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Theory of nonwetting fluid snap-off in porous media under vibration

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Snap-off represents a fundamental occurrence within the complex dynamics of multiphase flow in porous materials. Understanding the quantitative aspects of phenomena triggered by seismic activity within these media is vital for engineering applications and predicting natural events, particularly concerning snap-off investigations. Exploring the influence of vibrations on snap-off through numerical simulations demands substantial computational resources. Consequently, there is an urgent necessity for a theoretical model to deeply comprehend snap-off under vibrational influence. We developed a theoretical model based on volume conservation principles, elucidating the dynamic instability at the wetting/non-wetting interface in sinusoidally constricted capillary tubes experiencing vibrations. Our analysis focused on correlating vibration amplitude and frequency with non-wetting phase snap-off occurrences. Furthermore, we examined how vibrations affected non-wetting droplets, verifying adherence to static snap-off criteria. Investigating various capillaries with differing pore throat/pore size ratios allowed us to gauge the impact of vibration on snap-off. This research significantly advances our comprehension of snap-off phenomena in multiphase porous media subjected to seismic conditions, bridging a crucial gap in vibration-influenced porous media studies.

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