DNS Study on Mass Transfer at Fluidic Interfaces in Bubble Induced Turbulence

Bubbly flow is a kind of dispersed two-phase flow in which a gas and a liquid phase make contact with each other to generate free interfaces. Turbulence induced by the interaction of bubbles in a swarm and the surrounding liquid is an important phenomenon in industry, since turbulence might affect the mass transfer considerably. However, prediction of turbulent bubbly flows and mass transfer is extremely difficult, due to the vast ratio between the container size and a typical bubble size. Modeling the behaviors of bubbles with respect to their drag and mass transfer coefficient in a dispersed multiphase flow is still a practical way to meet the requirements of industry. However, most traditional correlation equations were proposed for the mean quantities, leading to uncertainties when they are applied to transient computational fluid dynamics (CFD) simulations. The objective of the research is to propose a more accurate and efficient macroscopic model for predicting bubbly flows and mass transfer in engineering applications. In the proposed project, as the first step, it is planned to propose novel correlations for calculating the drag force and transient mass transfer rate under the condition of bubble induced turbulence. Different from traditional correlations, the proposed correlation equations should be a function of transient quantities, including the bubble velocity, shape and rotation angle. The behaviors of bubbles are expected to be more precisely described by the new correlation equations. For this purpose, the influence of turbulent structures on the interfacial mass transfer of bubbles will be studied by using direct numerical simulation (DNS) with high spatial and temporal resolution. The accuracy of the new correlation equations should be assessed by experimental data for more realistic bubbly flows. Experimental and DNS data-base for validating models of bubbly flows and interfacial mass transfer will be established.