PhD in Energy and Mineral Engineering at PSU

Nicolás's Research - Reports

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Considerations

Goal: Test the pseudopotential approach for partially misc. mixtures, under the action of a second force.

Idea: test different flow regimes based on Reynolds and Bond (Eotvos) numbers, and capture particular bubble shapes, as found by Flit R, Grace JR, Weber M. *Bubbles, drops, and particles.* New York: Academic Press; 1978.

$$R_e = \frac{\rho_l u_b d_b}{\mu_l} = \frac{u_b d_b}{\nu_l}$$

$$B_o = \frac{g \Delta\rho d_b^2}{\sigma}$$

A thermodynamic state fixes $\rho, \Delta\rho, \sigma$. Redifining R_e:

$$Re = \frac{d_b \sqrt{g d_b}}{\nu_l} = \frac{\sqrt{g d_b^3}}{\nu_l}$$

We can sweep the spectrum by fixing g (fixes B_o), and moving ν_l (fixes R_e), as:

$$\nu_l = c_s^2 (\tau_l - \frac{\Delta t}{2})$$

$$g = \frac{B_o \sigma}{\Delta\rho d_b^2}$$

$$\nu_l = \frac{\sqrt{g d_b^3}}{R_e}$$

$$\tau_l = \frac{\nu_l}{c_s^2} + \frac{\Delta t}{2}$$

Initial setup

Domain: (!) 300x300 mesh (2D)
Fluid: Water at 485.33 K ($T_r = 0.75$), and $P_r = 0.092$.
$\rho_l^0 = 7.679$ (), $\rho_v^0 = 0.109$. $\rho_r = 70.45$.
Initial condition: Spherical droplet with $d_o = 30$, and $w_o = 8$.

Boundary conditions: The top and bottom boundaries are PERIODIC. On the left and right boundaries a no-slip condition is imposed. At the corners, where there is a PDF that may belong to two boundaries, the enumeration and assignation of conditions is as follows:

- Corner 1 (SW): No-slip (Left)
- Corner 2 (NW): No-slip (Left)
- Corner 3 (SE): No-slip (Right)
- Corner 4 (NE): No-slip (Right)

Parameters: Shan-Chen G=-1.0.
Beta = 0.2076
Time = 100000

Single static simulation:
$\Delta\rho = 7.59285$, $d_s = 29.45$,
$\Delta P = 0.00378$ ($P_l < 0$).
$\sigma = 0.1112$.

Initial setup 2 (Amaya)

Domain: (!) 160x400 mesh (2D)
Fluid: Water at 485.33 K ($T_r = 0.75$), and $P_r = 0.092$.
$\rho_l^0 = 7.679$ (), $\rho_v^0 = 0.109$. $\rho_L/\rho_g = 70$.
$\tau_l = 210.5$. $\tau_g = 0.8$. μ_l/μ_g =10.
Initial condition: Spherical droplet with $d_o = 40$, and $w_o = 8$.

Boundary conditions: Periodic on all boundaries (for static), walls on all boundaries (for dynamic). At the corners, where there is a PDF that may belong to two boundaries, the enumeration and assignation of conditions is as follows:

- Corner 1 (SW): No-slip (Left)
- Corner 2 (NW): No-slip (Left)
- Corner 3 (SE): No-slip (Right)
- Corner 4 (NE): No-slip (Right)

Parameters: Shan-Chen G=-1.0.
Beta = 0.2076
Time = 100000

Single static simulation:
$\Delta\rho = 7.2$ (7.7-0.5), $d_s = 40.0$,
ΔP = 8.5e-3 - 5.87e-3 = 2.623e-3
$\sigma = \Delta P \cdot r = 0.05254$. B_o =10. Then, $g = \frac{\sigma B_o}{\Delta\rho d^2}$ = 4.5e-5. $\mu_l = 0.85$, $\nu_l = 0.1105$. $\tau_l = 0.83$.

Spherical regime

First case (150 x 300)

- $g = |\mathbf{g}|$ = -1e-6. $B_o = 0.0592$. $\tau_l = 2.0$, $\nu = 0.5$. $u_b = 0.0121$.
- $R_e^{\text{org}} = 0.713$. $R_e^{\text{mod}} = 0.320$.
- This is spherical regime, and far away from the other regimes according to the Grace's plot.

Ellipsoidal case

Ellipsoid case (150 x 300)

- $g = |\mathbf{g}|$ = -1e-5. $B_o = 0.592$. $\tau_l = 0.51$, $\nu = 0.0033$. $u_b \approx = 0.35$.
- $R_e^{\text{org}} = 3092$. $R_e^{\text{mod}} = 151.61$
- This simulation is approaching to the Mach velocity limit and a perturbation is moving the bubble from the axis. I decided to open the channel more to avoid the interaction with the wall. I have reasons to believe that the movement beyond the axis is due to whom the corner was assigned to (number of boundary).

Ellipsoid case (300 x 300)

- $g = |\mathbf{g}|$ = -1e-5. $B_o = 0.592$. $\tau_l = 0.51$, $\nu = 0.0033$. $u_b \approx = 0.35$.
- $R_e^{\text{org}} = 3092$. $R_e^{\text{mod}} = 151.61$
- The ellipse shape of the bubble was better seen in this case, although eventually it moves away from the center. For the most part of the simulation, the ellipsoid maintains, although it is important to understand if the viscosity of the gas phase plays any role in the deformation ("plasticity" of the bubble).
- Apr 15/22. The ellipse is not moving anymore from the center.

Dimples

Dimples case (300 x 300)

- $g = |\mathbf{g}|$ = -2e-3. $B_o = 118$ $\tau_l = 0.72$, $\nu = 0.07348$. $u_b \approx = .$
- $R_e^{\text{org}} = .$ $R_e^{\text{mod}} = 100$
- The gravity value is too high and the method is diverging too soon. Not even with G = -0.1 or g = 1e-4.

Dimples case (3000 x 3000)

- $d_o = 300$. $g = |\mathbf{g}|$ = -1e-5. $B_o = 61$. $\tau_l = 0.993$, $\nu = 0.164$ $u_b \approx = .$
- $R_e^{\text{org}} = .$ $R_e^{\text{mod}} = 100$
- Did not run

Dimples case (3000 x 3000)

- $d_o = 300$. $g = |\mathbf{g}|$ = -1e-5. $B_o = 61$. $\tau_l = 5.43$, $\nu = 1.64$ $u_b \approx = .$
- $R_e^{\text{org}} = .$ $R_e^{\text{mod}} = 10$
- Did not run

Discussion

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Main discussion points:

- Topic 1
- Topic 2

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the text will be partially visible

In this slide
the text will be partially visible
And finally everything will be there

Sample frame title

In this slide, some important text will be highlighted because it's important. Please, don't abuse it.

Remark

Sample text

Important theorem

Sample text in red box

Examples

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Two-column slide

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$$E = mc^2$$

- First item
- Second item

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