Erratum: Effect of simple shear on liquid drainage within foams [Phys. Rev. E 73, 061408 (2006)]

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There is an error in section V.B. of this paper (Predicting the onset of the convective roll). Equation (36) is incorrect, since it represents the force gradient, rather than the strain. Assuming that a downward strain is positive, the correct equation can be derived by noting that the three forces acting on a volume of foam are a body force caused by the liquid content, an opposing pressure gradient and the shear stresses:

$$\frac{d\tau}{dx} = \frac{\Delta P}{l} - \rho g \varepsilon. \tag{1}$$

At low strains foams are elastic, meaning that a stationary foam can support a strain. The wall shear, though, does not display elastic behavior and can therefore not support a strain in a stationary foam. This means that the pressure gradient must support the weight of the foam (ε_{Ave} is the average liquid content):

$$\rho g \varepsilon_{Ave} = \frac{\Delta P}{l}. \tag{2}$$

If we assume that there is a linear fluctuation in the liquid content in the column (assuming $x=0$ is the midpoint):

$$\varepsilon = \varepsilon_{Ave} + \frac{d\varepsilon}{dx}x, \tag{3}$$

combining Eq. (1)–(3):

$$\frac{d\tau}{dx} = -\rho g \frac{d\varepsilon}{dx}x. \tag{4}$$

If the width of the column is d_C and assuming that there is no stress at the walls (at $|x|=\frac{d_C}{2}$, $\tau=0$) and noting that the liquid content gradient is a constant:

$$\tau = \frac{\rho g}{2}\frac{d\varepsilon}{dx}\left(\frac{d_C{}^2}{4} - x^2\right). \tag{5}$$

If we wish to find out if the disturbance is resulting in liquid being transferred from one half of the column to the other, by means of the shear induced anisotropy, and thus increasing the disturbance, we need to consider the shear stress at the midpoint of the column:

$$\tau_{mid} = \frac{\rho g}{8}\frac{d\varepsilon}{dx}d_C{}^2. \tag{6}$$

Using the above equation instead of Eq. (36) and following the same steps as in the original derivation results in the following equation for prediction of the onset of the convective roll (replacing Eq. (42) in the original paper):

$$\varepsilon_C = 4\left(k_g{}^2 k_\lambda\left(\sqrt{3} - \frac{\pi}{2}\right)\right)^{1/3}\left(\frac{\sigma}{\rho g d_C}\right)^{4/3}\left(\frac{\varepsilon_R - \varepsilon_C}{\varepsilon_R}\right)^{2\beta/3} r_b^{-4/3} \tag{7}$$

The equations are very similar, except that there is now a prefactor of 4 and a column diameter dependence. This means that, while the shape of the relationship shown in Fig. 10 will be similar, the actual numerical values will change. Using the published tube diameter of 2 cm from the work of Weaire *et al.* (Ref. [15] in the original paper), the shape of the curve can be recalculated (Fig. 10).

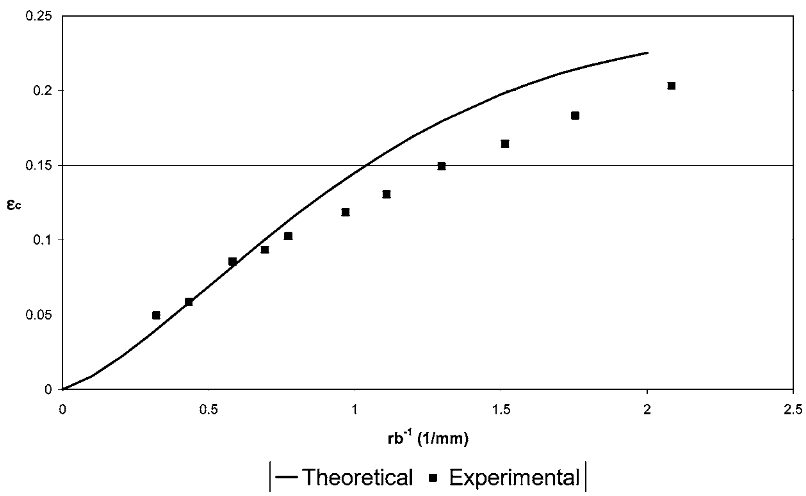

FIG. 10. The critical liquid fraction for the onset of the convective roll as a function of the inverse of the bubble size as predicted from Eq. (7) (using a surface tension of 0.02 N/m) and the experimental values (from Weaire *et al.* [15])

Very good agreement between the experimental and theoretical values can be obtained using a surface tension of 0.02 N/m. The surface tension is not reported for the experimental work of Weaire *et al.*, but a value of 0.02 N/m is well within the expected range for the surfactant system used.

There is a further typographical error in the text. The exponent on the liquid content in Eq. (39) has been omitted, and it should be:

$$F_g \approx \frac{\rho g}{3C_{PB}\mu}\frac{\varepsilon^2}{\lambda}. \tag{8}$$

I would like to thank Simon Cox for supplying me with the original experimental data for the onset of the convective roll.