Temperature field in the Magnetic Hyperthermia

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The mathematical modeling of the temperature field developed by the magnetic systems in the external alternating magnetic fields is essential in the Magnetic Hyperthermia. Optimization of the all parameters involved in the burning process of the malignant tissues can be realized more efficiently using an analytical model. Also the analytical models can be used for the validation of any numerical complex models of the heating processes.

This work focuses on the parameters which influences the therapeutic temperature field developed by the magnetic systems within the malignant tissues when the magnetic field is applied. An analytical model was developed to predict and control the bioheat transport within a malignant tissue. Infusion of a diluted suspension of magnetic nanoparticles (MNP) into liver tissue was modeled using the Darcy's equation. The MNP concentration and the temperature field were computed for different parameters as: i) ferrofluid infusion rates, ii) particle zeta potential and iii) magnetic field parameters. The convection-diffusion-deposition of the particles within tissues was considered in this analysis.

This study indicates the essential role of these parameters to predict accurately the hyperthermic temperature field. The ferrofluid injection with high infusion rate determines a high pressure gradient and consequently fast movements of the particles within tissues. As a result, the particles move on larger distances from the injection site. In this case, the temperature gradients become smaller. The analytical model presented in this paper predicts the optimum MNP dosage and the temperature at every point within the malignant tissue.

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