1. Joanna KOZIEŁ, 2.Michał MAJKA

Department of Electrical Engineering and Electrotechnology, Faculty of Electrical Engineering and Computer Science,
Lublin University of Technology ,
ORCID: 1. 0000-0003-1682-2589, 2. 0000-0002-7153-040X

doi:10.15199/48.2022.04.25

Comparative analysis of the results of electrical measurements taken during selected cosmetic and physical therapy treatments

Streszczenie. *W artykule przedstawiono wyniki pomiarów pola elektromagnetycznego w gabinecie kosmetycznym oraz w laboratorium „Urządzeń do fizykoterapii" Politechniki Lubelskiej dla wybranych 6 urządzeń. Pomiary wykonano przy użyciu miernika ESM 100 Firmy Maschek oraz miernikiem NHT 3DL firmy Microrad dla różnych poziomów składowych elektrycznych. Uzyskane wyniki zaimplementowano do oprogramowania Statistica 13.3 w celu zaobserwowania trendów.* ***(Analiza porównawcza wyników pomiarów elektrycznych wykonanych podczas wybranych zabiegów kosmetycznych i terapeutycznych).***

Abstract*. The article presents the results of electromagnetic field measurements in the beauty salon and in the laboratory of "Physical therapy devices" of the Lublin University of Technology for selected 6 devices. Measurements were made using the ESM 100 meter by Maschek and the NHT 3DL meter by Microrad for the various electrical components levels. The obtained results were implemented in the Statistica 13.3 software in order to observe the trends.*

Słowa kluczowe: pomiary pola elektromagnetycznego, bezpieczeństwo zabiegów kosmetycznych, składowa elektryczna PEM, fizykoterapia.
Keywords: electromagnetic field measurements, safety of cosmetic procedures, electric component of EMF, physical therapy

Introduction

The influence of the EM field on human organisms is still the subject of research in many research centers around the world. EM radiation is the factor we live in. Despite many years of intensive research on the impact of the EM field on human health, there is no clear answer to the question: "Are the effects of the impact negative?" Depending on the value of the frequency and duration of exposure, we can talk about a negative or positive impact of the EM field on organisms[1]-[6].

Therapies using the EM field in medicine are used in the modern world in clinical treatment. In medicine, research techniques such as hyperthermia, diathermy, etc. are developed. The positive effect of EM field in treatment is currently used in such areas as: magnetostimulation, magnetotherapy, etc.[7]-[11].

Along with the positive impact of the EM field, there is speculation about the negative impact of the EM field. Research is also conducted, to some extent, forced by social concerns related to the introduction of 5G and 6G wireless networks. On the one hand, society expects fast data transmission, ideal cell phone coverage everywhere, and on the other hand, it is full of concerns. Still, despite such a large number of experimental studies performed, it is difficult to draw unequivocal conclusions as to the impact of the EM field on human organisms. The influence of the EM field on people during telephone conversations is investigated [12]-[17].

In the area of the interest of researchers around the world, special attention is paid to the effects of the EM field on humans, both during work and when resting or sleeping.

Many people spend a lot of time in various cosmetic procedures or post-traumatic therapy. The aim of the research by the authors of the article was to measure the levels of the electric component of the electromagnetic field.

The article presents the results of experimental tests carried out with two ESM-100 meters by Maschek and NHT 3DL by Microrad for the electrical component levels of the electromagnetic field during the operation of selected devices used in cosmetology and physical therapy[18],[19]. The obtained results of measurements of selected devices were compared with the regulations in force in Poland: Regulations of the Minister of Health and the Minister of Family, Labor and Social Policy .

