minimizing emissions and may lead to emissions of pollutants that exceed the

normal values provided by law, respectively may cause discomfort to the population in the neighboring residential areas.

The case study refers to such an incident that occurred in November 2019. Due to bad weather conditions for the transport of manure to the platform of the cogeneration plant, the city of Vaslui faced the discomfort generated by a persistent odor for a period of 2 consecutive days. Thus, on November 28 and 29, the weather conditions were unfavorable compared to the previous days, November 23-27, namely: the temperature was higher for this period of the year, reaching +10.5°C, the atmospheric humidity reached the maximum threshold of 100%, the direction of movement of the air masses was towards the south and southeast towards the inhabited area, the wind speed had very low values, close to atmospheric calm (0 m/s). As a result of these topoclimatic characteristics, the dispersion of odors generated by the concentration of ammonia was not achieved efficiently, it persisted for more than 48 hours in the entire residential area. Figure 6 shows the values recorded at the sampling point of the Environmental Protection Agency in Vaslui County for the period 23-29 November 2019, including the interval in which the discomfort generated by the persistent smell of Ammonia $NH_3$ was recorded (Figure 6).

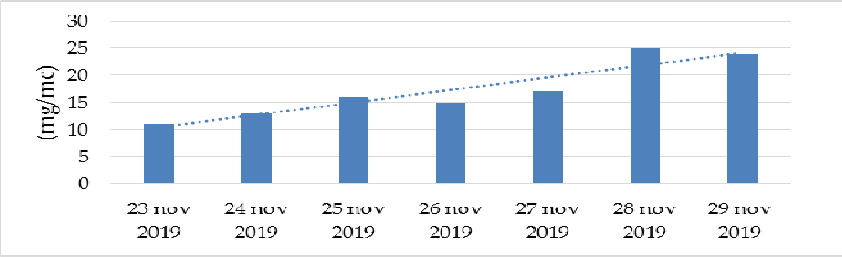


*Figure 6*. Daily evolution of ammonia ($NH_3$) emissions between November 23 and 29, 2019 (*Source:* primary data of SC AVICOM SA Poultry Farm, Vaslui County)

As can be seen from the graphic representation, the toxic emission values fall within the limit established by STAS 12574/87, the maximum being recorded on 28.11.2019, namely: 0.025 mg/m$^2$, the daily limit being 0.1 mg/m$^2$. However, inhabitants of the city of Vaslui noticed the discomfort produced by the smell of ammonia $NH_3$, which is also

perceived at lower concentrations in the air, due to the unfavorable local weather conditions for the dispersion of pestilential odors in the atmosphere.

To quantify the extent of the impact and establish its negative effects on the Vaslui population, a modeling program made available to the public by the United States Environmental Agency, we used LAKES ENVIRONMENTAL SOFTWARE – SCREEN MODEL. It provides an easy-to-use method for estimating the concentration of air pollutants. The mathematical modeling of the dispersion of pollutants in the residential area of the city of Vaslui consists in the processing of information and statistical data, such as: the establishment of geographical-topographical characteristics (relief), the area where the site is located in relation to the monitoring point, the processing of pollutant concentrations depending on the nature of the source, the values local meteorological parameters.

The modeling parameters were established following field observations:

- Geographical features of the relief – the flat surface, with the appearance of a wide plain with altitudes not exceeding 100 m, the direction of topographic inclination is from north to south, with a very low slope;
- Area where the site is located in relation to the monitoring point of the A.P.M. Vaslui – 2300/2400 m (animal manure platform of the poultry farm).

