

443a Development of a Magnetic Separator for Sequestration of Magnetic Micro Spheres Designed for Ex-Vivo Blood Detoxification

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A magnetically-based detoxification system for human blood is being developed with immediate applications for the military. One of the key components of the proposed system is a portable magnetic filter that is capable of separating magnetic microspheres from arterial blood flow in an ex-vivo unit. Since the objective is to minimize the time the patient is connected to the filter, we need to develop a filter that is capable of quantitative separation in potentially high-flow regimes (up to 200 ml/min).

The idea is to puncture an artery with a dual lumen catheter, to facilitate passing the blood directly into a portable ex-vivo magnetic separator. The magnetic separator consists of an array of alternating and parallel biocompatible capillary tubing and magnetizable wires of identical radius. This array is exposed to an applied magnetic field created from two parallel block magnets, such that the magnetic field is perpendicular to both the wires and the fluid flow. The high magnetic field gradients created by the magnetized wires increases the collection of the magnetic microspheres contained in the blood.

A FEMLAB-based theoretical model was used to study the capture efficiency of this system. The following factors were considered: blood velocity (1 - 20 cm/s), magnetic field (0.2 - 1.0 T), wire size (0.125 - 2.0 mm in radius), specific magnetization of the wires (400 - 2000 kA/m), tubing wall thickness (0 - 0.2 mm), and tubing length (10 and 20 cm). Preliminary theoretical results show that more than 95% capture of 400 nm spheres (containing 60 wt% magnetite) is indeed achievable even at flow rates of 200 ml/min. During this presentation, the results from the complete parameter study will be given, along with some in vitro experiments that confirm the theoretical predictions.