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Electromagnetic High-Frequency Transients Measurements of Some Household Devices

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Abstract

Voltage Transients are generated in power lines and emit both low-frequency electromagnetic fields and radio-frequency radiation. This study aims to highlight its existence and detrimental effects on human health. A comprehensive literature review is presented, encompassing studies by multiple authors exploring the topic of dirty electricity, its impact on well-being, and preventative measures. The electromagnetic spectrum analysis and measurements of both electric and magnetic fields are performed on various household appliances such as hair dryers, old televisions, blenders, heaters, toasters, vacuum cleaners, and microwaves. The findings indicates that microwaves and compact fluorescent lamps (CFL) bulbs exhibit similar spectral characteristics, with high-frequency voltage transients primarily originating from these two devices. Conversely, other appliances do not generate significant high-frequency voltage transients (HFVT). Overall, dirty electricity poses a substantial risk to human health and necessitates attention to minimize its adverse consequences.

Keywords: electromagnetic frequencies, dirty electricity, household devices, electromagnetic pollution, human body

1. Introduction

The increasing prevalence of modern energy-efficient technologies, including electronic devices and wireless appliances, has resulted in an increase in frequency deviations and subsequent exposure to a wide range of electromagnetic (EM) frequencies. At the end increased EM fields can incur various impacts on living organisms biologically and environmentally [1]. The electrical energy produced in power plants is distributed to consumer areas via high-voltage powerlines from 35 V to 400 kV. The voltage is reduced through transformers to 400/230 V for local distribution. The general population is exposed to magnetic fields at the network frequency of 50 Hz, via three individual sources, namely, the local system for distribution and low voltage electricity at home and work, high voltage transmission power lines, and electrical household appliances [2].

This has led to increased EM pollution in both rural and urban environments, pervasively called “dirty electricity.” This term is coined from the industrial term “dirty power,” which refers to high frequencies of voltage transients caused by interferences in connected equipment that might incur damage. While a 60 Hz steady electrical frequency is generally deemed safe for human health, deviations from this frequency can induce adverse aftermaths environmentally and physiologically. These deviations are typically in the radio frequency (RF) spectrum and should called “RF transients” or “high-frequency transients.” Specifically, the “transients” and “harmonics,” which are tiny spikes in electricity, transform the house wiring into

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an antenna andradite the formed spikes' frequencies. Dirty electricity is created within the home by household devices and some technological devices such as computers, plasma TVs, cordless phones, dimmer switches, wireless routes, energy-efficient lighting bulbs, and appliances. Moreover, it can also emerge from nearby cell phones and broadcast antennas. Over the last few decades, AC electrical power has been supplied in dirty and contaminated quality with hazardous RF radiation with the invention of new technologies. The exacerbating dirtiness can potentially aggravate health problems in some people. Therefore, the biologically active EM pollution is deemed to be dirty electricity by some experts [3-4].

However, the full extent of the aftermath of electromagnetic field (EMF) on public health cannot be evaluated due to biased classification, although most studies, if any, manifest that the risks are too extensive to be assessed in magnitude. Since the ubiquity of exposure to EMF regularly, many people may suffer from negative or waning health [4]. Thus, the INTERPHONE study has been conducted to address public concerns about the effects of EMF. Some other studies are being conducted to proffer a new approach to such exposure of EMF that may affect people and the explanation for the context of apocryphal environmental studies [5].

2. Dirty Electricity

In industrial settings, large capacitors are installed to remove high-frequency voltage transients (HFVT) and protect equipment from power surges. Similarly, Graham/Stetzer (G/S) filters, have been developed for home and office environments (produced by other firms as well).

The same principle is being used to remove or diminish HFVT on electrical circuits, with an optimal filtering capacity between 4 kHz and 100 kHz. Therefore, it means the exposure to HFVT is not the same as RF exposure, namely being within the frequency range of 100 kHz to 300 GHz. Rather, it decreases within a new EMF spectrum that ranges from low-frequency EMF up to the low spectrum of RF. Standard RF and low-frequency EMF measurement devices can be used in measurements. In Havas' reports, it is claimed that governments worldwide are prohibiting energy-efficient light bulbs to diminish fossil fuel consumption and greenhouse gas emissions. However, current energy-efficient light bulbs may harm both the environment and human health due to their high mercury content. Subjective symptoms including itching, burning, and drynessand a few objective symptoms such as redness and dryness emerged due to EM pollution [6-7]. Light bulbs are designed to generate light, which pertain to the EM spectrum. Incandescent bulbs also generate heat because of the infrared radiation about the EM spectrum, transforming heat into energy inefficiently. Compact fluorescent bulbs, which are newer than the two types above, generate RF radiation and ultraviolet radiation. However, notwithstanding less heat generated than incandescent bulbs, infrared radiation is still inevitable [6-8].

