Abstract:
Fine numerical simulation is one of the important branches in the field of numerical simulation of fluid machinery. The research studies the high-precision and high efficiency meshless schemes with certain functions, and proposed a fully Lagrangrian particle method for unsteady complex flows as nonhomogeneous flow.
Several new algorithms with high precision are designed. The fast and accurate modeling technique for arbitrary geometry shape is developed as a practical preprocessing tool of the simulation to discretize geometric models into particles. The multi-resolution model with variable size particle is proposed to increase the local resolution of the computational domain to save computation costs for integrally discretization and integrally solving of fluid machinery problems. Furthermore, the wall model in the particle method is improved by eliminating the roughness phenomenon, and a generic smoothed wall model is proposed. The computational efficiency of the particle method is substantially upgraded with higher precision by designing new numerical schemes.
The proposed method is used in several industrial applications. A large-scale jetting spray case is simulated by the proposed Lagrangrian method, and the simulation accurately reproduces the droplet spraying phenomenon after the jet collision and well predicts the spraying behaviors compared with experimental results. To better show the small droplet, variable size particle method is applied to increase the resolution adaptively by splitting large size particle into small size particles. What's more, the mechanism of liquid dispersion is systematically investigated by the case of a liquid passing through a mesh packing. The hydrophilicity of the mesh packing would have different effects on the formation of the free surface, which is the key to the mechanism of the liquid dispersion process. The flow in the pintle injector of aerospace engine with the cold state is calculated and analyzed. The results show good agreement with experimental results. The distribution of droplet size with different inlet velocities is investigated to show the mechanism of atomization.
A software base on proposed Lagrangrian particle method is developed to simulate the complex inner flow of fluid machinery and jetting flow in aerospace. A new fine numerical method is studied and the mechanism of new phenomenon is investigated, which are theoretically support the structure optimization and economic efficiency improving of turbopump system.