Method and Materials

In the experimental tests, the levels of the electromagnetic field intensity for the electric component in the vicinity of the devices for cosmetic treatments were measured. Measurements were carried out using the ESM-100 meter by Maschek (Fig. 1), with the use of dedicated software for this meter. The ESM 100 meter is a universal broadband device used to measure the electrical and magnetic components of electromagnetic fields. The tests were carried out for the "all" frequency band from 5Hz to 400kHz. The measuring range of the Maschek ESM 100 meter for the levels of the electric field strength E is from 0.1 V/m to 100 kV/m and the magnetic induction B value is from 1 nT to 20 mT. Due to the frequency range of the selected devices, measurements were also made using the NHT3DL broadband meter in the frequency range with the 01E measuring probe operating in the frequency range from 100kHz to 6.5 GHz, allowing measurements in the industrial, scientific, scientific, medical and telecommunications sectors. Detailed parameters of the meter are presented in the work [19],[20].

Table 1. Technical parameters of the analyzed devices [21]-[23]

No.	The type of devices	Technical data
1	Laser HS- 320C, Photorejuvenation Treatment System with RF Function	AC 230V, 50/60Hz
2	Laser (2) EunSung Global, Magic Polar ESM-7100MO,	150W, 100-240V 50/60Hz
3	Cryomax	220-240V, 50/60Hz, 220VA Max
4	EunSung Global, Spring ESM-4300MO	150W, 100-240V, 50/60Hz
5	Polaris 2 ASTAR	Power consumption 230 V, 50/ 60 Hz, 50 VA
6	Multitronic MT-3,	Power supply 230 V/ 50 Hz / 70 VA

The above-mentioned devices (Table 1) are equipped with many beauty salons, as well as students of Biomedical Engineering at the Lublin University of Technology, during

the laboratory classes "Devices in physical therapy", have the opportunity to experimentally test the levels of electromagnetic fields of selected devices used in physical therapy. Technical parameters of the analyzed devices are presented in Table 1. In the beauty salon, measurements of devices marked as 1, 2, 3 presented in table 1 were carried out. Next, the analysis of devices used for physical therapy marked in table 1 as 4, 5, 6 was performed.

Figure 1 shows a measuring stand in a beauty salon offering, among others, cosmetic treatments with the HS-320C device, which uses RF (1MHz) waves during treatments.

Fig. 1. Measuring station in an authentic beauty salon offering cosmetic treatments with the HS-320C device

The tests were carried out according to the same measurement methodology for each device in accordance with the PN_T 0658-3: 2002 standard [24]-[25]. The measurement time was 6 minutes. Due to the available broadband devices, the obtained values of the electric component of the electromagnetic field were compared with the lowest normative values in a given frequency range.

Result and discussion

The presented results of selected measurements of the electric component of the electric field using the NHT3DL meter with the E01 measuring probe and EST 100. The obtained RMS values were analyzed with the legal regulations in force in Poland.

Figure 2 shows the results of electric field measurements for the Laser HS-320C device.

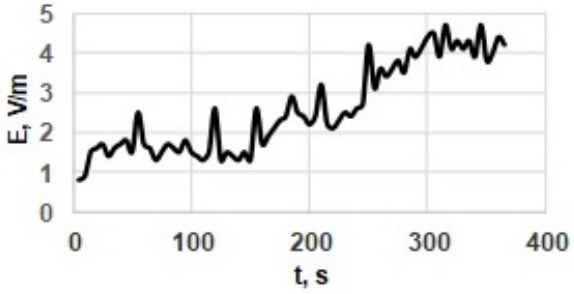

Fig.2. The course of the electric component of the electromagnetic field measured with the Microrad NHT 3DL meter for device no. 1

For the device no. 1, the maximum value recorded in the beauty salon was E = 4.7 V/m.

Figure 3 shows the electric field measurements for the EunSung Global Laser.

