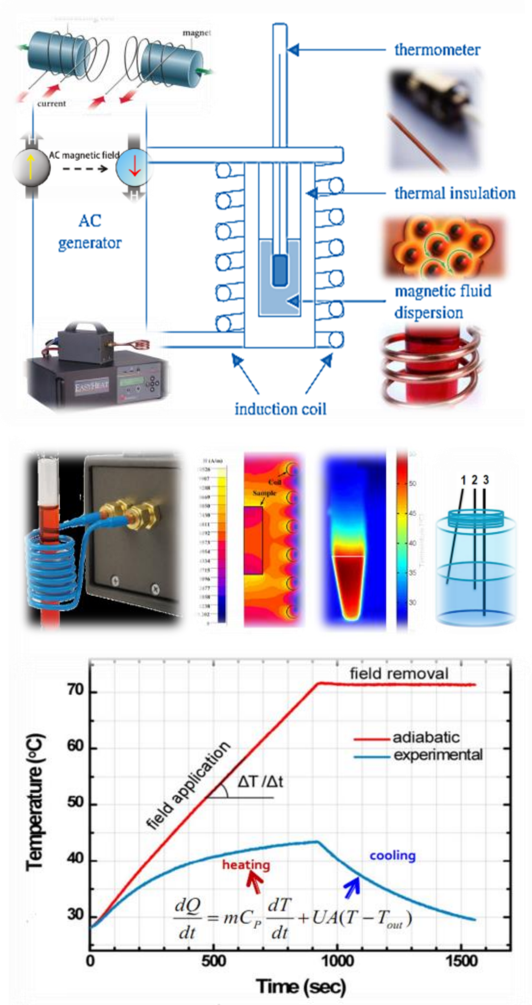
ABSTRACT



In this work, the objective is to propose an experimental protocol, together with a calculation sequence, providing more reliable assessment of heating efficiency values in Magnetic Particle Hyperthermia (MPH).

MPH is considered as a synergistic cancer treatment based on the fact that magnetic nanoparticles (MNPs) can transform electromagnetic energy from an external high-frequency field to heat. Local, mild temperature increase occurs when MNPs are injected in a tumor and subsequently exposed in alternating magnetic field. The elevation of temperature may enhance tumor oxygenation and radio- and chemo-sensitivity, thus resulting either directly and/or indirectly to eventual shrinking of tumor regions.

The heating ability of MNPs is quantified by Specific Loss Power (SLP) index, which refers to the amount of energy converted into heat per time and per mass of the magnetic material. A wide variety of magnetic nanoparticles have been developed for use in MPH, focusing initially on the facile preparation, expected biocompatibility and chemical stability and eventually on magnetic parameters tuning to further increase heating efficiency. For example, increase of the saturation magnetization, control of magnetic anisotropy through the crystallinity, shape, exchange and interparticle interactions of MNPs are also alternative approaches currently being examined to maximize heating efficiency.

Despite the intrinsic nature of heating efficiency described above, another important issue is related to the magnitude of reported SLP values that appear to vary considerably for similar materials. Such discrepancy is usually related to the experimental parameters and protocols followed by studies performed in different labs. This originates from the use of diverse commercial or custom-made devices working under different conditions and, as a consequence, the absence of a universal protocol to give reliable, comparable results.

The present study focuses on the examination of parameters affecting SLP. It includes experimental examination of the measurement setup parameters (such as various thermal insulations, different vessel materials and shapes, variable thermometer positions and coil setups frequency and amplitude of AC field) that may affect the SLP estimation by changing dramatically the experimentally observed temperature variations. Calculation of SLP includes correction of the heating curve slope by modeling and extracting the heat losses to the environment. Finite elements modeling (Comsol software) is used to examine heat transfer between the system and the environment as well as the magnetic field distribution.

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