360g An Electric Circuit Model for Electrical Field Flow Fractionation

Joseph J. Biernacki, P. Manikya Mellacheruvu, and Satish M. Mahajan

In Electric Field Flow Fractionation (EFFF) an electrical potential is applied across a narrow gap filled with a weak electrolyte fluid. Charge buildup at the two poles (electrodes) and the formation of an electric double layer shields the channel making the effective field in the bulk fluid very weak. Recent computational research suggests that pulsed field protocols, however, should improve retention and may enhance separation in EFFF through systematic disruptions of the double layer which results in a stronger effective field in the bulk fluid. Improved retention has already been demonstrated experimentally. Accurate modeling and subsequent device optimization and design, however, depends, in part, on formulating a suitable model for the capacitative response of the channel and double layer at the electrode surfaces. Early models do not correctly describe experimentally observed current-time response and are not physically meaningful even when accurate mathematical fits of the data. A new model and conceptual framework based on electrical resistance and capacitance variations of the double layer and of the electrolyte has been established. Physical interpretations of the electrical response have been developed and compared to the published experimental datasets.