PROTECTION OF PERSONNEL AND MILITARY EQUIPMENT AGAINST ELECTROMAGNETIC ATTACKS BY USING SHIELDING TEXTILE MATERIALS

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Abstract: *Because of the military aggression of the Russian Federation, the problem of protecting both the military and the civilian population from electromagnetic radiation (EMR) is becoming especially relevant for Ukraine. A wide range of research in the creating protective textile shields has shown their effectiveness not only for shielding the room and equipment, but also for creating comfortable clothing with a high degree of protection. Within this work, new knitted materials for shielding against EMR were developed using stainless steel wire as a conductive element and cotton yarn as ground. All developed materials have SE around 8 – 10 dB for 1.5 GHz frequency.*

Key words: *electromagnetic radiation, protection, EMR shielding, knitted fabric.*

1. INTRODUCTION.

Todays, the importance of protection against electromagnetic radiation is increasing. The inevitability of its impact on the population and the nature is a tribute to modern technological progress. This is due not only to the growing number of EMR sources, but also to the scope of their use. The modern populated areas is permeated by EMR of various ranges caused by different technical means and devices. Electromagnetic radiation, in general, is one of the special forms of matter, characterized by common characteristics of electric and magnetic fields. Any system, device or equipment produced, distributed and consumed electricity creates EMR. It leads to creation an electromagnetic field within and around the source.

Militarily developed countries, attracting the latest technologies, attach more and more importance to the creation of fundamentally new types of weapons based on different physical principles, as well as the creation of so-called non-lethal types of weapons. The humanity is faced the needs to conduct wars, anti-terrorist acts, peacekeeping and combat operations. The experience of research, testing and usage of non-traditional types of weapons and analysis of development prospects showed that the effectiveness of its combat impact on the personnel and equipment is expected to be greater than that of nuclear weapon. According to military experts [1], the high-frequency, infrasonic, ozone, radio-frequency, radiological and geophysical weapon is greatest danger among the new possible weapon of mass destruction in the near future. Such weapons include: disorienting lasers; aerosols that make metal brittle; sound generators, so loud that causes unbearable pain; blinding flashes; electromagnetic guns; non-nuclear electromagnetic pulses, etc.

2. EXPERIMENTAL AND RESULTS.

With the outbreak of the war in Ukraine, the problem of EMR protection becames particularly important, because military equipment, military communications, air defense equipment, planes, missiles, ships are EMR sources affected not only military, but also the civilians.

All types of military telecommunication activities and all their equipment work in the following ranges:

• up to 300 Hz (up to 1000 km) - fields of various origins, power plants and devices, high-voltage power lines, various terminals, radio and television towers;

• 0.3 ... 3 kHz (1000 ... 100 km) – various radars;

• 3 ... 30 kHz (100 ... 10 km) – mobile communication devices, navigation systems, medical equipment;

• 30 ... 300 kHz (10 ... 1 km) - radio broadcasting, radio navigation, maritime and aviation communication, means of communication, radar;

• 0.3 ... 3 MHz (1 ... 0.1 km) - radio broadcasting, communication, radio navigation, marine radio telephony, amateur radio communication;

• 3 ... 30 MHz (100 ... 10 m) - radio broadcasting, amateur radio communication, global communication, magnetic resonance exciters;

• 30 ... 300 MHz (10 ... 1 m) – frequency-modulated radio broadcasting;

• 0.3 ... 3 GHz (100 ... 10 cm) - radio relay lines, radar, radio navigation;

• 3 ... 30 GHz (10 ... 1 cm) - radar, satellite communication, meteorological radars, radio relay lines, plasma heating, thermonuclear fusion installations;

• 30 ... 300 GHz (10 ... 1 mm) - radar, satellite communication, radio relay lines, radio navigation.

The main methods of protection against EMR are the following: time protection; distance protection; shielding of radiation sources; shielding of workplaces; reduction of radiation in the radiation source itself; personal protective equipment; organizational methods of protection. EMR protection solutions include the use of both special shielding materials and coatings, as well as technical features of building structures and electromagnetic properties of the surrounding environment. The various materials and structures are used to shield biological and technical objects from EMR. They are divided into two classes - screens and absorbers of electromagnetic radiation. Targeted application of these elements allows solving specific protection tasks for both military radio equipment and personnel.

Among the available protection methods, the military mostly use shielding methods and personal protective equipment. Shielding paints, metal structures (copper, nickel, aluminum, steel) that have shielding properties can be used to shield military premises and equipment. To protect personnel, it is advisable to use personal protective equipment, which includes special clothing, shoes, protective equipment for the head, hands, face, eyes, and respiratory protection.

The current research task is the development of the advanced textile materials for EMR shielding combined a high level of protection and improved clothing comfort. Textile protective materials can be made from conductive polymers, metal fibers, metal wires, metal-coated threads or complex threads [2]. Currently, the research of EMR protective materials has switched to the use of light, thin and soft fabrics [3], by inserting metal fibers [4], metal foam [5] and methods of metal coating [6]. However, such electromagnetic shielding fabrics do not have the necessary elasticity, and

therefore their application is limited.

Within this work, new knitted materials for shielding against EMR were developed. Four variants of knitted fabric were produced on 8 gauge flat knitting machines, using 0.12 mm diameter stainless steel wire as conductive element and 30 x 2 tex cotton yarn as ground. The conductive element was placed in the structures according to particular repeats and forms different stitches: loop, tuck, or float. Electromagnetic shielding of textile samples EMI SE [dB] was measured on frequency range 30 MHz – 1.5 GHz according ASTM 4935-10. All developed materials have SE around 8 – 10 dB for 1.5 GHz frequency. It was found that better shielding effectiveness had the fabric in which structure steel wire forms float stitches. This preliminary result is the first step in developing advanced shielding materials with high shielding effectiveness and improved comfort.

3. CONCLUSIONS

With the development of science and technology, the creation and use of non-traditional weapons, the issue of protection against the electromagnetic radiation becomes especially relevant. Today, due to the war, Ukraine, its population and the military need EMR protection more than ever. Which the study, it was found that it is advisable to use paint and metals with shielding properties to protect military equipment. The special protective clothing made of shielding materials should be used for militaries and civilians. The new knitted structures were developed using steel wire in order to create EMR shielding material. A preliminary study showed that all developed materials have SE around 8 – 10 [Db] for 1.5 [GHz] frequency. Future work is on improving the developed structures in order to get higher shielding effectiveness.

4. REFERENCES

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