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Fractal analysis of instability structures of a miscible ferrofluid droplet in a Hele–Shaw cell under a perpendicular magnetic field

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Several studies have demonstrated that the hydrodynamic interaction of two mixing fluids within a Hele–Shaw cell can lead to fractal growth [1]. Similarly, researchers have observed the formation of instability structures when they place a ferrofluid in a Hele–Shaw cell subjected to a perpendicular magnetic field [2]. In this work, we show that the instability structures arising from the application of a perpendicular magnetic field to a miscible ferrofluid droplet in a planar Hele–Shaw cell can be quantitatively characterized by their fractal dimension. We specifically examine the fractal dimension of the concentration isolines and demonstrate that this value increases with the magnitude of the applied magnetic field. The time dependence of the fractal dimension exhibits a characteristic maximum, which is attributed to the competition between magnetic forces and diffusion processes. Furthermore, the dependence of the fractal dimension on the thickness of the Hele–Shaw cell is investigated. The experimental results are compared with numerical simulations based on the finite-volume method, showing satisfactory agreement.

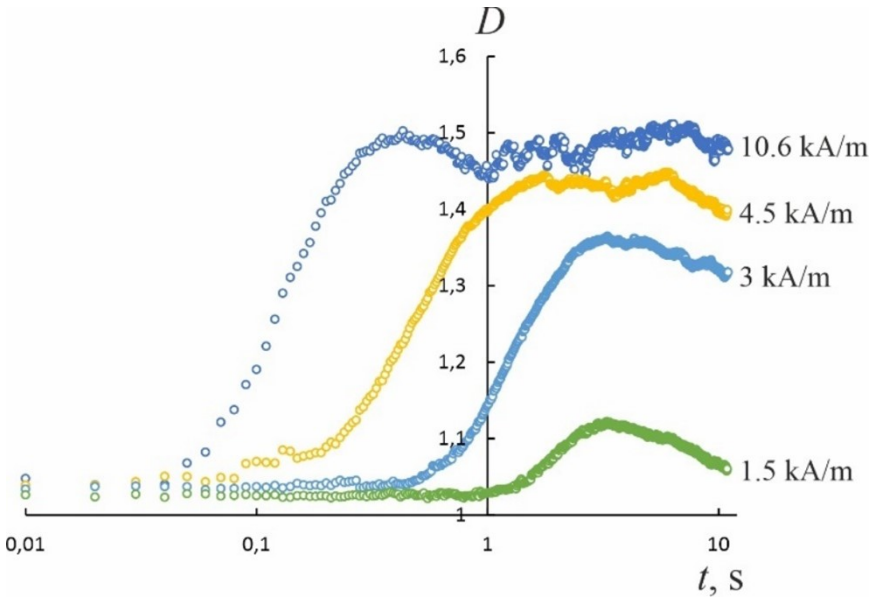

Figure 1: Dependence of the fractal dimension of instability structures on the duration of field action at various field strengths.

References

[1] J. Nittmann, G. Daccord, H.E. Stanley. When are viscous fingers fractal? In: *Fractals in Physics*. Elsevier, 1986, pp. 193–202.

[2] C.-Y. Wen, C.-Y. Chen, D.-C. Kuan, S.-Y. Wu. Experimental studies of labyrinthine instabilities of miscible ferrofluids in a Hele-Shaw cell. *Phys. Fluids.* 19, 084101 (2007).

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