Anna KOZIOROWSKA, Beata PRUCNAL

Rzeszow University, Faculty of Mathematics and Natural Sciences, Laboratory of Bioelectromagnetism

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The risk to employees from the effects of electromagnetic fields in the vegetable and fish processing plant

Abstract: *The electromagnetic field, as a factor affecting employees' health is the subject of research presented in this paper. The electromagnetic field commonly accompanies employees of companies and enterprises in the work environment and this is the result of numerous applications in technological processes. The human body is not able to sense the threat of electromagnetic field in the environment by means of senses, unlike other physical processes (e.g. vibrations, noise). Two devices used during the production process were tested. This paper presents the results of measurement tests carried out at the fish and vegetable processing plant. This was to ensure employees that their workplace does not expose them to the additional danger associated with the impact of fields exceeding the permissible values. It has been shown that the values of the emitted field are low and do not exceed the values set in the standards.*

Streszczenie: *Pole elektromagnetyczne, jako czynnik wpływający na zdrowie pracowników jest tematem badań przedstawionych w niniejszej pracy. Pole elektromagnetyczne powszechnie towarzyszy pracownikom firm i przedsiębiorstw w środowisku pracy i jest to wynikiem licznego zastosowania w procesach technologicznych. Organizm ludzki nie jest w stanie za pomocą zmysłów wyczuć zagrożenia związanego z polem elektromagnetycznym w otoczeniu, w przeciwieństwie do innych procesów fizycznych (np. drgania, hałas). Badaniom zostały poddane dwa urządzenia wykorzystywane podczas procesu produkcji. W niniejszej pracy przedstawiono wyniki badań pomiarowych przeprowadzonych w zakładzie przetwórstwa warzywno-rybnego. Miało to na celu upewnienie pracowników, iż ich miejsce pracy nie naraża ich na dodatkowe niebezpieczeństwo związane z oddziaływaniem pól o wartościach przekraczających dopuszczalne. Wykazano, iż wartości emitowanego pola są niskie i nie przekraczają wartości ustalonych w normach. (**Zagrożenia dla pracowników zakładu przetwórstwa warzyw i ryb wynikające z działania pól elektromagnetycznych**)*

Keywords: electromagnetic field, magnetic induction, measurement tests, electromagnetic field impact on workers.
Słowa kluczowe: pole elektromagnetyczne, indukcja magnetyczna, badania pomiarowe, oddziaływanie pola elektromagnetycznego na pracowników.

Introduction

With the development of civilization electromagnetic field interaction occurs in the work environment, which is closely related to the use of devices generating electromagnetic fields [Gryz 2000]. A measure of the magnitude of the electromagnetic field strength are the values of intensity of electric and magnetic fields occurring in the work environment [Directive 2004, ICNIRP 1998, Karpowiecz&Gryz 2004, Regulation of the Council of Ministers of September 2, 1997]. A constant desire to improve working conditions is to use an increasing number of electrical and electronic devices in workplaces. Therefore, employers to keep up with changes use the amenities and increasingly reach for new equipment in production halls. In the analyzed workplace, each investment in subsequent devices to facilitate work results in potential exposure of employees to increase electromagnetic field emissions. During the operation of devices powered by electricity, there is a process of its dissipation in the vicinity of working machines and devices. It is associated with the impact of radiation on the human body and its nature depends on the frequency, time of exposure and the value of magnetic induction [Ganatra et al. 2015]. In the available scientific papers there is a lack of research confirming or denying and strictly determining the degree of harmfulness of this impact. [Morawski T., Gwarek W. 2014]

With the increasing number of articles adhering before the harmful effects of electromagnetic fields, the author decided to perform a study measuring the magnetic induction, to see if the values are permissible within the legal standards. The purpose of the research carried out in the vegetable and fish processing company was to identify the places of occurrence of electromagnetic field emission sources, select measurement points, perform measurement tests and thoroughly analyze the results. The plant produces vegetable and herring salads as well as herring marinades, which are the main form of production. During the production process there are used devices supporting employees, which are a potential source of electromagnetic field emissions, and include devices powered from 50 Hz web (refrigerators, mixers, slicers, central heating pumps, compressor, transformers), electronic devices (heating tunnel, heat guns) and electric tools. The devices selected for research studies, due to the dimensions and power, are one of the largest machines operated during the production process. Appropriate arrangement of machines in different parts of the production hall and the building results in no overlap of individual fields emitted by these machines.

