The noise exposure, at a municipal mechanical-biological waste treatment plant

Narażenie na hałas w zakładzie mechaniczno-biologicznej przeróbki odpadów

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DOI 10.36119/15.2022.2.3

Poland in the European Union statistics, takes the penultimate place, in terms of generated municipal waste in European countries. By 2035, in accordance with the EU law, Member States are to achieve a recycling level of 65% for municipal waste. According to GUS data for 2020, Poland reached a general recycling level of 26.7%, excluding bio-degradable waste. Pressure from the European Union, for much higher recycling levels, is prompting the construction of many more modern facilities, including mechanical-biological treatment (MBT) plants. MBT plants often have difficult working conditions for employees: A very foul odor, excessive light, biological hazards, rodents and noise. Excessive noise, can not only damage hearing, but can also cause other negative health issues. Examples, include reduced mental capacity, reduced precision of movement and visual disturbances.
The purpose of the research presented here, was to analyze and study noise exposure in selected areas of the MBP plant in order to determine the maximum and average exposure of workers to this factor.
Keywords: MBT, noise exposure, municipal waste

Polska w statystykach Unii Europejskiej, zajmuje przedostatnie miejsce, pod względem wytwarzanych odpadów komunalnych w krajach europejskich. Do 2035 r., zgodnie z prawem unijnym, państwa członkowskie mają osiągnąć poziom recyklingu odpadów komunalnych w wysokości 65%. Według danych GUS za rok 2020 Polska osiągnęła ogólny poziom recyklingu w wysokości 26,7%, z wyłączeniem odpadów ulegających biodegradacji. Presja ze strony Unii Europejskiej na znacznie wyższe poziomy recyklingu skłania do budowy wielu nowoczesnych instalacji, w tym zakładów mechaniczno-biologicznego przetwarzania odpadów (MBP). W zakładach MBP często panują trudne warunki pracy dla pracowników: bardzo nieprzyjemny zapach, nadmierne światło, zagrożenia biologiczne, gryzonie i hałas. Nadmierny hałas może nie tylko uszkadzać słuch, ale także powodować inne negatywne problemy zdrowotne. Przykładem może być obniżona sprawność umysłowa, zmniejszona precyzja ruchów oraz zaburzenia widzenia.
Celem artykułu było przeanalizowanie i zbadanie narażenia na hałas w wybranych obszarach zakładu MBP w celu określenia maksymalnego oraz średniego narażenia pracowników na ten czynnik.
Słowa kluczowe: MBP, ekspozycja na hałas, odpady komunalne

Introduction

There are many models, which show the annoyance of sound [1,7,22-24]. According to them, the annoyance, caused by a given noise can be calculated precisely based on its physical characteristics [2]. The greater the annoyance of noise, the greater the negative effects on humans. Scientific studies confirm, the validity of the multifactorial (environmental) approach to assessing noise annoyance [25-26]. The advantages of the environmental approach are undoubtedly based on multiple factors, the same loudness for different types of noise does not mean the same annoyance. With the multifactor approach, however, there is the problem of the lack of standardized procedures, to reliably and reproducibly measure quantities such as Zwicker loudness, sharpness, fluctuation strength, or roughness [27-29]. There are no measures widely available for these quantities. As a result, institutions, whose task is to protect people from harmful noise, use the classic single-factor model of noise annoyance, which assumes, that it depends on only one factor, namely noise level. The size of the measured noise level in the classical approach, is defined by the so-called noise dose. Noise is characterized by variability of its spectral structure and duration. In order to determine the noise dose, instantaneous and long-term indices should be used. This is necessary, because of the effects that temporary and long-term exposure to noise causes [7]. According to the EU Directive on the assessment and management of environmental noise and WHO recommendations, the impact of noise on humans should be determined on an annual basis [3]. Studies have shown that being exposed to noise above 75 dBA causes changes in the vegetative state of the body, sounds induce motor reflexes, such as contraction of neck and head muscles. Impulse signals cause rapid responses such as bending of the knees and squinting of the eyelids. Muscle spasms can also affect the internal organs and manifest themselves as increased blood pressure or disorders of the digestive system. Excessive noise, as many studies have shown, causes a general increase in metabolism as well as increased activity of the cerebral cortex, changes and disturbances in the metabo-

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lism of carbohydrates, fats and proteins. During exposure to very high noise levels, visual field disturbances, changes in color perception and balance disturbances may occur [1, 4-6, 8, 10]. For the noise exposure level related to the 8-hour daily working time or the noise exposure level related to the working week - the action threshold value is 80 dB, while for the peak C sound level - the NDN value of 135 dB is taken as the action threshold value [21].

Specifics of Mechanical-Biological Treatment Plants for Municipal Waste

Municipal waste, should be processed properly as soon as possible after it is collected, as it is a source of renewable energy and raw material fraction, while long storage of the produced alternative fuel or waste, creates environmental hazards and deteriorates its quality [11-12]. Since January first 2016, landfilling of combustible fractions of municipal waste has been banned in Poland, this fraction is among the main products of mechanical-biological processing (MBT) [16].