Several studies [9-12] were carried out in three schools with ameliorated design compared to the initial study. The instructors reported larger improvements in well-being during the "filter periods" than in the initial study, including reductions in the incidence of headaches, general weakness, dry eyes or mouth, facial flushing, depression, mood swings, dizziness, pain, skin irritation, and clarity of thought. In addition to the first study, the discarding of HFVT in this study was also associated with a decrease in the incidence of asthmatic symptoms and other symptoms among instructors. Although the abnormal improvements in student behavior in elementary and middle school were discovered, it remains incomprehensiveness in high school studies. The scientists suggested that the low values of an outcome at the high school level might be due to other sources of RF radiation, such as cell phone use and wireless devices in classrooms, or in agreement with the previous study, that students with attention deficit disorder (ADD) or attention-deficit/hyperactivity disorder (ADHD) might be more sensitive to EMF energy.

3. Materials and Method

An experiment was performed on related publications, with dirty electricity or high-frequency voltage transients as the keyword. This search resulted in publications and books [13-18]. Briefly, the laboratory and Semi-nonreflecting room [Fig. 1(a)] were set up, and household devices were brought to the laboratory for measurement [Fig. 1(b)]. The tools for magnetic and electric field measurements are the electromagnetic Compatibility Experiment, and the venue was the Test Laboratory† at Sakarya University of Electrical and Electronics Engineering Faculty. The details were presented as follows;

(1) Narda SRM-3006 selective radiation meter for spectrum analysis

(2) ETS Lindgren HI-3604 Survey Meter

(3) Narda exposure level tester ELT-400

(a) View of Semi-nonreflecting room/Nonreflecting characteristic mostly provided by ferromagnetic plaque

(b) Measuring the EMF spectrum analysis of tools at different distances

Fig. 1 Electric field measurement in a well-prepared room and measuring tools for EMF

The used household devices are listed below, while the figures of the experimental studies are given in Section 4 The measurement results as figures in Figs. 1-8. All the figures except Fig. 7 and Fig. 8 comprise the measured data of the EM field spectrum while all the devices were operated separately.

(1) Arcelik MD-574 microwave oven

(2) Arcelik TV-3355 55 cm model TV

(3) Philips compact fluorescent lamp (CFL)

(4) Bosch Ergomaxx 2200 W vacuum cleaner

(5) Braun Satin Hair 7 SensoDryer HD785 Hair Dryer

(6) Tefal Easy Toast 1800 Watt

(7) Luxell LX-3530 Oven 2000 Watt

(8) Moulinex DD100 model blender

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4. Results and Discussion

The following figures are spectrum analyses and electric and magnetic field tracings obtained from household devices such as CFL bulbs and microwave ovens. Fig. 2 shows the relation between the electric field and distance in cm of overlapping values of the CFL bulb and microwave oven. Separated charts are given in Figs. 3 and 4. It's clear that at a 10 cm point, the CFL value is twice that of x, while at other points, they have parallel values.