In the work environment, employees are often exposed to the magnetic component of the extremely low frequency (50 Hz) electromagnetic field, being completely unaware of this. The tested devices are not located in the central part of the plant, and during their operation only persons controlling the device are in their immediate vicinity.

The impact of the electromagnetic field, both on the human body and the work environment, can cause health risks [Koziorowska et al. 2018] or employee safety. Man staying too long in a strong electromagnetic field is exposed to the biophysical effects such as:

- stimulation of muscle and nervous tissues, as well as stimulation of the senses (observed at low or medium frequencies),
- increase in tissue temperature (phenomenon observed under the influence of megahertz or gigahertz frequencies),
- limb currents.

Just being in the areas exposed to the presence of an electromagnetic field can also cause:

- problems maintaining balance,
- problems with visual-motor coordination,
- nausea,
- abnormal heart rhythm and blood pressure [Kasprzyk 2013, Souques et al. 2013]
- headaches and dizziness,
- memory impairment,
- nervous irritability [Rączkowiski 2010],
- sleep problems [Koziorowska et al. 2016],

• increased heart-related effects [Elmas 2015].

The effects of EMF can cause fertility problems and impaired sperm quality [El-Helaly et al. 2010].

Such effects of the field make it difficult or impossible to perform certain operations in the production process (particularly demanding precision of visual-motor) can also cause serious accidents. Employees of the tested vegetable and fish processing enterprise are familiarized with the risk assessment and the effects that are associated with both non-compliance with safety rules during operation of equipment powered from the network, and staying in rooms where electromagnetic fields are emitted. In order to assess the value of the emitted electromagnetic field, measurement tests were carried out in the company's production hall.

Measurements equipment

In the tested electromagnetic field frequency value (50 Hz), the magnetic component of the field is important, hence we have made the magnetic induction measurements. The MIE–EX480826 (Extech) meter was used, which has the function of 3-axis measurement of the generated electromagnetic field in three ranges and units: μT lub mGs (1μT=10 mGs). The meter can be used to make measurements in the frequency range from 30 Hz to 300 Hz, at temperatures ranging from 0 °C to 50 °C. In order to accurately determine the measuring points, the Bosh PLR 30C rangefinder was used. It accurately determines distances in the measuring range from 5 cm to 30 m, with a measuring accuracy of 2 mm, which allowed the accurate placement of the meter at the measuring points.

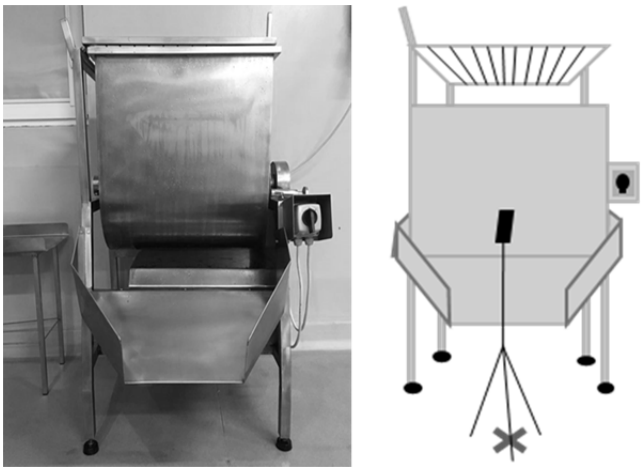

Photo 1. Salad mixer with own design defining the measuring point (own photo)

Measurement tests

The measurement tests were carried out around selected devices with the highest power. The salad mixer and cabbage shredder were tested. These devices are operated during the entire shift (8 hours) and employees are located in the immediate vicinity.

