

TRANSPORT PHENOMENA & FLUID MECHANICS

前进搅拌槽内流动非轴对称性的数值模拟

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**摘要** The aim of this work is to investigate the flow instabilities in a baffled, stirred tank generated by a single Rushton turbine by means of large eddy simulation (LES). The sliding mesh method was used for the coupling between the rotating and the stationary frame of references. The calculations were carried out on the "Shingao-21C" supercomputer using a computational fluid dynamics (CFD) code CFDS. The flow fields predicted by the LES simulation and the simulation using standard k- $\epsilon$  model were compared to the results from particle image velocimetry (PIV) measurements. It is shown that the CFD simulations using the LES approach and the standard k- $\epsilon$  model agree well with the PIV measurements. Fluctuations of the radial and axial velocity are predicted at different frequencies by the LES simulation. Velocity fluctuations of high frequencies are seen in the impeller region, while low frequencies velocity fluctuations are observed in the bulk flow. A low frequency velocity fluctuation with a nondimensional frequency of 0.027Hz is predicted by the LES simulation, which agrees with experimental investigations in the literature. Flow circulation patterns predicted by the LES simulation are asymmetric, stochastic and complex, spanning a large portion of the tank and varying with time, while circulation patterns calculated by the simulation using the standard k- $\epsilon$  model are symmetric. The results of the present work give better understanding to the flow instabilities in the mechanically agitated tank. However, further analysis of the LES calculated velocity spectra by means of fast Fourier transform (FFT) and/or spectra analysis are recommended in future work in order to gain more knowledge of the complicated flow phenomena.

**关键词** stirred tank, flow instabilities, computational fluid dynamics, large eddy simulation, k- $\epsilon$  model, particle image velocimetry

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Large eddy simulation of flow instability in a stirred tank generated by a Rushton turbine

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**Abstract** The aim of the work is to investigate the flow instabilities in a baffled, stirred tank generated by a single Rushton turbine by means of large eddy simulation (LES). The sliding mesh method was used for the coupling between the rotating and the stationary frame of references. The calculations were carried out on the "Shingao-21C" supercomputer using a computational fluid dynamics (CFD) code CFDS. The flow fields predicted by the LES simulation and the simulation using standard k- $\epsilon$  model were compared to the results from particle image velocimetry (PIV) measurements. It is shown that the CFD simulations using the LES approach and the standard k- $\epsilon$  model agree well with the PIV measurements. Fluctuations of the radial and axial velocity are predicted at different frequencies by the LES simulation. Velocity fluctuations of high frequencies are seen in the impeller region, while low frequencies velocity fluctuations are observed in the bulk flow. A low frequency velocity fluctuation with a nondimensional frequency of 0.027Hz is predicted by the LES simulation, which agrees with experimental investigations in the literature. Flow circulation patterns predicted by the LES simulation are asymmetric, stochastic and complex, spanning a large portion of the tank and varying with time, while circulation patterns calculated by the simulation using the standard k- $\epsilon$  model are symmetric. The results of the present work give better understanding to the flow instabilities in the mechanically agitated tank. However, further analysis of the LES calculated velocity spectra by means of fast Fourier transform (FFT) and/or spectra analysis are recommended in future work in order to gain more knowledge of the complicated flow phenomena.

**Key words** stirred tank, flow instabilities, computational fluid dynamics, large eddy simulation, k- $\epsilon$  model, particle image velocimetry

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