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Unsteady Capillary Filling By Electrocapillarity[1] IN SEOK KANG, JUNG A LEE, Dept of Chem Eng, POSTECH, Pohang — Unsteady filling of electrolyte solution inside a nanochannel by the electrocapillarity effect is studied. The filling rate is predicted as a function of the bulk concentration of the electrolyte, the surface potential (or surface charge density), and the cross sectional shape of the channel. Since the driving force of the flow is the electrocapillarity, it is first analyzed by using the solution of the Poisson-Boltzmann equation. From the analysis, it is found that the results for many different cross sectional shapes can be unified with good accuracy if the hydraulic radius is adopted as the characteristic length scale of the problem. Especially in the case of constant surface potential, for both limits of $\kappa h \to 0 \text{and} \kappa h \to \infty$, it can be shown theoretically that the electrocapillarity is independent of the cross sectional shape if the hydraulic radius is the same. In order to analyze the geometric effects more systematically, we consider the regular N-polygons with the same hydraulic radius and the rectangles of different aspect ratios. Washburn's approach is then adopted to predict the filling rate of electrolyte solution inside a nanaochannel. It is found that the average filling velocity decreases as N increases in the case of regular N-polygons with the same hydraulic radius. This is because of that the regular N-polygons of the same hydraulic radius share the same inscribing circle. .

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In Seok Kang
Dept of Chem Eng, POSTECH, Pohang

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