291y Energy Dissipation and Nanoparticle Transport in Magnetic Fluid Hyperthermia Treatment of a Spherical Cancer Tumor

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Simultaneous energy dissipation and nanoparticle transport in a spherical cancer tumor was modeled using Penne's bio-heat equation and an analogous mass conservation equation. Various cases were numerically investigated, using the finite element modeling program FEMLAB. Local heat generation was estimated using the energy dissipation model of Rosensweig and accounting for changes in the various physical and magnetic parameters with temperature. The effect of particle size, initial particle concentration, and magnetic field frequency and amplitude were studied parametrically. It was found that the magnetic field and the initial concentration were the parameters that most affected energy dissipation. Various case studies will be presented, illustrating the predictions of the model. For example for a tumor radius of 1 cm, subjected to a magnetic field with 13.2 kA/m peak amplitude and 520 kHz frequency, a core temperature of 45.9°C was achieved in 180 seconds with a particle volume fraction of 0.001. For an initial particle concentration of 5.18 mg/cm^3, perfusion into the blood stream after 180 seconds resulted in a loss of 0.7 mg of nanoparticles.