Interaction of foams with a porous support [Poster]

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Interaction of foams with a porous support

Omid Arjmandi-Tash
Department of Chemical Engineering, Loughborough University, Loughborough, UK
o.arjmandi-tash@lboro.ac.uk

MOTIVATION

Foams are omnipresent in our everyday life. They are widely used in food, cosmetics, pharmacy etc [1,2]. For many applications, particularly in pharmacy and cosmetics, the interaction of foam with substrate is of great importance. This interaction can affect, for example, the kinetics of the release of acting substances from foam and therefore have to be taken into consideration when looking for optimal formulations. Often the surfaces where foam is applied are porous (skin, hair). To identify the methods to control the kinetics of liquid release in this case we performed direct numerical simulations of foam drainage in contact with a porous substrate.

REFERENCES:

MATHEMATICAL MODEL

Schematic diagram of a foam placed on a porous medium

\[ \frac{d\phi}{dt} = \frac{2Bo}{1+\alpha} \phi^2 - \sqrt{\phi \xi} \frac{\partial \phi}{\partial z} = 0 \]

\( \phi \) is the dimensionless liquid volume fraction, \( t \) is the dimensionless time, \( \xi \) is the dimensionless vertical co-ordinate, down directed with \( z=0 \) at the top of the foam. Bo and \( \alpha \) are two dimensionless parameters respectively expressed as a ratio of hydrostatic pressure in foam to capillary pressure in bubbles, and a ratio of capillary pressure in the porous substrate to capillary pressure in the bubbles [3].

SIMULATIONS RESULTS

Time evolution of liquid volume fraction over the foam height at \( \phi(z, 0) = 5\% \), \( \alpha = 10 \), and various Bond numbers: a) \( Bo=1.23 \), b) \( Bo=5.45 \) and c) \( Bo=9.81 \)

Time evolution of liquid volume fraction at foam/porous substrate interface at \( \alpha=10 \), \( \varepsilon =0.03 \), \( \phi(z, 0) = 5\% \) and various Bond numbers: a) \( Bo=5.45 \), b) \( Bo=5.45 \), c) \( Bo=5.45 \), d) \( Bo=5.45 \), and e) \( Bo=9.81 \)

CONCLUSIONS

- It was found that the kinetics of foam drainage depends on three dimensionless numbers (Bo, \( \alpha \), \( \varepsilon \)) and initial liquid volume fraction, \( \phi(z, 0) \), inside the foam.
- The result shows that there are three different regimes of the process:
  1. rapid imbibition: the liquid volume fraction inside the foam at foam/substrate interface remains constant near a critical liquid volume fraction.
  2. intermediate imbibition: the liquid volume fraction at the interface with porous substrate experiences a peak point and imbibition into the porous substrate is slower as compared with the drainage.
  3. slow imbibition: the liquid volume fraction at foam/substrate interface increases to a maximum limiting value, and a free liquid layer is formed between the foam and the porous substrate.
- The transition points between these three different drainage regimes were delineated by introducing two dimensionless numbers.

REFERENCES:

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