NE-577
Homework #8

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Problem 8.4

group 1: $\bar{D} = 1\times10^{-3}m$, $\alpha = 0.03$
group 2: $\bar{D} = 1.5\times10^{-3}m$, $\alpha = 0.01$
group 3: $\bar{D} = 2.0\times10^{-3}m$, $\alpha = 0.01$

Part (a)

for continuous liquid $\nu_{cl} = 1.05\times10^{-6} \frac{m^2}{s}$
and $\nu_{2\phi} = 0.6 D_{dr} \alpha_{dr} |v_r|$
now normalizing: $\nu_{2\phi}$ i.e $\nu_{2\phi}/\nu_{cl}$

$$\left(\frac{\nu_{2\phi}}{\nu_{cl}}\right)_1 = \frac{0.6\times(1\times10^{-3})\times0.03\,|v_r|}{1.05\times10^{-6}} = \frac{120}{7}|v_r| = 17.143|v_r|$$

$$\left(\frac{\nu_{2\phi}}{\nu_{cl}}\right)_2 = \frac{0.6\times(1.5\times10^{-3})\times0.01|v_r|}{1.05\times10^{-6}} = \frac{60}{7}|v_r| = 8.571|v_r|$$

$$\left(\frac{\nu_{2\phi}}{\nu_{cl}}\right)_3 = \frac{0.6\times(2.0\times10^{-3})\times0.01|v_r|}{1.05\times10^{-6}} = \frac{80}{7}|v_r| = 11.439|v_r|$$

$$\sum_{n=1}^{3}\left(\frac{\nu_{2\phi}}{\nu_{cl}}\right)_n = \frac{260}{7}|v_r| = 37.143|v_r|$$

contribution from each grap will be
group1: $(120/7)/(260/7) = 46.15\%$
group 2: $(60/7)/(260/7) = 23.08\%$
group 3: $(80/7)/(260/7) = 30.77\%$

Part (b)

single group containing bubbles from group 1, group 2 and group 3. with $\alpha = 0.04$

estimating equivalent bubble diameter

$$\bar{D}_{eq} = \frac{(\alpha_1 \bar{D}_1) + (\alpha_2 \bar{D}_2) + (\alpha_3 \bar{D}_3)}{\Sigma \alpha}$$

$$\bar{D}_{eq} = \frac{(1\times10^{-3})(0.03) + (1.5\times10^{-3})(0.01) + (2\times10^{-3})(0.01)}{0.03 + 0.01 + 0.01}$$

$$\bar{D}_{eq} = 1.3\times10^{-3}\,m$$

$$\left(\frac{v_{2\phi}}{v_a}\right)_{eq} = \frac{0.6 \times (1.3\times10^{-3}) \times 0.04 |v_r|}{1.05\times10^{-6}} = \frac{208}{7}|v_r| = 2$$

$\left(\frac{v_{2\phi}}{v_a}\right)_{eq}$ is different. this is because summation of void fraction of group 1, group 2 and group 3 in part (a) is not equal to void fraction of single group in part (b).

therefore $\frac{v_{2\phi}}{v_a}$ may be different depending on weightage factors.