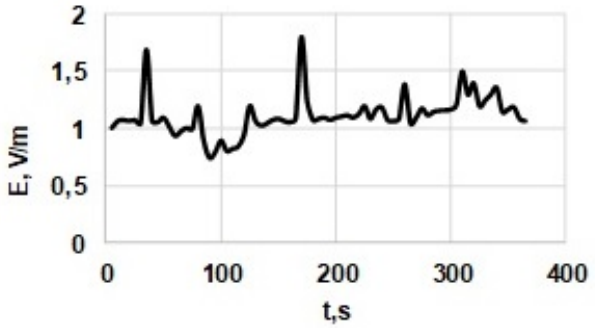

Fig. 3. The course of the electric component of the electromagnetic field measured with the Microrad NHT 3DL meter for device no. 2

Highest recorded value of E = 1.8 V/m.

The next analysis was carried out for the Cryomax device, marked as no. 3. The maximum value of the electric component of the electric component of the electromagnetic field during testing of the device no. 3 in a beauty salon is E = 2.61 V/m.

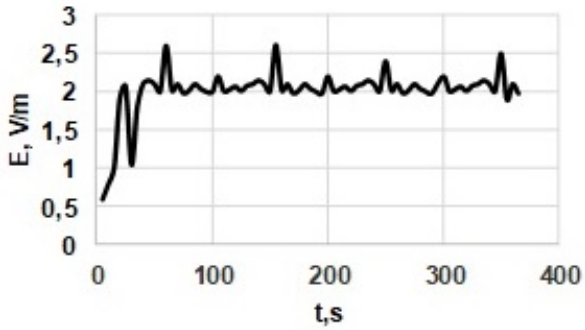

Fig.4. The course of the electric component of the electromagnetic field measured with the Microrad NHT 3DL meter for the operating device no. 3

Another analysis was carried out for the EunSung Global, Spring ESM-4300MO device, marked as no. 4. The maximum value of the electrical component of the electromagnetic field during testing of the device no. 4 in a beauty salon is E = 1.7 V/m.

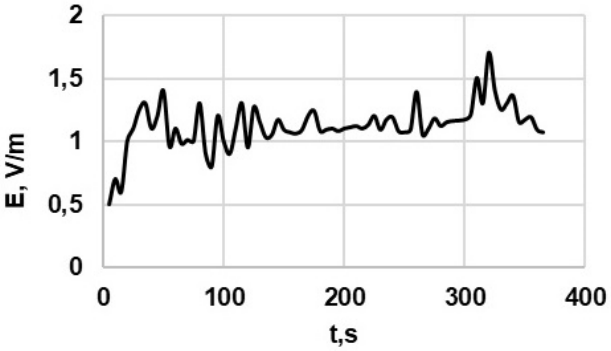

Fig.5. The course of the electric component of the electromagnetic field measured with the Microrad NHT 3DL meter for device no. 4

The results of measurements carried out in the "Laboratory of Physical Therapy Devices" of the Lublin University of Technology are presented for devices no. 5 and 6 (table 1) in Figs 6 and 7.

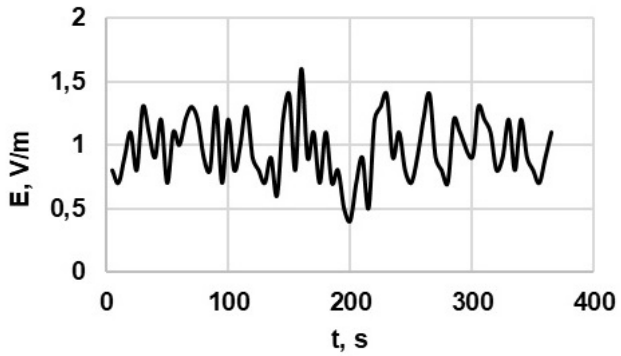

Fig. 6. The course of the electric component of the electromagnetic field measured with the ESM 100 meter for the device no. 5

For the Polaris 2 ASTAR device, on which, among others, students perform laboratory exercises, the highest recorded value is E = 1.6 V /m.

