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Computational Fluid Dynamics Simulation of a Quadrupole Magnetic Sorter Flow Channel

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Insulin independence can be achieved in type 1 diabetes by transplanting 10,000 IEQ/kg recipient weight of purified islets. Isolation of the pancreatic islets is the important step in preparing islets for the transplantation in type 1 diabetes patients. Quadrupole magnetic flow sorting (QMS), effective in the separation of suspensions of single cells, is being modified for isolation of pancreatic islets. The separating mechanism in QMS is created by the magnetic field strength and gradient induced by a modified Halbach quadrupole magnet assembly and applied to an annular channel of separands flowing through the magnet bore. Thus, islets are subjected to vertical parallel annular flows, horizontal magnetic force, vertical sedimentation and flow through inlet and outlet spreaders and splitters as well as through peristaltic pumps. The purity of the magnetically isolated particles in Quadrupole Magnetic Sorter is affected by the migration of nonmagnetic particles across transport lamina in the annulus flow channel. Computational fluid dynamics (CFD) models were used to simulate the islet separation in the flow channel and flow distributors in the QMS channel. Analyses of particle trajectories, splitter geometries and transport lamina were performed. The CFD results provided an adequate match with the experimental data. CFD simulations were employed to compare performance of various models of QMS flow channel with change in splitter position. Results of the simulations show that the modified design gives up to 10% less non specific crossover and this model can be used to optimize the flow channel design to achieve maximum purity of magnetic particles.