The salad mixer (Picture 1) is intended primarily for mixing meat with the addition of other components. It may also be suitable for mixing vegetables and other loose materials. The operation process can take place in the range of ambient temperature.

The machine is driven by an electric motor with a power of 0.55 kW, 1400 rpm and a voltage of 400 V, the frequency f of 50 Hz. Electrical equipment is housed in a box mounted on the mixer frame under the mixing tank. The mixer consists of the following elements:

– drive located in the lower part of the device, consisting of a motor with a reducer (gearing). The drive to the shaft is transmitted by means of a chain transmission.

- the tank in which the products are mixed is made of stainless steel in the shape of a cuboid passing into the shape of a cylinder in the lower part,
- the device base in the form of a gutter is made of stainless material,
- protective grille made of stainless profiles. Machine operation is possible only after closing the grille (lattice protection),
- electrical equipment,
- rotary knob to activate the stirrer rotation (left – right).

The tests were performed at 2 heights and 3 distances from the machine, which gave 6 measuring points for the space where employees are most often located. Figure 1 presents the values of individual x, y and z magnetic induction components measured at heights of 0.9 m and 1.2 m at 0.2 m, 0.5 m and 1 m from the device.

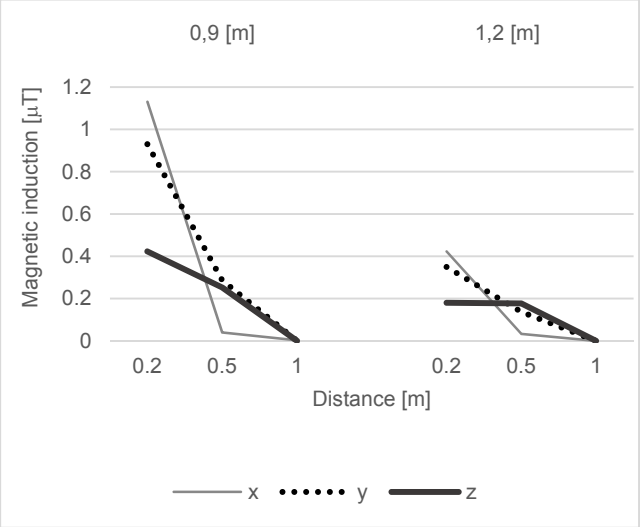

Fig. 1. The values of the components x, y, z of magnetic induction for the measurement point at a height of 0.9 m and 1.2 m.

The highest value of magnetic induction was measured at a height of 0.9 m at a distance of 0.2 m for the x component and it was 1.13 μT.

Photo 2. SZ–40 cabbage slicer with own design specifying the measuring point (own picture)

There are shown the values of individual components of x, y and z of magnetic induction for different heights on Figure 2.

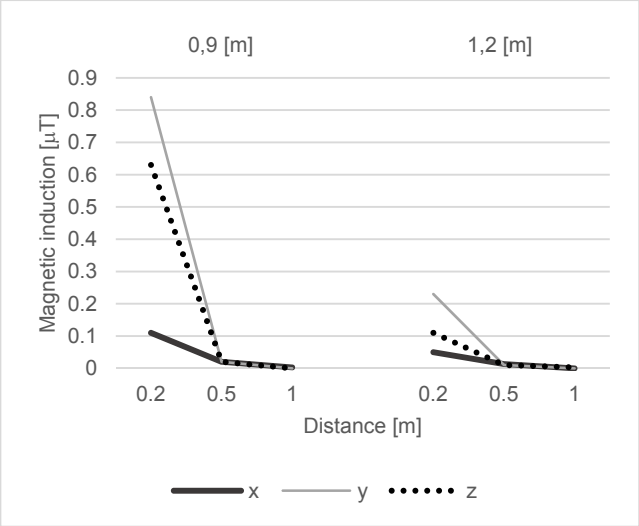

Fig. 2. The values of the components x, y, z of magnetic induction for the measurement point at a height of 0.9 m and 1.2 m.