The data entered for modeling through the SCREEN MODEL program were:

- platform size: surface = 5642 m, Length = 91m, width = 62 m;
- ammonia emission factor according to CORINAIR 2016: 0.22 kg/capita/year;
- average number of chickens per year: 181,000 heads;
- ammonia emission in g/m$^2$/s required by the program: 0.000224 g/m$^2$/s, calculated as follows:
  - an emission factor x number of chickens: 0.22 kg manure/capita/ year x 181,000 capita = 39800 kg/year on the manure platform of 5642 sqm;
  - emissions per second required by the program are: 39800 kg: (365x24x3600 s) = 0.00126 kg/s, i.e.: 1.26 g/s per platform;
  - emissions per second per square meter required by the program are: 1.26 g/s: 5642 sqm = 0.000224 g$NH_3$g/sqm/s;

– prevailing wind direction: 170 degrees (according to the data recorded by the automatic air quality monitoring station, urban background SV1 Vaslui).

In Table 6, the first columns show the ammonia concentrations measured at the cogeneration facility of the poultry farm, compared to the distance up to which the unpleasant odors persisted, and the last two columns show the values of the maximum concentrations allowed by STAS 12574/1987 regarding the conditions air quality in protected areas and the alert threshold values according to the legislative norms in force (Order no. 756/1997 for the approval of the regulation on the assessment of environmental pollution) for the ammonia $NH_3$ concentration.

*Table 6*

**Inclusion of ammonia ($NH_3$) concentration in the limit values allowed by the legislation in force**

| No. | Distance (metres) | Modeled concentration (mg/cbm) | Maximum allowed concentration according to STAS 12574/1987 regarding air quality conditions in protected areas | Alert threshold according to Order no. 756/1997 for the approval of the regulation regarding the assessment of environmental pollution |
|---|---|---|---|---|
| 1. | 200 | 1,0060 | **0,100** | **0,070** |
| 2. | 300 | 0,5597 | | |
| 3. | 400 | 0,3568 | | |
| 4. | 500 | 0,2499 | | |
| 5. | 600 | 0,1868 | | |
| 6. | 700 | 0,1462 | | |
| 7. | 800 | 0,1186 | | |
| 8. | 900 | 0,0987 | | |
| 9. | 1000 | 0,0839 | | |
| 10. | 1100 | 0,0727 | | |
| 11. | 1200 | 0,0637 | | |
| 12. | 1300 | 0,0566 | | |
| 13. | 1400 | 0,0507 | | |
| 14. | 1500 | 0,0459 | | |
| 15. | 1600 | 0,0418 | | |
| 16. | 1700 | 0,0383 | | |
| 17. | 1800 | 0,0353 | | |
| 18. | 1900 | 0,0328 | | |

| | | | | |
|---|---|---|---|---|
| 19. | 2000 | 0,0305 | | |
| 20. | 2100 | 0,0285 | | |
| 21. | 2200 | 0,0267 | | |
| 22. | 2300 | 0,0251 | | |
| 23. | 2400 | 0,0237 | | |
| 24. | 2500 | 0,0224 | | |
| 25. | 2600 | 0,0213 | | |

*Source:* primary data of SC AVICOM SA Poultry Farm, Vaslui County

The result of SCREEN MODEL modeling is shown in the graph in Figure 7, which shows how the curve of ammonia concentration *versus* distance decreases as we move away from the point of emission/ immission.

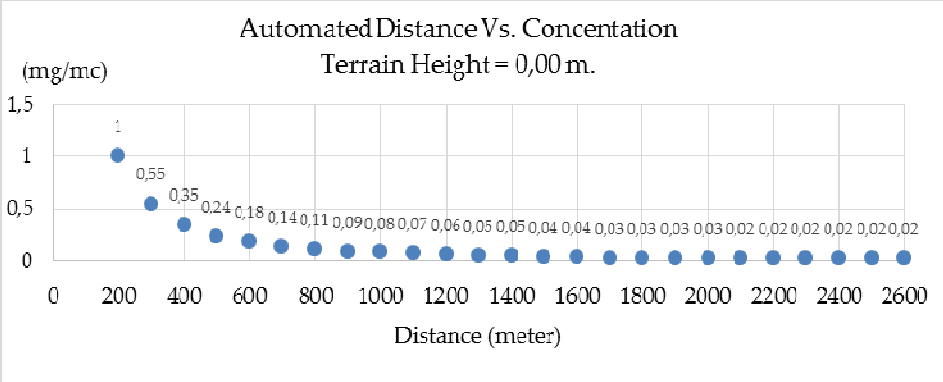


*Figure 7*. Variation of Ammonia NH3 concentration in relation to distance, according to the SCREEN MODEL program

