２０２３年　８月　４日

学　位　論　文　の　要　旨

Time-resolved Dynamics of Horizontal Particle-laden Jets

（粒子を含む水平噴流の時間分解ダイナミクス）

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The dynamics of particle-laden jet is a challenging issue, and it is important to both jet-related industry applications and understanding the transmission of virus through violent expiratory events. The turbulence, being strongly interacted with and modulated by the collective motion of particles over a wide range of time and length scales, composes the major difficulties of the issue. Therefore, this thesis combines both experimental and simulation methods to analyze the dynamics of a horizontal jet flow system with three typical particles, with particular emphasis on the jet velocity field, jet dispersion process, drag model, particle volume fraction model, etc. The main contents and results are as follows:

1. To better understand the dynamics of the particle-laden jet at the particle level, we construct a hybrid 3D-PTV & PIV platform, thereon develop a real tracking-precede-reconstruction, time-resolved, 3D particle flow field reconstruction method.

2. For the high-Stokes-number particle-laden jet with large particles, a new drag model is obtained based on the hybrid measurement of 3D-PTV and PIV. A simple particle volume fraction model is also developed based on the self-similarity theory of

the jet, showing good agreement with the experimental data.

3. The dynamics of low- and middle- Stokes-number particle-laden jets are investigated with PIV. The experimental data provide the basis for the verification of the new drag model and volume fraction model.

4. Both the high- and middle- Stokes-number particle-laden jets are simulated using the CFD-DPM method. The effects of different drag models on jet velocity and the sensitivity to the Re is revealed. The results indicate that the new drag model more accurately predicts the velocity of particle-laden jets.

In summary, the dynamics of three typical particles are studied. A new drag model is established and verified, bridging the gap on the drag modeling in the field of particle-laden jets.