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Free drainage of aqueous foams stabilized by mixtures of a non-ionic (C_{12}DMPO) and an ionic (C_{12}TAB) surfactant

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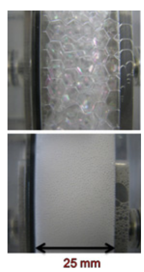
HIGHLIGHTS

- ▶ Influence of the composition of a surfactant mixture, the bubble size and the initial liquid fraction on free drainage.
- ▶ Immobile surfaces and thus Poiseuille-like flow under all experimental conditions.
- ▶ Drainage behavior is not correlated with respective foam stabilities.

GRAPHICAL ABSTRACT



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ABSTRACT

The study at hand investigates the influence of the composition of a surfactant mixture on the free drainage of the respective foams. The Foam Conductivity Apparatus (FCA) was used to study free drainage of foams of homogeneous initial liquid fraction $\varepsilon_{\text{init}}$. The foams were stabilized with mixtures of the non-ionic surfactant dodecyldimethyl phosphineoxide (C_{12}DMPO) and the cationic surfactant dodecyl trimethylammonium bromide (C_{12}TAB) at mixing ratios of C_{12}DMPO:C_{12}TAB = 1:0, 50:1, 1:1, 1:50 and 0:1. In all cases the liquid fraction ε follows a power law with respect to time t, *i.e.* $\varepsilon \sim t^{\eta}$ with $-1.0 < \eta < -0.8$. The η-values are all very similar which indicates a Poiseuille-like flow ($-1 < \eta < -2/3$) for all samples irrespective of changes in composition and bubble size. For all studied mixtures drainage led to fairly dry foams ($\varepsilon \sim 10^{-3}$), which then either coalesce (C_{12}DMPO and 50:1 mixture) or drain further (1:1 mixture). An evaluation of the critical liquid fraction $\varepsilon_{\text{crit}}$ (liquid fraction at which foam coalescence sets in abruptly) revealed that $\varepsilon_{\text{crit}}$ is independent of the foam height and the bubble size which is in line with literature. However, it depends on the composition of the surfactant mixture and decreases with increasing content of C_{12}TAB.

1. Introduction

In order to measure the drainage of aqueous foams one needs to determine the time evolution of the liquid fraction ε. The latter is typically calculated from the foam's conductivity. Although the conductivity of aqueous foams has been investigated in numerous experimental studies [1–6], conductivity measurements still need to be optimized [7,8]. Recently, Karapantsios et al. examined critical design aspects for measuring the liquid fraction ε in foams such as electrode size, shape, separation distance, intrusiveness, excitation current frequency and multiplexing of electrical conductance probes [7]. Theoretical considerations of how to calculate the liquid fraction ε from the conductivity of a foam has made significant strides. Lemlich developed the relationship between the foam conductivity and its liquid fraction ε for low liquid fractions ($\varepsilon \to 0$) through theoretical analysis [9]. For high liquid fractions ($\varepsilon \to 1$) Lemlich [10] suggests to use the Maxwell formula [11]. Recently, Feitosa et al. successfully used an empirical relationship based on a

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