Interpretation of the diagram was made according to Order no. 756 of 1997 for the approval of the Regulation on the assessment of environmental pollution, as amended, Article 13*): "b) the alert thresholds for the concentrations of pollutants in atmospheric emissions and in the ambient air are set at 70% from the intervention thresholds of the same pollutants, taking into account the relevant time period in which these concentrations must be measured."

*Analysis results*

Further to observing the situation on site, we concluded that the entire area is connected to the sewage network, and the residential owners do not raise domestic animals (birds, pigs or cattle), so there are no emissions of pollutants/smells additional to those from the farm.

Further to reviewing the statistical data processing, we noted that the limit value allowed for the concentration of ammonia $NH_3$ in the air, for a long period (24 hours), according to STAS 12574/1987, is 0.1 mg/m$^3$. The alert threshold established by Order no. 756/1997 for the approval of the regulation regarding the assessment of environmental pollution is 0.070 mg/cbm and it can be seen that it was exceeded in the distance range of 1100-1000 m by 0.0027 mg/cbm. If we refer to the alert threshold, as defined in Order no. 756/1997, it is exceeded starting from the distance of 1000 m, where the value is 0.0839 mg/cbm, compared to the alert threshold which is in relation to the permitted limit concentration of 0.070 mg/cbm. Thus, it can be appreciated that the value of the maximum allowed concentration is not exceeded outside the sanitary protection zone of the farm of 1000 m. The highest values of the concentration of NH3 from the generating source were recorded at distances of 300 m (0.5597 mg/cbm), 400 m (0.3568 mg/cbm) and 500 m (0.2499 mg/cbm), and as the distances increased, the $NH_3$ concentration values decreased. It can be seen from the table that the highest value of the concentration of $NH_3$ was 1.0060 mg/cbm recorded at the shortest distance of 200 m, however, most notifications regarding the persistence of odors were made by the population to the local authorities in the habitable area of distances from 300 and 400 m. Figure 8 shows the allowed limit values and the measured alert threshold values, according to the legislative norms in force for SC Avicom SA Poultry Farm.

The provisions of Art. 4 of Order no. 756/1997 as amended and supplemented, show what are the operators' obligations regarding the alert thresholds, namely: "... a) warn the relevant authorities about the existence, in a certain situation, of a pollution potential in air, water or soil; b) when the concentration of one or more pollutants exceeds an alert threshold .... the relevant authorities will request and monitor the implementation of measures to reduce the concentrations of pollutants

from emissions/discharges..." Under these conditions, the competent authority in applying sanctions considered that the poultry farm, not observing the meteorological conditions for the management of droppings on the operating platform (mandatory condition so that the odor has as little impact as possible on the population) can be punished as an offense.

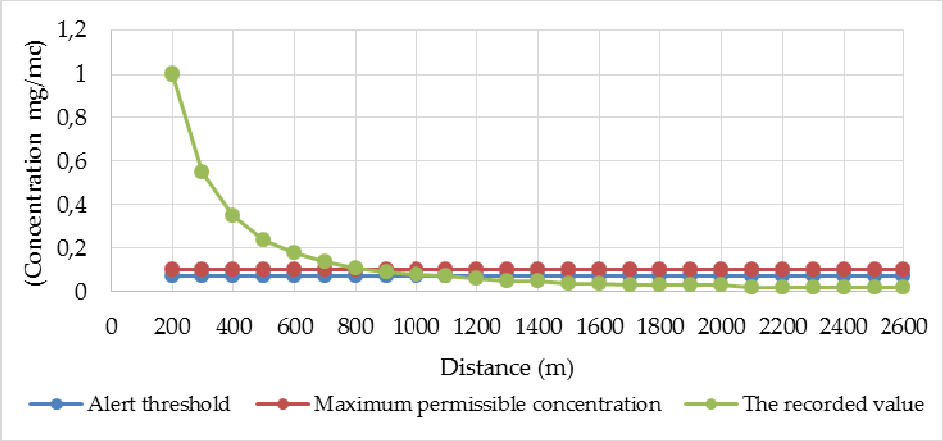


*Figure 8*. Variation of ammonia concentration ($NH_3$) in relation to distance (m)