Another tested device was the cabbage shredder SZ–40 (Picture 2), which is used in this case to chop the onion into a homogeneous slice. It also has the ability to chop other vegetables into chips of different sizes, which can be adjusted thanks to the discs, which are additional equipment. The device is driven by an electric motor of 0.75 kW at 20 revolutions per minute at a voltage of 400 V, the frequency f of 50 Hz. The construction of the shredder consists of a drive unit, which transmits the drive by means of two V-belts to about belt pulleys on the main axis. The main axle is supported by ball bearings. The drive elements are closed under a cover. The element protecting the shaft and bearings against organic substances is the higher positioned sleeve-shaped disc.
The generalized values of magnetic induction were calculated from the formula:

$$\vec{B}=\sqrt{\vec{B}_x^2+\vec{B}_y^2+\vec{B}_z^2} \quad (1)$$

where: $\vec{B}-$ magnetic induction vector, $\vec{B}_x-$ x component of magnetic induction vector, $\vec{B}_y-$ y component of magnetic induction vector, $\vec{B}_z-$ z component of magnetic induction vector.

These values were compared with the permissible values regulated in the Polish standard PN-EN 50413: 2013 and in the Regulation of the Minister of the Environment of October 30, 2003 on permissible levels of electromagnetic fields in the environment and ways to check compliance with these levels [Polish Standard PN–EN 50413 : 2013, Regulation of the Minister of the Environment of October 30, 2003 on permissible levels of electromagnetic fields in the environment and methods of checking compliance with these levels]. The value of magnetic induction [μT] for each of the tested devices is presented in figures 3 and 4**.**

for the workplace depending on distance and height

By calculating the magnetic induction values from formula (1) at measuring points,in which the employees are staying the highest value of magnetic induction for salads mixers was obtained at a height of 0.9 m, at a distance of 0.2 m and it was 1.161 μT. For cabbage chopper the highest value was also recorded at a height of 0.9 m and at a distance of 0.2 m it was 0.559 μT. All measured values are definitely smaller than allowed in the standard.

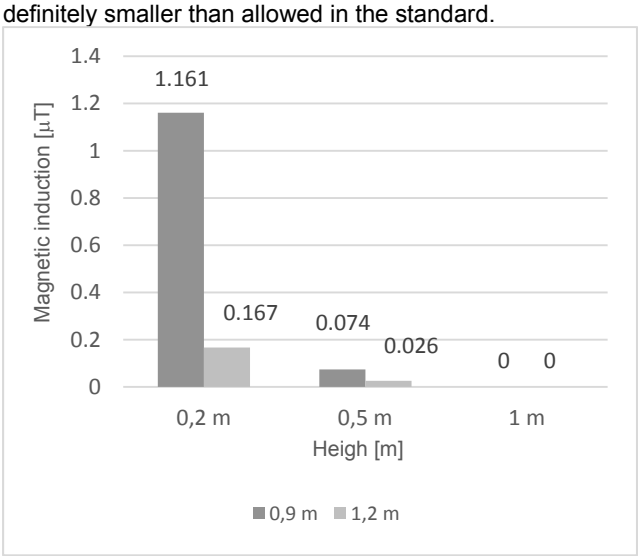

Fig. 3. The values of the magnetic induction of the salad mixer

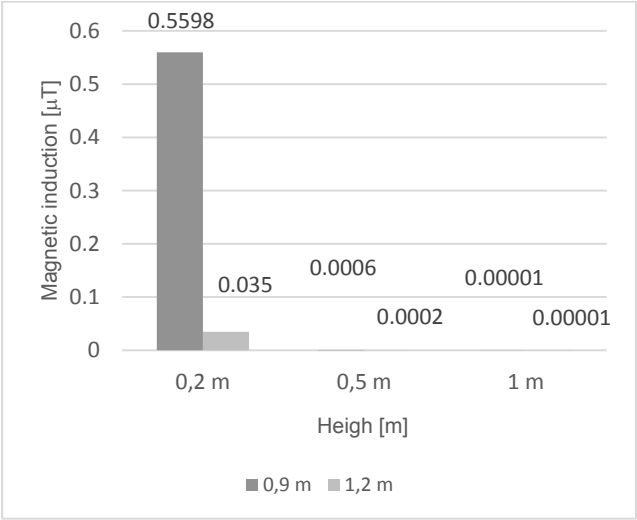

Fig. 4. The magnetic induction values of cabbage slicer for the workplace depending on the distance and height