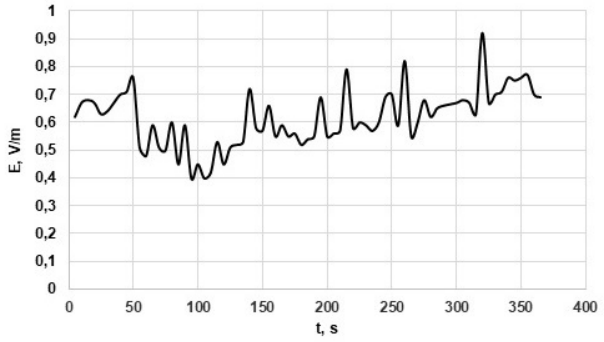

Fig.7. The course of the electric component of the electromagnetic field measured with the ESM 100 meter for device no. 6

For the Multitronic MT-3 device, on which, among others, students perform laboratory exercises, the highest recorded value is E = 0.92 V/m.

In order to observe the regularities in the studied phenomena of the EM field in connection with the large amount of measurement data (sampling time of the measuring probe 2 seconds), a statistical analysis was performed. On the basis of the performed measurements, a statistical analysis was performed using the Statistica 13.3 software.

The electromagnetic field characteristics are presented in Table 2 giving the mean, minimum, maximum and range of variability.

Table 2. Characteristics of the electric component of the analyzed

No.	Mean	Min	Max	St
1	2.55	0.8	4.7	1.12
2	1.1	0.75	1.8	0.16
3	2.01	0.6	2.61	3.1
4	1.12	0.5	1.70	1.7
5	0.97	0.4	1.60	2.4
6	0.61	0.4	0.92	0.1

The average value of electric fields for the analyzed devices ranges from 0.61-2.55 V/m. the parameters of the tested test are high in the range of 0.4 to 4.7 V/m. In order to verify this hypothesis, the differences between the indications of the tested devices are shown in fig. 8.

It can be observed that the highest values of the electric field obtained during the measurements occur in the selected device no.1 (Laser HS-320C).

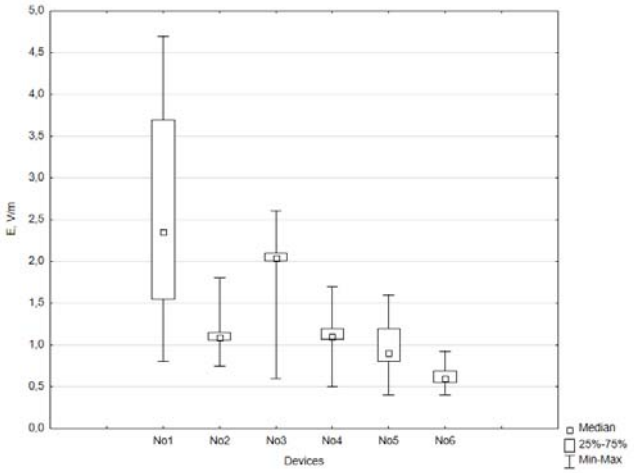

Fig.8. Box plots of the measurement of electric field using devices, standard deviation value

Conclusions

During the measurements of electromagnetic field, both during the cosmetic procedures and selected physiotherapeutic treatments, with the use of two types of meters, no increase in the value of the electromagnetic field was found, the value of which would exceed in individual frequency bands the regulation of the Regulation of the Minister of Health on permissible electromagnetic fields in the environment that apply to people undergoing treatments cosmetic. When analyzing the Regulation of the Minister of Family, Labor and Social Policy of June 12, 2018 on the maximum allowable concentrations and intensities of factors harmful to health in the work environment, it can be concluded that the normative values for equipment operators were not exceeded [27],[28].

It is very important to monitor the safety of devices in the human environment, to check whether the standards are complied with, and whether people are actually not exposed to too high levels of the electromagnetic field. It is important to take care of the health of both working people, including students who test physiotherapeutic devices during laboratory classes and have contact with electromagnetic devices and those who undergo rehabilitation and use treatments in beauty salons.

