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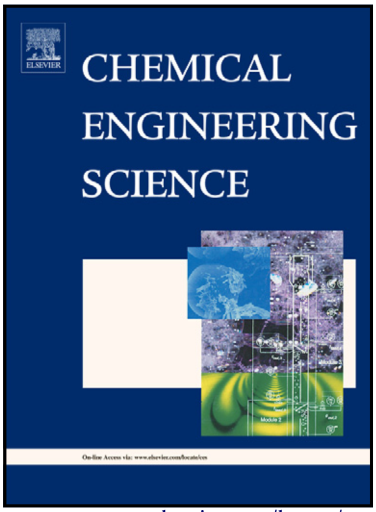

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Viscoelastic fluid behaviors around a rising bubble via a new method of mesh deformation tracking

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Abstract

The deformation of a hydrogen microbubble line and/or mesh in a viscoelastic fluid around a rising bubble was tracked from the original static position in order to discuss the mechanism of the typical phenomena such as the negative wake or the cusp shape. This new experimental method is essentially important because of the hysteresis-dependent nature of the viscoelastic fluid. This new method makes this study distinctive from a number of conventional studies of viscoelastic fluids focusing on the non-Newtonian properties and/or the instantaneous flow field. According to our experimental results, the flow mechanism responsible for the negative wake or cusp shape was attributed to the accumulation and release of the shear strain energy. Some residual displacements were observed after the bubble rising, which were almost completely reproduced as the internal dissipations in a Maxwell model modified with a non-linear spring.

Keywords: Viscoelastic fluid, Rising bubble, Tracking, Negative wake

1. Introduction

Behaviors of viscoelastic fluids of polymer solutions play important roles in chemical engineering. They can also be applied as functional fluids distinguished by not only the effect of significant drag reduction on the turbulent flows called "Toms effect" (Toms, 1949), but also the temporary accumulation and release of the strain energy. However, there seems to be few studies related the viscoelastic multiphase flow. Therefore, as a starting point for the research of the viscoelastic gas-liquid two-phase flow, a viscoelastic fluid behavior around a rising bubble was studied.

It is well known that there are typical phenomena such as a "negative wake" whose flow direction is opposite from the usual wake and a cusp shape forms at the bottom of a rising bubble in a non-Newtonian fluid (Astarita, 1965; Hassager, 1979). Non-Newtonian properties such as a shear-thinning are common

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