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Transition from Hele-Shaw Flow to 2-D Creeping Flow JOHN CIMBALA, Penn State, MANOOCHEHR KOOCHESFAHANI, Michigan State — In the Hele-Shaw experimental technique, liquid flows at very low Reynolds number through the narrow gap b between parallel plates. When a body is inserted between the plates, and dye is introduced upstream, the streaklines appear nearly identical to streamlines of steady 2-D potential flow over a body of the same shape. For example, Hele-Shaw flow does not separate at sharp corners, just like potential flow. However, if the plates are very far apart (large b), the resulting creeping flow at the same low Reynolds number is observed to separate at sharp corners, unlike potential flow. Here, we investigate how the flow changes from Hele-Shaw flow (small b) to 2-D creeping flow (large b). Low Reynolds number CFD simulations of a fence of height s along a wall in a channel reveal that the transition from Hele-Shaw flow to 2-D creeping flow is not sudden, but rather quite gradual as channel gap width is increased. Separation bubbles appear at small b/s, and grow in size as b/s increases. The reattachment length reaches 1% of the 2-D value at $b/s \approx 0.21$, but it does not reach 99% of the 2-D value until $b/s \approx 150$. Furthermore, for all values of b/s for which separation and reattachment are observed, even for large b/s (> 100), the reattachment length of the separation bubble is non-uniform across the span; it starts high, dips to a minimum, and then slowly rises, reaching 99% of the center plane value beyond about $15s$ to $20s$ from the wall.

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