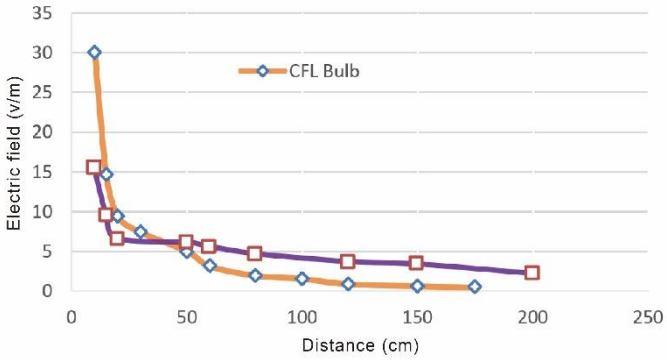

Fig. 2 Electric field measurement of Arcelik MD-574 microwave oven and CFL bulb

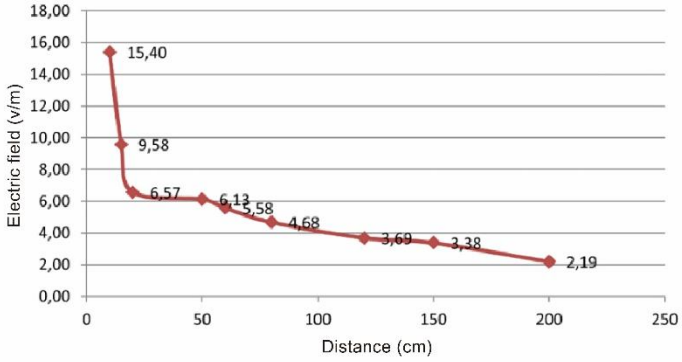

Fig. 3 Electric field measurement of Arcelik MD-574 microwave oven

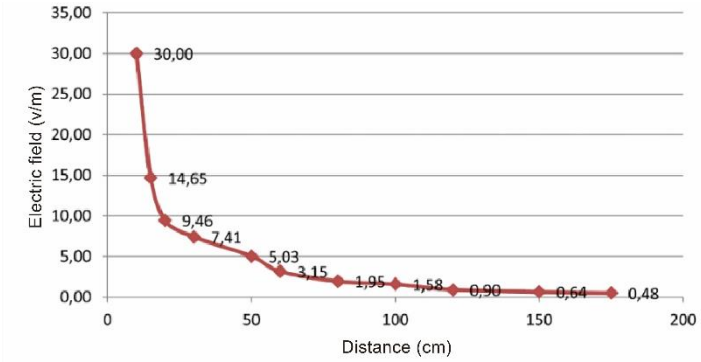

Fig. 4 Electric field graph of CFL light bulb

Concerning the magnetic field measurement of the microwave oven which operates at 2450 MHz, the laboratory did not have the proper probe, and HI-3604 did not proffer any significant results for the magnetic field. The bulb measurements are evaluated through Narda ELT-400 exposure level tester with a 100 kHz-6 MHz probe for the electric field and a 27 MHz-1 GHz probe for the magnetic field.

Regarding the CFL light bulls, they are deemed safe for lightning in a room from the ceiling but risky for table use. To reduce the exposure to EM fields, the CFL light bulb shouldn't be used for table lightning even though it consumes less energy. In other words, less energy is not meant to be safer.

The EM field spectrum analysis was conducted while all the devices were in operation, as illustrated in Fig. 7. Also as shown in Fig. 2, CFL bulbs exhibit a significantly greater magnetic field dispersion in centimeters compared to other household

devices. While the CFL bulbs have greater dispersion, the vacuum cleaner is the lowest at the same distance in cm.

In this paper, the main purpose is to highlight the potential health effects of dirty electricity. According to the results in Section 4, it is evident that microwave ovens produced significant HFVT, whereas other household appliances investigated did not manifest substantial emissions of this kind. The analyzed results of all devices were presented as follows:

(1) Microwave ovens: Fig. 5 demonstrates the radiation levels below 2450 MHz on the EM field spectrum, which represents the operating frequency of microwaves. This frequency is above the World Health Organization (WHO) standards and may pose risks to human health.

(2) Compact fluorescent lamp (CFL): Fig. 6 reveals a high spike before 1 GHz, which represents an effective high-frequency transient voltage for CFL. Eliminating spikes between 850 MHz and 900 MHz can help reduce transient outcomes. Switching to incandescent light bulbs, which do not produce significant HFVT, might be a modus vivendi with less efficiency.

(3) Hair dryers: Fig. 7 manifests hazardous results (10.1 μT) when the hair dryer is held at merely 10 cm away, further exceeding the standard the WHO suggests, namely 0.4 μT as the safe level. To reduce potential harm, avoiding using hair dryers is recommended.

(4) Combined results: Fig. 7 and Fig. 8 demonstrate negligible differences between microwave and CFL bulb spectra, indicating that all the transient values come from CFL and microwave ovens, which are the two major devices producing HFVT. On the other hand, other devices do not produce significant HFVT, and the Bosch Ergomaxx vacuum cleaner evinces no meaningful results.

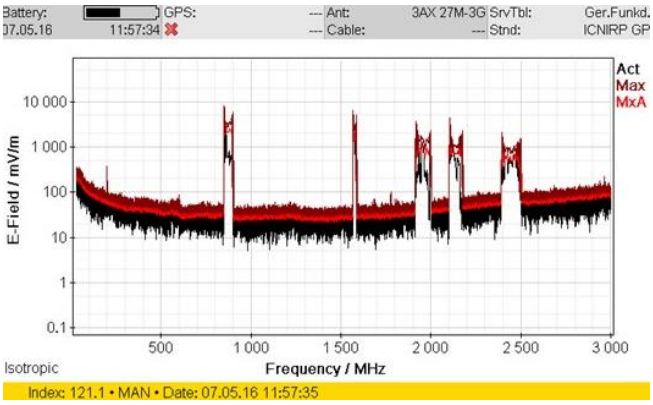

Fig. 5 Electromagnetic spectrum analysis of microwave oven (f = 2450 MHz)

