



Impact of Technological Solutions and Operating Procedures on Odour Nuisance of Municipal Solid Waste Treatment Plants in Poland

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This paper analyses 144 municipal solid waste treatment plants operated in Poland, in terms of technological solutions used for storage, segregation, preliminary treatment and biological processing of waste as well as other operational procedures aimed at reduction of the odour nuisance of waste to the neighbourhood. The odour nuisance of most examined facilities was assessed by respondents (employees of the facilities) as low, or the facilities were considered to be without any odour impact at all: 95 % of the analysed segregation plants (109/114) and 97 % (28/29) of the examined biological treatment facilities respectively. The remaining 5 % and 3 % of the municipal solid waste treatment plants covered by the questionnaire survey were characterised as medium and high nuisance in terms of emitted odours. The main reasons behind the odour nuisance of the municipal solid waste processing plants in Poland and the most frequently employed and, at the same time, the most effective measures aimed at minimisation of odour emissions are presented.

1. Current situation in municipal solid waste management in Poland

In the past few years the amount of municipal solid waste (MSW) collected in Poland stabilised at the level of around 10 million tons per year. Merely 6.8 % (0.68 Mt) of that quantity was subject to selective collection. The waste are transported to recovery and treatment facilities (apart from disposal on landfills), such as green and selectively collected biodegradable waste composting plants, fermentation plants, mixed municipal waste mechanical-biological treatment plants, selectively collected and residual waste segregation plants and one municipal solid waste incineration plant. It is expected that in the years to come the volumes of produced municipal waste will grow (at the rate of 1.2 % to 1.6 % per year). This growth will be accompanied by a very intensive development of selective waste collection followed by an increase in waste segregation activities (KPGO , 2010).

2. Materials and research methodology

The assessment of odour nuisance of the waste treatment plants can be made using various methods, examples of which are presented in the following papers: Ariano et al. (2010), Nicolas at al. (2008) and Schauburger et al. (2008). Identification and inventorying of municipal solid waste treatment plants in Poland were done using various source data. In order to collect all dates (technical, technological and about the odour nuisance) an attempt was made to conduct a questionnaire survey for each facility. The methodology employed to catalogue the municipal waste treatment plants operated in Poland is described in detail in the paper by Kulig et al. (2010). A preliminary database, was used as a contact

and address base for the purposes of the survey based on the Computer Assisted Telephone Interviewing (CATI) method. Characteristics and olfactory assessment of the treatment plants were determined and made on the basis of a survey conducted throughout Poland in the period of November to December 2007 and January to February 2009. The facilities were described by their employees (selected for participation in the questionnaire survey), namely specialists (medium level managers or chief technologists), who, on the one hand, demonstrate high level of competence and limited adaptation to olfactory sensations due to the fact that they are exposed to the plant environment only for limited periods of time but, on the other hand, may not be fully objective in their judgements because they identify personally with the facility they manage. Locations of all 144 catalogued MSW management facilities covered by the questionnaire survey can be found in Figure 1.