Autorzy: dr inż. Joanna Kozieł, *Department of Electrical Engineering and Electrotechnology, Faculty of Electrical Engineering and Computer Science, Lublin University of Technology, Nadbystrzycka Street 38A, 20-618 Lublin, e-mail: j.koziel@pollub.pl,* ***dr hab. inż. Michał Majka, prof. LUT,*** *Department of Electrical Engineering and Electrotechnology, Faculty of Electrical Engineering and Computer Science, Lublin University of Technology, Nadbystrzycka Street 38A, 20-618 Lublin, e-mail: m.majka@pollub.pl*

REFERENCES

[1] Kozieł J. et al, Safety analysis of selected cosmetic treatments, *Przegląd Elektrotechniczny*, (2021) vol. 97, no.1,(2021), p.148-151, doi:10.15199/48.2021.01.29.

[2] Michałowska J. et al, Monitoring of the Specific Absorption Rate in Terms of Electromagnetic Hazards, *Journal of Ecological Engineering,* vol. 21, issue. 1, 2020, doi.org/10.12911/22998993/112878.

[3] Bieńkowski P. et al, Electromagnetic fields from mobile phone base station - variability analysis, *Electromagnetic Biology And Medicine,* 2015, vol. 34, no. 3, p: 257-261.

[4] Gontarz A., et.al, Numerical analysis of unconventional forging process of hollowed shaft from Ti-6Al-4V alloy, *Journal of Shanghai Jiaotong University (Science*), vol. 7, no. 17, (2013), p.73-76.

