Usage Report for Fiscal Year 2023

Project Title:

Multiscale modeling of ultrasonic-controlled drug delivery system processing

Name:

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1. Background and purpose of the project, relationship of the project with other projects

We consider an oscillatory spherical bubble travelling in a shear-thinning power-law fluid and investigate the effects of the oscillatory frequency on the fluid behaviors induced by the oscillatory spherical bubble. Our results shed light on the dynamics of bubbles in shear-thinning fluid with the occurrence of ultrasonic irradiation.

2. Specific usage status of the system and calculation method

(1) Specific usage status of the system

Numerical simulations of the shear-thinning fluid flow induced by an oscillatory spherical bubble

(2) Calculation method

The numerical simulation predicts the fluid behaviors of the flow induced by a translational oscillatory spherical bubble, and the viscosity of the fluid is constrained by the power-law model. To exactly impose the boundary condition and to exactly evaluate the fluid force acting on the bubble, the governing equations are described by a spherical coordinate system and discretized in a finite-difference scheme. Thread parallelization (OpenMP) is applied to all the loop operations over the entire grid points in the code.

3. Results

For the strong shear-thinning fluid, the results predicted by the quasi-steady state model show excellent agreement with the numerical results over a wide range of oscillation amplitude and angular frequency.

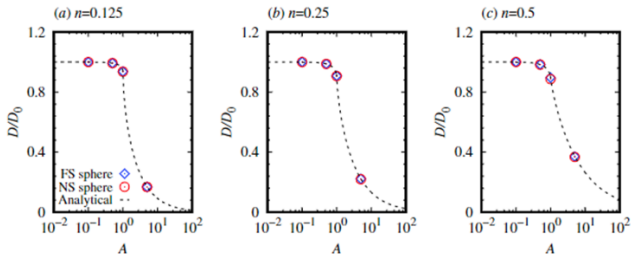

Figure1 The time-averaged scaled drag force

4. Conclusion

The quasi-steady state model can precisely capture the scaled drag force.

5. Schedule and prospect for the future

We have finished this project, and do not have plan for the future.

Fiscal Year 2023 List of Publications Resulting from the Use of the supercomputer

[Conference Proceedings]

Zhang, X., Sugiyama, K. and Watamura, T., The drag force on an oscillatory spherical bubble in power-law shear-thinning fluid, Proc. of International Conference on Multiphase Flow 2023 (ICMF2023), No. 90 (2023.4).

[Oral presentation]

杉山和靖，Zhang, X.，渡村友昭，擬塑性流体中における振動球の抵抗低減に対する周波数の影響，日本流体力学会年会 2023，東京農工大学, (2023.9).

[Others (Book, Press release, etc.)]

Zhang, X. On the flow behaviors induced by an oscillating sphere travelling in power-law shear-thinning fluid, Ph.D thesis, Osaka University, (2023.9)