Electroosmotic flow (EOF) describes the induced fluid flow at the interface between a buffer solution and a charged surface upon application of an external potential. One of EOF’s main applications is in capillary electrophoresis, an analytical chemistry separation technique. For sample reproducibility, a mathematical model of EOF in a dynamic buffer system would be advantageous. Several models exist, but these models do not capture the observed trends in real-time data. We examine a series of data sets, and ultimately conclude that EOF as a function of time, $v(t)$, is most appropriately modeled by the biexponential function, $v(t) = Ae^{r_1t} + Be^{r_2t}$. We reach this conclusion after fitting both experimental and simulated biexponential data with a single exponential function and observing a series of residual plots with polynomial shape which ultimately we show to be indicative of the Taylor series expansion for the missing exponential term. (Received September 21, 2009)