Wireless Power Transfer: Technology Review, Standardization and Human Body RF Exposure Assessment

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Wireless power transfer (WPT) technology has been for a long time envisioned as a game-changing solution to the problem of wireless supply of electric power. Recently, it has been recognized as one of the most promising means for powering the electric vehicles (EV), IoT wireless devices and wireless sensors used for healthcare/lifestyle applications. This talk will present the review of modern WPT technology and its historical milestones, discuss the issues of human safety assessment of WPT systems being developed for practical deployment and latest advances in standardization related to the human safety of EMF radiation from the WPT devices. We will begin with the brief description of two main types of WPT systems, namely 1) inductive WPT technology as well as its magnetic resonance type operating at 80 kHz to 30 MHz frequency band where the transmitting and receiving circuits are near-field coupled and 2) radiative (or RF) WPT systems working at 920 MHz, 2.45 and 5.75 GHz frequencies with the receiving antennas typically being in the far-field zone of beamforming transmitters. Next, the importance of the human body RF exposure assessment and human safety compliance of WPT devices necessary for their wide acceptance and practical commercialization of WPT technology will be discussed.

According to the ICNIRP guidelines and international standards [1,2], Specific Absorption Rate (SAR) is a basic restriction in the exposure guidelines while the incident EM strength values are defined as the reference levels. They are used as the metric for assessing the human safety of any EM radiation devices in the frequency range from 100 kHz to 6 GHz. The necessity of RF dosimetry as the quantification of the magnitude and distribution of absorbed EM energy within biological objects exposed to RF fields will be discussed. Next, the results of EM simulation of inductive WPT coils operating close to the heterogeneous human model and elliptical phantom as a detailed study of the dependency of SAR on the phantom material properties and size will be presented. An example of measurement E-field assessment of radiative WPT 2.45 GHz system in the near-field and far-field zones of beamforming “retrodirective” transmitter is introduced. This assessment procedure includes the use of cylindrical phantom to model the human body effect on the system performance. The results of elliptical phantom SAR measurements of the radiative WPT systems operating at 2.45 and 5.75 GHz will also be presented.

Finally, the latest developments of the IEC activities on the international standardization of the assessment methods of the human exposure to EM fields from inductive WPT systems (frequency range from 1kHz to 30 MHz) and from radiative WPT systems (frequency range from 30 MHz to 300 GHz) will be presented. The new trends of the WPT technology and challenges to its world-wide applications will also be discussed.

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References

1. ICNIRP. “Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz)”. *Health Phys*. 118(5):483–524; 2020.
2. IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, *IEEE Standards Dept.*, New York, USA, C95.1, 2005.