Further to searching the history of the agricultural farm, we found that another pollution event occurred in 2017, in approximately the same unfavorable weather conditions, which is similar to the one in 2019 that is the subject of this study. Thus, it can be appreciated that the information provided by the results of modeling by SCREEN MODEL program of the dispersion of ammonia $NH_3$ concentration in relation to the distance, justifies the values acquired by measurement at the monitoring point from the Vaslui Environmental Protection Agency.

### *Results of the study*

Demonstrated that in the area of Vaslui city, favorable weather conditions may occur periodically for the accumulation of persistent toxic emissions/ odors such as ammonia. Their smell can become increasingly accentuated against the background of a topoclimate that prevents effective

dispersion in the atmosphere and can lead to the discomfort caused to the population in the immediate vicinity of the poultry farm. As a result, strict compliance with the legal norms in force regarding the management of organic waste of animal origin within the SC Avicom SA Poultry Farm in Vaslui County, becomes very important for human health.

The study aims to emphasize the importance of complying with the rules for pollution prevention and to reduce pollution by applying the best available techniques (BAT) provided by Directive 2010/75/EU on industrial emissions and fully transposed into the Romanian environmental legislation.

Adherence to the best available techniques BAT – considered in the study as COMPLIANT PRACTICES refers to the management of manure storage and the management of storage platform. Observations on site proved that this construction complies with BAT rules: the manure is taken from the technological halls on conveyor belts and transported to the basins related to the biogas production facility. The manure storage platform ensures a sufficiently large capacity for depositing the manure until it is spread on the soil or converted into green electricity. The construction is bi-compartmentalized, waterproofed, provided with a ledge with H=2.5 m and a collector base for collecting the leachate. It is specified that poultry droppings are used for the ecological production of electricity and thermal energy, in the biogas facilities in the immediate vicinity of the poultry farm. The use of manure in the biogas plant leads to their ecological management, in compliance with the provisions of the European Union and the Kyoto Protocol on atmospheric protection.

Failure to comply with the European BAT rules – considered in the paper as NON-COMPLIANT PRACTICES does not ensure the necessary conditions to minimize emissions into the atmosphere and may generate emissions of pollutants above the normal values provided by law (allowed limit values), causing discomfort to the population of neighboring residential areas. In the technological process of the biogas plant, the manure is dried as follows, depending on the weather conditions: in the warm period of the year, the manure is dried by adduction of hot air from outside, and in the cold period, the manure is dried by using heated air from the premises of the sheds coming from the biological heat of birds. The manure resulting from the poultry rearing process is discharged into the

biogas station, and the resulting sludge is spread over the agricultural land. The periods when it is allowed to spread animal manure on the soil depends on the local climatic conditions and the type of crops.

The BAT conclusions for the maintenance of air quality detail the techniques to reduce the ammonia $NH_3$ emissions by a poultry farm, which generate an unpleasant and persistent odor. These details are also provided in the Integrated Environmental Permit issued in 2016 in order to relicense the operation of the SC AVICOM SA poultry farm in Vaslui County, which is valid for 10 years. During this time, the operator has the obligation to comply with the technological process regarding: frequent evacuation of animal droppings; use of forced ventilation in shelters; use of an adequate nutritional regimen; keep the bedding dry thanks to the forced ventilation and the heating system; manure management depending on weather conditions.

