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Wed-Mo-Po3.04-07 [27]: Optimum Design of Continuously Workable Transcranial Magnetic Stimulator

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Repetitive Transcranial Magnetic Stimulation (rTMS) is a non-invasive biological stimulation technology. For ideal therapeutic effect, the stimulation current usually has a rather high amplitude. Since the resistance of stimulation coil can't be neglected, large Joule heat will be generated during treatment. Once the coil temperature is beyond safety margin, the stimulator will be suspended, resulting in low stimulation efficiency.
To solve this problem, an integrated heat dissipation transcranial magnetic stimulator for continuous working is proposed in this paper. The stimulation coil is winded by hollow copper wire and the hollow part provides circulation channel for deionized cooling water. The cooling water source is provided by a small silent chiller. Low-temperature cooling water from the outlet takes away the Joule heat when running through the coil, then the heated cooling water returns to chiller to complete the cooling circulation. The stimulation system and the heat dissipation system are controlled by the same computer. Temperature and flow rate of the cooling water can be adjusted on-line by tracking the stimulation parameters through the control module to ensure that the temperature of stimulation coil is maintained at desired value.
Adaptive genetic algorithm is adopted to globally optimize the key parameters of the transcranial magnetic stimulator including coil turns, layers, hollow diameter as well as temperature and minimum flow velocity of cooling water. Optimal design of transcranial magnetic stimulator is obtained with minimum power loss and satisfies both medical needs and heat dissipation requirements. Finite element analysis is adopted to obtain three-dimensional spatial distribution of the intracranial induced electric field. Results show that compared to traditional magnetic stimulator without considering heat dissipation, this novel transcranial magnetic stimulator design can work continuously under the premise of guaranteeing the stimulation intensity and focalization.

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