科氏力與表面應力對可互溶Hele-Shaw流場界面不穩定之數值分析

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摘 要

在Hele-Shaw 流場中，因離心力所產生的界面不穩定問題，由 於具旋轉塗覆技術(Spinning coating)的潛在應用價值而成為最近研 究的主題。此一流場界面穩定性具有兩種相反作用的機制：「黏性 驅使界面穩定的機制和離心力驅使界面不穩定的機制，此兩種相反 作用彼此之間的競爭決定了界面之間的穩定性。」而且其於旋轉效 應中，所產生的指狀化不穩定現象，與單純的徑向推斥所引發的指 狀化不穩定性現象，亦有許多方面的差異，主要歸因於：「在旋轉 效應中，可互溶流體間黏滯度的差異，會因擴散的效應，而隨著徑 向距離的增加而衰減，使得黏滯度對界面的穩定效應相對的減小， 然而不穩定的離心力，會因旋轉半徑增大而增強，此與徑向推斥其 不穩定性隨徑向距離增加而減弱不同」。本文利用高準確率的數值 方法，模擬旋轉Hele-Shaw 流場中，可互溶液滴與液環界面不穩定 性指狀化情形，其界面的不穩定性取決於五個主要的控制參數，即 旋轉強度、黏滯度比控制參數、表面應力係數、科氏力控制參數及 注入強度。液滴中心注入流體的強度，會導致界面的不穩定性成長 被迫延遲；在高的旋轉強度及低的黏滯係數下，液滴的指狀化情形 顯得較為活躍，且呈現較不穩定的現象；科氏力及表面應力將使界 面的不穩定趨於緩和。

關鍵詞 : 指狀化不穩定，旋轉Hele-Shaw 流場，科氏力，表面應力。

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