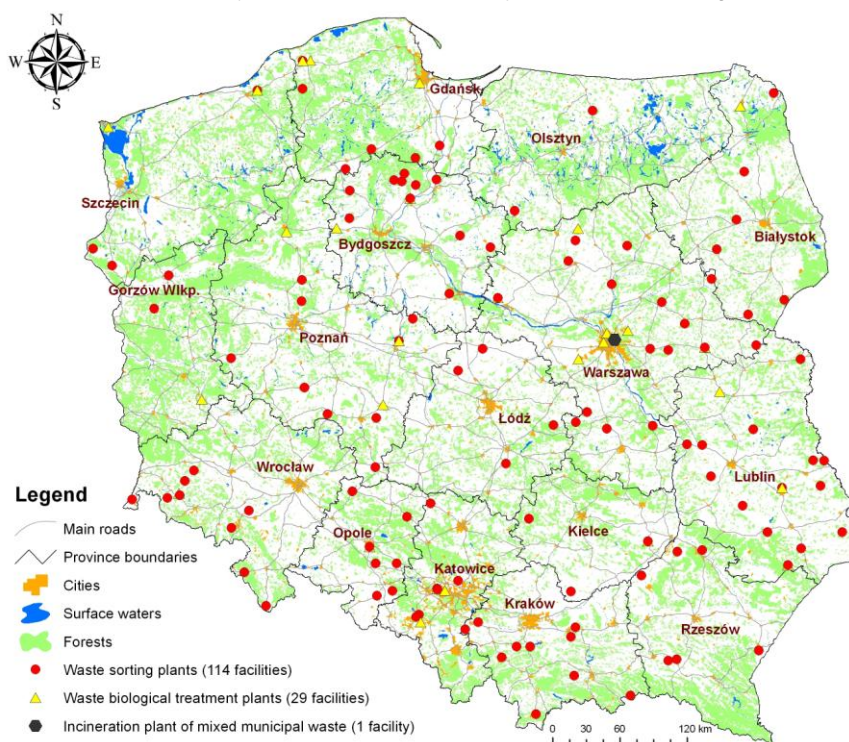


Figure 1: Geographical locations of the MSW sorting or biological treatment, or incineration plants, operated in Poland, covered by the survey: potential sources of odorant emissions

3. Results of research on odour nuisance of municipal solid waste treatment plants

3.1 Type and number of the facilities covered by the survey

The research took into consideration three basic types of facilities: municipal solid waste segregation plants, biological processing facilities and a thermal transformation plant. Results of the analyses covering landfill sites operated in Poland can be found in the paper (Kulig et al., 2010).

The total number of municipal solid waste segregation plants, which were covered by the questionnaire survey was 114 (there were 173 of them in Poland as at 1 January 2010). That number included facilities handling both mixed and selectively collected municipal waste. The study covered a total of 29 facilities which processed the waste biologically although the number of the facilities was 104 as at 1 January 2010. The questionnaire survey was conducted both in selectively collected biodegradable waste composting plants and mechanical-biological treatment plants processing mixed municipal waste. Moreover, there is a technological line, operated in Poland, used for thermal transformation of municipal solid waste, covered by the survey, too (Kulig and Lelicińska-Serafin, 2011).

3.2 Odour nuisance of analysed facilities

The odour nuisance to the immediate vicinity of examined facilities was assessed by respondents in four-gradual scale: high, medium, low and no odour. The survey shows that 54 % of the analysed segregation plants do not have any odour impact on their neighbourhood at all and in 41 % of cases their odour nuisance is low. The perspective of local residents is not taken into account, it is felt of sites managers. Most of the surveyed biological processing plants demonstrate a similar pattern: in the opinion of their representatives 80 % of the plants have no olfactory impact at all or 17 % show low odour nuisance. Odour emissions of the technological line (the only one operated in Poland) used for thermal transformation of municipal waste have been assessed as low and, moreover, the emissions have been attributed to a waste biological processing facility operated in the vicinity of the incineration plant. The core technological activity run in the surveyed municipal solid waste management facilities is the main reason behind their odour nuisance. It is segregation or biological processing of waste (rather than any accompanying activities) that constitutes the main source of odour emissions. A similar situation is observed in the case of landfill sites operated in Poland, as described in the paper of Kulig et al. (2010). Places where the waste is stored (received), situated at the beginning of relevant technological lines, have a significant impact on the odour nuisance of the examined facilities, too. Protests voiced by members of a local community, caused by odour nuisance of municipal solid waste processing plants, have been recorded only in the case of a small group of the examined facilities (14 % of the biological processing plants and 5 % of the surveyed segregation lines), whereas dissatisfaction about the odour nuisance of landfill sites is at the level of 7 % (Kulig et al., 2010).

3.3 Technological solutions and operating procedures employed

Solutions and procedures, employed in order to limit the odour nuisance of the municipal solid waste processing plants operated in Poland include, first and foremost: shortening of the waste storage time, creation of casing for individual sections of the technological line, the use of exhaust ventilation systems, turning of waste piles taking into consideration current wind direction, the use of isolating green zones, application of biofilters, and other measures aimed at deodorisation of the collected process gases, such as: chemical agents and biological preparations, and odour masking. Measures of that kind are applied domestically, first and foremost, in the examined biological processing plants (41 %), and, as far as the segregation facilities are concerned, application of the measures has been pointed to in the case of 18 % of the surveyed facilities. The operation of the technological line used for thermal transformation of municipal solid waste, in the opinion of the employees, does not result in odour emissions thanks to, among other things, measures implemented in the facility, consisting in airtight sealing of the waste storage and segregation processes, collection of the contaminated air and its deodorisation in biofilters as well as application of other methods aimed at elimination of the odour nuisance (periodical creation of mist) (Kulig and Lelicińska-Serafin, 2011).

