

PROTECTION OF HUMAN LIFE AGAINST ELECTRIC SHOCK

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Abstract. This article analyzes the effects of electric current on the human body and examines the physical principles of protection against electric shock. The main technical and organizational safety measures used to ensure electrical safety are discussed, including insulation, grounding, protective devices, and residual current protection systems. The study emphasizes the importance of applying physical laws to reduce the risk of electrical injuries and to ensure human life safety when working with electrical equipment.

Keywords: electric shock, electrical safety, human protection, grounding, insulation, electrical hazard, residual current device (RCD), electrical injuries.

Introduction

Electric energy is one of the fundamental factors of modern technological progress and is widely utilized in industry, transport, information and communication systems, and household sectors. Alongside the increasing volume of electricity consumption, the number of accidents associated with electric shock is also rising. Electric shock is considered one of the most hazardous factors for human life and health, often resulting in severe injuries or fatalities. From a physical perspective, the phenomenon of electric shock is directly related to factors such as voltage, current intensity, electrical resistance, and the path of the current through the human body. When the human organism is viewed as part of an electrical circuit, the impact of the current manifests differently depending on skin condition, humidity levels, contact surface, and duration of exposure. Based on Ohm's law, an increase in current intensity leads to a sharp escalation of the physiological impact on the human body. Ensuring electrical safety is a critical issue that holds not only technical but also social significance. Non-compliance with safety regulations when working with electrical devices, improper use of protective equipment, and technical malfunctions of electrical hardware are the primary causes of electric shock incidents. Therefore, studying the physical foundations of protection against electric shock and applying them in practice remains an urgent task. This article analyzes the effects of electric current on the human body based on physical laws and highlights effective methods of protection against electric shock from a scientific point of view. The results of the research serve to enhance electrical safety, prevent accidents, and ensure the safety of human life.

The Main Problem

In the context of the expanding use of electric energy, the fact that the number of accidents related to electric shock remains significant emerges as a primary problem in the field of electrical safety. The increasing complexity of modern electrical devices, the widespread use of high-voltage systems, and the influence of the human factor further elevate the risk of electric shock. In many cases, the occurrence of electrical injuries is linked to the insufficient application of technical protective measures or their malfunction. From a physical perspective, the core

problem lies in the inadequate consideration of the mechanisms by which electric current affects the human organism. The electrical resistance of the human body is not constant; it changes drastically depending on environmental conditions, particularly humidity, temperature, and contact surface. Consequently, even relatively low-voltage power sources can generate dangerous current values. Ignoring these factors leads to serious problems in ensuring electrical safety. Another significant issue is the insufficient practical application of theoretical knowledge regarding electrical safety. Despite the existence of physical laws and technical solutions for protection against electric shock, the level of their full implementation in industrial and domestic environments remains low. Specifically, the systematic monitoring of grounding, neutralizing (nulling), and the use of residual current devices is often neglected. At the same time, the lack of sufficiently developed organizational and preventive measures is also one of the main problems. The shortage of regular training sessions on electrical safety, indifference to safety regulations, and a low culture of using personal protective equipment contribute to the persistence of electrical injury cases. As a result, the main problem regarding protection against electric shock manifests in the lack of harmony between technical, physical, and organizational factors. Resolving this issue requires a comprehensive approach to ensuring electrical safety.

Methods of Protection Against Electric Shock

Protection against electric shock consists of a complex of technical, organizational, and personal measures aimed at preserving human life and health. These methods are developed based on physical laws to ensure electrical safety and serve to reduce or completely eliminate the possibility of electric current passing through the human body.

Technical Protection Methods

Technical protection methods are based on the structural solutions of electrical devices and power networks. First and foremost, these include the reliable insulation of current-carrying parts. Insulation materials increase electrical resistance, thereby limiting the direct impact of the current on the human body. Grounding (earthing) is one of the most effective methods of electrical safety, preventing dangerous current values by diverting excess voltage that appears on the metal parts of electrical equipment to the ground. The neutralizing (nulling) system ensures the rapid activation of protective circuit breakers in the event of a short circuit. Residual Current Devices (RCDs) detect current leakages in the electrical network and automatically disconnect the power supply. These devices are particularly highly effective in humid and hazardous environments.

Organizational Protection Methods

Organizational measures are aimed at ensuring compliance with safety regulations during processes involving electricity. These include training personnel on electrical safety, providing safety briefings (instructions), conducting technical monitoring, and performing scheduled inspections. Organizational measures enhance the overall effectiveness of technical protective equipment.

Personal Protective Equipment (PPE)

Personal protective equipment provides direct protection against electric current. Dielectric gloves, rubber boots, special insulating mats, and protective clothing restrict the passage of current through the human body. The correct and regular use of these tools significantly reduces the risk of electrical injuries

Preventive Measures

Preventive measures include the continuous monitoring of the technical condition of electrical equipment, prohibiting the use of malfunctioning devices, and promoting a culture of electrical safety. These measures play a crucial role in preventing accidents.

Impact of Electric Current on Human Life

When electric current passes through the human body, it exerts a significant influence on physiological processes. The danger of electric shock is directly related to current intensity, voltage, the electrical resistance of the human body, the path of the current, and the duration of exposure. From a physical point of view, the current intensity (I) is determined by **Ohm's law**

$$I = \frac{U}{R}$$

Where U is the voltage, and R is the electrical resistance of the human body. The electrical resistance of the human body varies depending on skin condition, moisture level, contact surface area, and the path of the current. Consequently, even low-voltage currents can be dangerous, especially in humid environments.

Physiological Effects of Electric Current

Mild effect (1–5 mA): The person only senses the current; pain or discomfort occurs.

Moderate effect (10–20 mA): Risk of muscle contraction (let-go threshold), paralysis, and loss of consciousness.

Strong effect (50–100 mA): Heart arrhythmia, fibrillation, respiratory distress, and an increased probability of death.

Very high current (100–200 mA): Severe burns on the body, serious damage to internal organs, and an extremely high probability of death.

Electric current particularly affects the heart, the central nervous system, and the muscles. Cardiac arrest or ventricular fibrillation is considered the most dangerous consequence, as it can lead to immediate death. Furthermore, the duration of the current's impact is also critical: a short-term electric shock often results in milder consequences, whereas long-term exposure significantly increases the risk of serious injury or death, even at lower current intensities. Therefore, strict adherence to electrical safety regulations and the use of protective equipment are of vital importance in preserving human life.

Conclusion

Electric current poses a serious threat to human life and health. The results of this study demonstrate that current intensity, voltage, the electrical resistance of the body, and the duration of exposure determine the degree of impact on the human organism. When current passes through the body, it exerts a significant effect on the muscles, the nervous system, and cardiac activity, with high current intensities potentially leading to death. Protection against electric shock is achieved through the comprehensive application of technical, organizational, and personal measures. Insulation, grounding, residual current devices (RCDs), and personal protective equipment reduce the passage of current through the human body and ensure safety. At the same time, knowledge of electrical safety and adherence to preventive measures remain critical factors. In conclusion, ensuring electrical safety is not only a technical issue but also a social and scientific one, serving to preserve human life and minimize the occurrence of accidents.

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