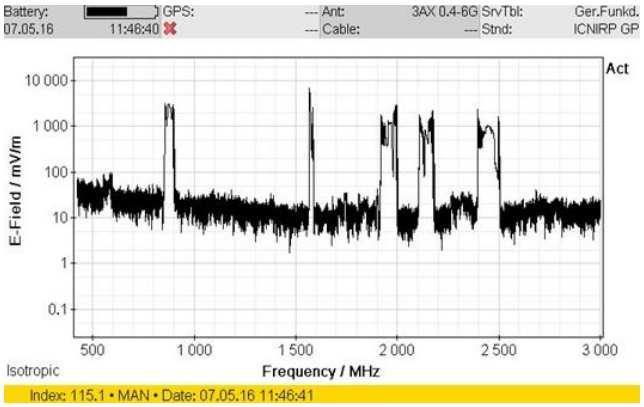

Fig. 6 Electromagnetic field spectrum of CFL

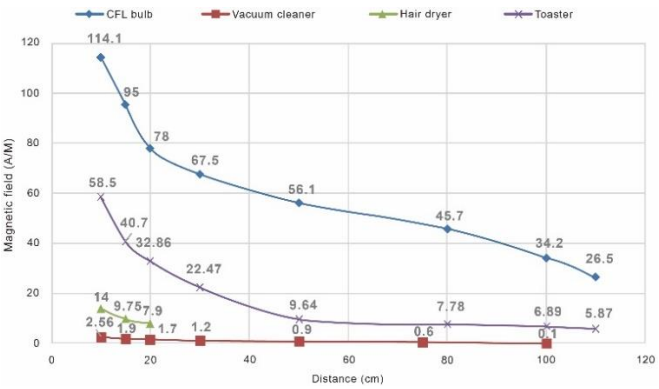

Fig. 7 Magnetic field strength graph of CFL light bulb, vacuum cleaner, hair dryer, and toaster

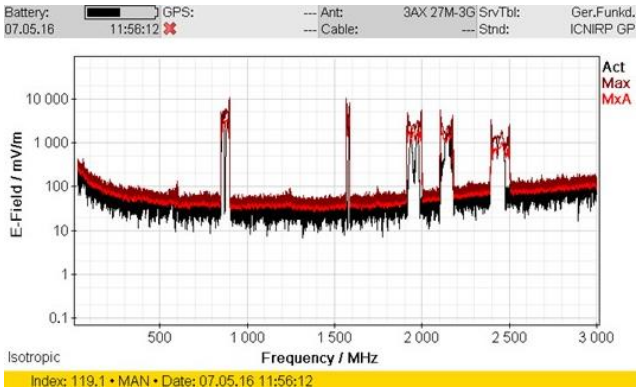

Fig. 8 Electromagnetic field spectrum analysis of all the used household devices

5. Conclusions

This study presented the EM spectrum analys and measurements of EMF, as well as dirty electricity fields performed on various household appliances such as hair dryers, old televisions, blenders, heaters, toasters, vacuum cleaners, and microwaves. The findings of this study indicated that microwave ovens and CFL bulbs exhibited similar spectral characteristics with high-frequency voltage transients primarily originating from these two devices. Conversely, other appliances did not generate significant HFVT. Overall, dirty electricity incurs a substantial risk to human health and necessitates attention to minimize its adverse consequences.

Since extensive exposure to EMF, people may suffer from negative or waned health effects. The INTERPHONE study has been conducted to address public concerns about the effects of EMF. Some other studies being conducted evaluate the aftermath of exposure to EMF. The International Agency for Research on Cancer (IARC), one of the agencies forming part of the WHO, has classified the radiation emitted by RF areas, including cell phones and base stations, as "possibly carcinogenic" (Category 2B) in the cancer-causing list. Furthermore, high-frequency transient voltage outcomes have not been thoroughly acknowledged by the scientific community, even though they may have significant impacts on health as shown by certain studies. Individual-level exposure assessment with local factors is necessary instead of aggregated measures such as the distance to transmission lines.

Conducting further research is crucial to understanding HFVT exposure in the environment. This requires well-powered studies and a comprehensive assessment of exposure across a wide EMF frequency range. Properly designed studies will provide valuable insights into the causes of dirty electricity.

Conflicts of Interest

The authors declare no conflicts of interest.

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