Types of waste received

In the case of the examined segregation plants, no clear difference in their odour nuisance, depending on the type of waste received (dry fraction or mixed waste), was found. Slightly different trend was observed for the biological processing plants. The processing of biodegradable waste and selectively collected waste in composting plants does not result in any odour nuisance in 22 % of cases whereas in 78 % of cases the olfactory impact is low. But in the case of biological processing of mixed municipal waste the share of the facilities with low (82 %) or medium odour nuisance (9 %) is greater (Table 1).

Table 1: Odour nuisance of MSW biological treatment plants in Poland, considering the types of waste

Declared odour nuisance of examined plants	Selectively collected (biodegradable) waste	Mixed municipal waste
High	0	0
Medium	0	9 % (1/11)
Low	78 % (14/18)	82 % (9/11)
No odour nuisance	22 % (4/18)	9 % (1/11)
Total number of the facilities	18	11

Casing for individual sections of the technological line, and the use of exhaust ventilation systems

A casing for individual elements of the technological line may be created, in particular, both for the beginning of the line, i.e. the waste storage area, and the core process carried out in the facility, i.e. the segregation line, the mechanical part (preliminary processing) and the biological processing. The influence of the casing created for waste storage areas on the odour nuisance of the segregation plants was very small in situations where the casing was considered merely as a measure preventing the spreading of odours, see Table 2 below. The waste storage areas can be numbered among the key elements contributing to the odour nuisance, and creation of a casing for those areas and only for them turned out to be insufficient to counteract their nuisance. Only a solution consisting in air-tight sealing of the areas, coupled with equipping them with deodorisation installations, will surely bring about positive effects in terms of reduction of odour emissions.

Table 2: Odour nuisance of MSW sorting plants in Poland, considering the casing of waste storage

Declared odour nuisance of examined plants	Waste storage	
	unencapsulated	encapsulated
High	2 % (1/68)	0
Medium	4 % (3/68)	2 % (1/46)
Low	37 % (25/68)	48 % (22/46)
No odour nuisance	57 % (39/68)	50 % (23/46)
Total number of the facilities	68	46

The importance of the casing created for segregation lines was much more noticeable. The combination of two elements: the line being placed in a closed hall and the hall being equipped with an exhaust ventilation system, gave quite positive results. The odour nuisance is not declared in 66 % of cases where the approach described above has been employed. But in the cases where the casing created for a segregation line is the only measure taken to prevent the odours from spreading (without air-exhaust system), no odour emissions was declared by 54 % of the facilities – see Table 3.

Table 3: Odour nuisance of MSW sorting plants operated in Poland, considering the casing of the segregation line, and the use of exhaust ventilation systems

Declared odour nuisance of examined plants	Segregation line situated in a closed hall	
	Segregation line situated in a closed hall	Segregation line situated in a closed hall equipped with exhaust ventilation system
High	0	0
Medium	2 % (1/46)	3 % (1/29)
Low	44 % (20/46)	31 % (9/29)
No odour nuisance	54 % (25/46)	66 % (19/29)
Total number of the facilities	46	29

In the case of biological treatment plants the impact of a casing created for individual elements of the technological line is not so clear due to a smaller number of the survey exercises carried out.

The survey indicates that exhaust ventilation systems are installed more frequently in biological treatment plants (41 %) than in waste segregation plants (31 %). Aeration of waste, as an operational component of a biological processing plant, is applied in 59 % of the surveyed facilities. However in Poland the aeration process consists, first and foremost, in mechanical turning of waste rather than application of a forced system cooperating with an exhaust ventilation system. A vast majority of the facilities (82 %), where mechanical turning of waste is applied, show low odour nuisance, but low impact is typical also for most examined biological processing plants receiving municipal solid waste.

Other technological procedures employed in order to reduce the odour nuisance

Apart from creation of a casing for individual sections of the technological line and application of exhaust ventilation systems, also other methods are employed in order to reduce the odour nuisance. Analysis of the employed technological solutions and operating procedures indicates that the principal measure taken in order to reduce the odour nuisance of the municipal solid waste segregation plants

operated in Poland is the creation of a casing for individual sections of the technological line. This approach has been employed in 40 % of the surveyed facilities, both at the beginning of the line, i.e. at the stage of waste storage, and at the segregation line. Other measures identified by the survey include the use of exhaust ventilation systems (31 %), and, although to a smaller extent, the shortening of the waste storage time and the use of chemical agents, as shown in Table 4.

