**MATERIALS AND METHODS**

**Governing Equations**

Maxwell’s Equation:
\[
\vec{B} = -\nabla \Phi
\]

Force Equation:
\[
\vec{F} = (\vec{B} \cdot \nabla) \vec{B}
\]

Brinkman’s Equation:
\[
\frac{\partial \vec{u}}{\partial t} + \nabla \cdot (\vec{u} \vec{u}) = -\nabla p + \nabla \cdot \left( \frac{1}{\rho} \nabla \Phi \right) - \nabla \cdot \left( \mu \frac{\partial \vec{u}}{\partial t} \right) + \vec{F}
\]

Convection and diffusion equation:
\[
\frac{\partial C}{\partial t} + \nabla \cdot (\vec{u} C) = \nabla \cdot \left( D \nabla C \right)
\]

**Method for Precipitating and Cleaning the Nanoparticles**

Our iron oxide nanoparticles are superparamagnetic in order to counteract agglomeration and were externally guided by Neodymium-Iron-Boron magnets. Movement and the resulting distribution of magnetically guided nanoparticles using external magnets were obtained in the COMSOL model and the results were verified with experimental brain phantom models. Ultimately, our outcomes demonstrate the capacity to treat neurodegenerative diseases and brain cancer by directing therapeutic agents to targeted areas in the brain, which presents an important breakthrough in the field of biomedical engineering and medicine.

**RESULTS**

**Method for Detecting Nanoparticles**

A 0.5% agarose gel brain phantom was placed in 6 petri dishes at 1/6 inch or 1/3 inch thickness. 200 microliters of 10 nm diameter Iron Oxide magnetic nanoparticles in distilled water were placed on top of gel. Half of the dishes were control and the other half had Neodymium-Iron-Boron magnets placed under them. These magnets have a pull force of 35 lbs and a diameter of 0.7 inces and a thickness of 0.5 inches. After 3 hours, the Prussian blue stain was applied and the agarose gel was cut in cross sections.

**CONCLUSION**

We have determined a simple, inexpensive and effective way of detecting nanoparticles in agarose gels using Prussian blue stain. Our nanoparticles are attracted by external magnets without CED. Our COMSOL model verifies our results. The next step would be to show CED with magnetic nanoparticles for increased speed and accuracy.

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