Conclusions

Employee safety is a priority for the employer. The results of the measurement tests confirmed that the values of electromagnetic fields emitted by the tested devices in the plant's production hall do not exceed the values allowed in the standards. Table 1 shows the permissible maximum values of magnetic induction for frequencies in the range from 0 to 50 Hz. For devices powered from an industrial network it is 0.25 mT.

Table 1. Permissible magnetic induction B values depending on frequency.

Frequency range	B [T]
0 Hz ≤ *f* ≤ 0,5 Hz	100mT
0,5 Hz < f < 50 Hz	0,25mT

Electromagnetic waves emitted in space are considered a threat to the health or life of employees. Nevertheless, it is worth noting that the measurement tests showed that low values (maximum 1.161 μT) do not significantly affect the safety of employees. Due to the lack of solutions allowing complete avoidance of exposure to electromagnetic fields, it is important to perform regular inspection. The

measurements and analysis have shown that according to existing legal conditions, there is currently no need to carry out further tests. This is due to the low values of the measured magnetic induction. The arrangement of machines in different parts of the building is also important because it does not overlap the individual emitted fields. The values of the electromagnetic field emitted by the tested devices were well below the norm. As the distance increased, the magnetic induction value decreased for each case. Each of the tested machines is made of steel elements, which is important because it acts as a protective barrier. By comparing nominal electromagnetic field strength values for network-powered devices to the obtained test results, we conclude that the emission values of the electromagnetic field are almost negligible at some measuring points and do not exceed the norms at all. Due to the very low values of the emitted field at each workplace, the work zone can be qualified as a safe zone for each device.

Discussion:

In this paper, we present the results of measurements of electromagnetic field emissions in a processing plant, where employees are exposed to the field for a long time. The electromagnetic field generated by devices in the vegetable and fish processing plant may affect human health and life. The authors in this paper undertook to carry out the measurement tests to determine whether the electromagnetic field emitted by machines working in the production hall threatens the safety of employees. The most frequently used devices and places where employees spend the longest time were selected. The workplaces indicated by employees were tested in accordance with PN-EN 50413: 2013 [Polish Standard PN–EN 50413: 2013]. It has been shown different values depend on distance and height. Conducting the research showed the influence of the metal machine housing on the value of the measured field, which suppressed the emitted waves. Where at least part of the engine emerged behind the enclosure area higher values were noticeable. Manufacturers of machinery used in the production process were aware that these are the main sources of emission of electromagnetic fields in the workplace. The construction of these devices made of steel was not only intended to maintain the good condition of the machine or to shield mechanical parts, but also to protect employees' health. This is confirmed by the results of the tests. The magnetic induction values for each of the devices are so small that they have no negative impact on the health and life of people working in the hall.

Current research in the field of bioelectromagnetism indicates that the biological impact of electromagnetic fields exists, and all information about its positive or negative effects are important and should be used, among others to protect organisms from their effects.

Authors:

Anna Koziorowska, PhD, DSc Eng., Rzeszow University, Faculty of Mathematics and Natural Sciences, Laboratory of Bioelectromagnetism; ul. Rejtana 16c, 35-959 Rzeszów, e-mail: akozioro@ur.edu.pl,

Beata Prucnal, Eng. (student), Rzeszow University, Faculty of Mathematics and Natural Sciences, Laboratory of Bioelectromagnetism; ul. Rejtana 16c, 35-959 Rzeszów

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