[5] Tofil A, Research of new splitting process of pipe billets from 2618A aluminium alloy basing on cross-wedge rolling, *Archives of Metallurgy and Materials*, vol. 58, Issue 3, p. 725 – 7292013.
[6] Tofil A. et.al., Cross wedge rolling with upsetting, *Archives of Metallurgy and Materials*, vol 58, issue 4, (2013), 1191-1196.
[7] Krawczyk A., et al, An attempt to verify the effectiveness of therapy in an electromagnetic field, *Przegląd Elektrotechniczny,* no. 12 (2006), p.83-86.
[8] Krawczyk A, et al, Influence of the therapeutic environment on the effectiveness of electromagnetic field therapy, *Przegląd Elektrotechniczny*, no.12 (2008), p. 205-206.
[9] Krawczyk A. et al., Świadomość zagrożenia elektromagnetycznego i edukacja pacjentów z implantami kardiologicznymi, *Przegląd Elektrotechniczny*, no. 12, (2009), p. 131-133.
[10] Krawczyk A. et al. Właściwości PEM o częstotliwościach terahercowych w zastosowaniu do technologii 6G, *Przegląd Elektrotechniczny,* vol. 97,no. 12, (2021), p. 125-128, doi:10.15199/48.2021.12.24
[11] Pater Z et.al, Steel balls forming by cross rolling with upsetting, *Metalurgija*, volume 52, issue 1, p. 103 – 1062013.
[12] Mazurek P. et al., The intensity of electromagnetic fields in the range of GSM 900, GSM 1800 DECT, UMTS, WLAN in built-up areas*, Applications of Electromagnetics in Modern Techniques and Medicine (PTZE*) 2018, DOI: 10.1109/PTZE.2018.8503156.
[13] Michałowska J, et.al, Measurement of high-frequency electromagnetic fields in CNC machine tools area, *4th International Symposium on Wireless Systems within the International Conferences on Intelligent Data Acquisition and Advanced Computing Systems (IDAACS-SWS),IEEE Xplore (2018*),162-165.
[14] Mazurek P. et al, The intensity of electromagnetic fields in the range of GSM 900, GSM 1800 DECT, UMTS, WLAN in built-up areas, *Przegląd Elektrotechniczny,* (94) 2018, no. 12, p. 202-205, doi: 10.15199/48.2018.12.45.
[15] Michałowska J. et al, Identification of the Electromagnetic Field Strength in Public Spaces and During Travel, *Applications of Electromagnetics in Modern Engineering and Medicine (PTZE),* 2019, p. 121-124, DOI:10.23919/PTZE.2019.8781737.
[16] Korzeniewska E. et al., Technologia 5G jako etap rozwoju komunikacji bezprzewodowej, *Przegląd Elektrotechniczny*, vol. 95, no. 12, (2019). p.144-147, doi:10.15199/48.2019.12.31.
[17] Korzeniewska E., et al. Resistance of metallic layers used in textronic systems to mechanical deformation, *Przegląd Elektrotechniczny* , 93 (2017), no. 12, p 111 – 114, doi: 10.15199/48.2017.12.28.
[18] Komarzyniec G. et al, The calculation of the inrush current peak value of superconducting transformers, 2015 Selected Problems of Electrical Engineering and Electronics, WZEE 201527 January 2016, Article number 7394042,Selected Problems of Electrical Engineering and Electronics, WZEE 2015, Kielce, 17– 19, September 2015.
[19] Michałowska J. et al., Assessment of training aircraft crew exposure to electromagnetic fields caused by radio navigation devices, *Energies*, vol. 14, issue 1, January 2021 Article no. 254.
[20] Michałowska J. et al, Monitoring the Risk of the Electric Component Imposed on a Pilot During Light Aircraft Operations in a High Frequency Electromagnetic Field, *Sensors,* vol.10. no. 24, 2019, DOI: 10.3390/s19245537.
[21] Kozieł J., Stępniak P. Badania eksperymentalne zakłóceń elektromagnetycznych od urządzeń fizykoterapeutycznych, Wybrane zagadnienia z inżynierii biomedycznej / red.: Paweł Mazurek, Piotr Filipek, Tomasz Kołtunowicz, Andrzej Kociubiński, Maciej Laskowski.- Lublin : Politechnika Lubelska, (2016),p. 127, ISBN 978-83-7947-222-2
[22] Murawski P.et al., Nowe podejście do projektowania urządzeń używanych w terapii polem elektromagnetycznym, *Przegląd Elektrotechniczny*, vol 91, no. 12, (2015), p. 170-172, doi:10.15199/48.2015.12.43.
[23] Kozieł J., et al., Badania eksperymentalne pola elektromagnetycznego w otoczeniu urządzeń fizykoterapeutycznych, *XXIX Sympozjum Środowiskowe PTZE Zastosowania Elektromagnetyzmu we Współczesnej Inżynierii i Medycynie* / przew. kom. nauk. Karol Bednarek.- Warszawa, Polskie Towarzystwo Zastosowań Elektromagnetyzmu, (2019), p. *388 , ISBN 978-83-88131-01-1*.
[24] Michałowska J. et al Measurements of the level of harmful factors in the workplace of numerically operated milling machine, *Przeglad Elektrotechniczny*, vol.92, no.12, (2016) p. 97 – 100, doi: 10.15199/48.2016.12.25
[25] Pytka J., et al., IMUMETER – A Convolution Neural Network Based Sensor For Measurement of Aircraft Ground Performance, *Sensors*, (2021), 21, 4726. doi.org/10.3390/ s21144726
[26] Michałowska J. et al, Prediction of the parameters of magnetic field of CNC machine tools, *Przegląd Elektrotechniczny*, vol. 95, no 1, (2019), p. 134-136, doi:10.15199/48.2019.01.34.
[27] Rozporządzenie Ministra Zdrowia z dnia 17 grudnia 2019r. w sprawie dopuszczalnych poziomów pól elektromagnetycznych w środowisku, Dziennik Ustaw Rzeczpospolitej Polskiej, poz. .2448, Warszawa 19.12.2019r.
[28] Rozporządzenie Ministra Rodziny, Pracy i Polityki Społecznej z dnia 12 czerwca 2018r. w sprawie najwyższych dopuszczalnych stężeń i natężeń czynników szkodliwych dla zdrowia w środowisku pracy, Dziennik Ustaw Rzeczpospolitej Polskiej, poz. 1286, Warszawa 03.07.2018r.