Table 4: Other methods employed to limit the odour nuisance of MSW treatment plants in Poland

Types of examined municipal solid waste processing plants	Measures taken	Number of facilities	Declared odour nuisance of examined plants
Segregation plants	Shortened waste storage time	1	Low
	Chemical agents	2	No odour nuisance
		1	Medium
Biological processing plants	Shortened waste storage time	1	Low
	Turning of waste piles when direction of the wind is suitable	2	Low
	Chemical agents and biological preparations	3	Low
	Use of isolating green zones	2	Low
	Biological filters	2	Low

In the case of biological treatment plants the technological solutions and operating procedures aimed at prevention of the odour nuisance were employed in 41 % of the examined facilities (Kulig and Lelicińska-Serafin, 2011). In this context it is important to mention both the operation of the mechanical part with a partial or full casing: in 24 % of the examined plants; and the biological part (at least the 1st phase of the process): in 21 % of the surveyed facilities. The exhaust ventilation system can be found in 41 % of the facilities. There are also other measures, although applied less frequently, namely: shortening of the waste storage time, the use of chemical agents and biological preparations, and isolating green zones as well as the application of biological filters (Table 4). The operation of most biological processing facilities covered by the survey is based on waste treatment in piles in an open space, which is inconsistent with recommendations issued by Ministry of the Environment, describing a two-stage process where the first stage should be carried out in reactors or a closed hall with forced aeration and cleaning of the process air (Ministry of the Environment, 2012). Moreover, the survey indicates that in the analysed biological processing facilities proper and adequately frequent aeration of waste is not always the case, which may be another reason behind their odour nuisance.

4. Conclusions

The questionnaire survey which covered 114 segregation plants and 29 biological treatment plants operated in Poland and receiving municipal solid waste, made it possible to formulate the following conclusions:

1. The core technological activity carried out in the municipal solid waste treatment plants operated in Poland, namely the segregation and biological processing (rather than any accompanying activities), is the main reason behind their odour nuisance. The waste storage areas contribute to the nuisance significantly, as well.
2. The biological processing facilities handling selectively collected waste are characterised by lower odour nuisance than the facilities receiving mixed municipal waste.
3. Measures aimed at reduction of the odour emissions of the surveyed municipal solid waste management facilities are applied, first and foremost, in the biological treatment plants.
4. The most effective and most frequently employed measures aimed at minimisation of odour emissions of municipal solid waste processing plants include creation of a casing for individual sections of the technological line and the use of exhaust ventilation systems. Measures consisting in shortening of the waste storage time, turning of waste piles when direction of the wind is suitable,

- the use of isolating green zones, application of biofilters, chemical agents and biological preparations, are employed less frequently.
5. The most effective measure applied in order to minimise the odour nuisance of the municipal solid waste segregation plants is the creation of a casing for the segregation lines by placing them in a closed hall, and the combination of this solution with the use of exhaust ventilation systems proves to be clearly effective.
 6. In the case of municipal solid waste management facilities, especially those characterised by substantial odour nuisance, implementation of a single measure aimed at reduction of the nuisance turns out to be ineffective. It is the combined application of several methods (consisting in air-tight sealing of the waste storage areas, creation of a casing for the segregation lines and the use of exhaust ventilation systems) and deodorisation procedures that may improve the overall situation. In order to reduce the odour emissions effectively it is necessary to carry out deodorisation measures covering the entire facility, but those measures have been employed in municipal solid waste management facilities, operated in Poland, to a small extent, as yet.
 7. A majority of the biological processing facilities covered by the survey treat the waste in piles in an open space, which is inconsistent with national recommendations and may be one of the reasons contributing to the odour nuisance. The waste is not always aerated properly and with adequate frequency, and a forced aeration system with process air cleaning is rarely employed, which may result in excessive odour emissions, too.
 8. The odour nuisance of the municipal solid waste incineration plant (the only one operated in Poland) has been assessed as low and, moreover, the nuisance has been attributed to a technological line used for biological treatment of waste, operated in the vicinity of the thermal transformation plant.
 9. On the average, 96 % of the surveyed municipal solid waste processing facilities operated in Poland show no odour impact on their neighbourhood or is characterised by low nuisance caused by odour emissions.

Acknowledgments

Investigations financed with funds for science in 2007 – 2010, as a commissioned research project PBZ-MEiN-5/2/2006 entitled “New Deodorisation Methods and Technologies in Industrial Production, Farming and Municipal Management”.

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