## Conclusions and recommendations

If Company implements the measures imposed by the Poultry Farm Management Program of SC AVICOM SA, regarding the facilities, the way of organizing the technological flow and related activities, the business activity of the poultry farm should not be a local or regional polluter for the environment and neighboring areas.

The negative impact on inhabited areas depends on several factors, such as: the way in which the operator manages the processing of poultry droppings; distance from receivers or residential areas; wind direction and speed. It is obvious that the manifestation and evolution of meteorological parameters cannot be controlled, but compliance with the rules imposed by the best techniques available in the field (BAT rules) can be successfully managed by complying with the provisions of the Management Plan and Company's Action Plan. These reference documents provide for the measures and actions by which odor-generating emissions and immissions can be reduced through the proper management of droppings, their transport according to meteorological conditions, so that the local accumulation of toxic emissions and odors is not increased. On the contrary, the handling of significant amounts of manure in

optimal climatic conditions leads to the dispersion of pollutants in the atmosphere on air currents, ensuring the minimization of the impact of odors on human receptors.

This study demonstrated that the SC Avicom SA poultry farm in Vaslui County can be a polluter for the environment and for people regarding the air quality factor, as long as the legislation specified by the Integrated Environmental Permit is not observed. In case of air pollution through the persistence of odor, the degree of damage decreases with the distance. Diagram in Figure 8 Variation of ammonia ($NH_3$) concentration in relation to distance (m) shows how the value of the maximum allowed concentration for ammonia is not exceeded outside the sanitary protection zone of 1000 m of the objective. In order to avoid unpleasant situations generated by foul odors, it is mandatory that, in the case of erecting constructions, the distances of the sanitary protection zone of the farm are observed, and the buildings are located outside it.

The proposed ***recommendations*** can prevent the problems observed in the case study, being achievable in the short, medium or long term:

- Permanently comply with phytosanitary rules in chicken rearing halls; in the site area, pollutant emissions must fall within the limits allowed according to Law 104/2011 on ambient air quality for pollutants CO, $SO_2$, $NO_x$, suspended dust and STAS 12574/87 on air quality conditions in protected areas for the indicator ammonia ($NH_3$) and hydrogen sulfide ($H_2S$).
- Comply with the rules of managing waste and prohibit its discharge in places other than those specially arranged;
- Plan activities for picking up droppings from the specially arranged platform and comply with the Code of Good Agricultural Practices in the activity of spreading droppings;
- Monitor the technological processes of processing the droppings resulting from the poultry rearing process;
- Permanently monitor emissions, immissions and odors coming from the farm site in order not to exceed the limit values allowed by law;
- Create a forest curtain with dendrological species with a high capacity to absorb atmospheric pollutants (linden, poplar, elm) around the poultry farm to reduce the concentration of persistent unpleasant odors in the atmosphere;

– Carry out open demonstrations organized by relevant institutions through which the population is informed about the importance of complying with the legislation when expanding constructions in the bordering areas of cities located near economic objectives considered potential polluting sources. It is also necessary for the population to accept that by complying with the measures imposed by the issued Construction Permits, the future buildings or households are placed under sanitary protection and are outside the man-made risk areas. These communication sessions can be organized by the relevant local authorities such as: townships – represented by employees of the Urban Planning and Territorial Planning Office, County Council and Local Councils represented by councilors and with the support of environmental consultants of the County Environmental Protection Agency Vaslui, and other local or regional decision-makers.

In this sense and according to the Order of the Ministry of the Environment no. 598/June 20, 2018 regarding the approval of the lists of municipalities drawn up as a result of being included in the management regimes of areas in the areas and agglomerations provided for in Annex no. 2 to Law no. 104/2011 regarding the quality of the surrounding air, published in the Official Gazette no. 549 of July 2, 2018, at the County level, an Air Quality Maintenance Plan for Vaslui County 2018-2022 was drawn up, which aims to ensure increased efficiency regarding the air quality improvement process and maintaining the concentration of pollutants below the limit values provided by legislation.

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