Mechanical-biological processing of mixed municipal waste consists of two stages. The first stage - mechanical consists of the separation of fractions from 0 dB to 80 dB, from which the supersite fraction is directed to further processing aimed at energy and raw material recovery. The second stage - where the subsieve fraction of waste is directed to aerobic or anaerobic biological treatment. Aerobic stabilization is applied to biodegradable fractions of municipal waste which, due to the pollutants they contain, cannot become a raw material for compost production. This process results in so-called stabilization. The purpose of biological treatment of waste is to reduce the weight and volume of waste and the water it contains, to stabilize the organic matter, to sanitize it, and to produce usable products such as compost or biogas. MBT plants are large in area and have their own specifics depending on the type of technology used. Generally, they consist at the initial stage of a system of belts, separators, screens, shakers, sorting belts and sorting cabins only at a later stage of the equivalent of digesters and a system of compost heaps [17-20].

This technological arrangement makes for difficult working conditions for employees at MBT plants. They are often exposed to odors, dust, rodents, harmful microorganisms, excessive artificial light and noise. According to studies conducted by Tiihonen et al, 1997 and Tovanen et al. 2006, particular noise exposure of MBT plant workers occurs in the drying room of the biological recovered fraction [13-14].

Proposed Research Methodology

In the proposed research approach, a research methodology was proposed to determine the noise levels at selected sites of the MBT plant and to determine the exposure: minimum, maximum, average and peak noise levels for the workers residing at these sites. The scope of this proposed work is:

- selection of study location and time
- choice of test sites
- choice of test method
- development of results and conclusions

The research was conducted on the premises of the Municipal Mechanical-Biological Waste Treatment Plant. The investment makes it possible to manage almost 60 thousand tons of municipal waste per year and can produce 3 million kWh of electric and thermal energy from it. The plant meets the requirements contained in BAT conclusions. Thus, it fits into the map of an integrated network of similar installations at the national and provincial level.

The research was conducted in the month of May during a period of increased intensity of waste unloading to the site for 10 working days.

A sonometer - RS Pro SLM52N - was used to implement the study and was set up on a tripod for 8 hours for each study site.

The study details the minimum, maximum, average and peak noise exposures for 6 randomly selected workers.

Compilation of Survey Results

The results of the study from 10 working days of 8 hours each day for six selected workplaces of six randomly selected workers are presented in Table 1. The average noise exposure for a given work place from the MBT plant is shown in Figure 1.

The highest noise exposure (average 86 dB) was recorded for a worker working in the unloading hall. Unloading trucks emitted additional noise here in addition to the belt. Similar noise exposure was recorded for workers in the waste sorting and compacting rooms (average 85 dB). At the same level (78 dB), noise exposure occurred for workers in control room 2 and the room where stabilizer was stored. The lowest average noise exposure (68 dB) occurred for the worker working in the control room 1. In other studies conducted at MBT facilities, the noise levels were: the highest noise level measured in the drying hall was 92.6 dBA [14]. Noise levels in the plant were higher than in two British waste sorting plants, where they were 60–80 dBA [30].

Table 1. Noise exposure, for selected workers at MBT plant
Tabela 1. Narażenie na hałas, dla wybranych pracowników zakładu MBP

Work	workplace	activity	min. noise exposure [dB]	max. noise exposure [dB]	peak sound level [dB]	exposure time [h]
1	dispatcher's cabin	process monitoring	56,8	78,6	80,1	7,5
2	press	waste compacting	80	83,8	85	7,5
3	landing hall	waste disposal	76	86	97	7,5
4	waste sorting plant	waste sorting	69,7	87,1	88,4	7,5
5	dispatcher's cabin 2	process monitoring	68,1	81	86	7,5
6	stabilizer room	distribution of stabilizer	70,8	79,5	83	5

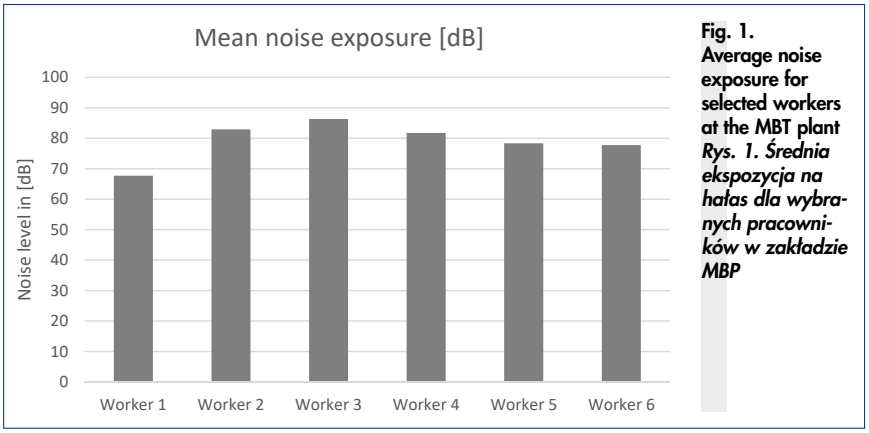

Fig. 1. Average noise exposure for selected workers at the MBT plant
Rys. 1. Średnia ekspozycja na hałas dla wybranych pracowników w zakładzie MBP

Conclusions

1. Conducted research on exposure to noise for 6 employees working in the MBT plant, gave an idea about the level of their exposure to harmful effects of noise.
2. Due to the fact that noise level between 70 dB to 85 dB has a significant

impact on reducing the efficiency of work and can be harmful to health, it is advisable to introduce hearing protectors for employees

3. Noise levels above 85 dB cause various diseases of the organism and cause incomprehensibility of speech - therefore it is necessary to introduce good hearing protectors and additional medical examinations for employees exposed to this noise.
4. Workers throughout the plant are exposed to high levels of vibration (emitted by belts and separators) which can adversely affect their health and hearing.

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