Secondary flow effect on steady electrokinetic transports in a microchannel with low Dean numbers

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The electrokinetic flow in curved rectangular microchannels, which is frequently encountered in the lab-on-chips system, was explored by extending previous works relevant to the straight channel. Based on an explicit model coupled with Poisson-Boltzmann, Navier-Stokes, and the net charge conservation with Nernst-Planck principle, the numerical framework was developed by employing the finite volume scheme with SIMPLE (semi-implicit method for pressure-linked equations) algorithm. Attention is focused upon the geometry effect on the fluid velocity profile at the turn of charged rectangular channels ranging complementary aspect ratios (i.e., H/W = 0.2–5.0). An inward skewness was observed in the axial velocity profile with an attenuated secondary motion, because the spanwise pressure gradient overwhelms the inertial force according to a low Dean number. The skewed pattern becomes greater with increasing a degree of the channel curvature and decreasing the channel aspect ratio. As H/W gets lower, the greater distance traveled by the fluid along the outer wall further adds horizontally broadening of the profile.