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RESEARCH PAPERS

气-雾超音速两相流过渡段内速度滑移和相间动量传递

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摘要　Modelling and simulations are conducted on velocity slip and interfacial momentum transfer
for super-sonic two-phase (gas-droplet) flow in the transient section inside and outside a Laval jet(L J). The initial velocity slipbetween gas and droplets causes an interfacial momentum transfer flux as high as (2.0-5.0) × 104 Pa. The relaxationtime corresponding to this transient process is in the range of 0.015-0.090 ms for the two-phase flow formed insidethe LJ and less than 0.5 ms outside the LJ. It demonstrates the unique performance of this system for application tofast chemical reactions using electrically active media with a lifetime in the order of 1 ms. Through the simulationsof the transient processes with initial Mach number Mg from 2.783 to 4.194 at different axial positions inside theLJ. it is found that Mg has the strongest effect on the process. The momentum flux increases as the Mach numberdecreases. Due to compression by the shock wave at the end of the L J, the flow

pattern becomes two dimensionaland viscous outside the LJ. Laser Doppler velocimeter (LDV) measurements of droplet velocities outside the LJ arein reasonably good agreement with the results of the simulation.

关键词　supersonic gas-droplet two-phase flow　interfacial momentum transfer　velocity slip

relaxation time　numerical simulation　laser Doppler velocimeter measurement

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Velocity Slip and Interfacial Momentum Transfer in the Transient Section of Supersonic Gas -Droplet Two-Phase Flows

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Abstract Modelling and simulations are conducted on velocity slip and interfacial momentum transfer for super-sonic two-phase (gas-droplet) flow in the transient section inside and outside a Laval jet(L J). The initial velocity slipbetween gas and droplets causes an interfacial momentum transfer flux as high as (2.0-5.0) × 104 Pa. The relaxationtime corresponding to this transient process is in the range of 0.015-0.090 ms for the two-phase flow formed insidethe LJ and less than 0.5 ms outside the LJ. It demonstrates the unique performance of this system for application tofast chemical reactions using electrically active media with a lifetime in the order of 1 ms. Through the simulationsof the transient processes with initial Mach number Mg from 2.783 to 4.194 at different axial positions inside theLJ. it is found that Mg has the strongest effect on the process. The momentum flux increases as the Mach numberdecreases. Due to compression by the shock wave at the end of the L J, the flow pattern becomes two dimensionaland viscous outside the LJ. Laser Doppler velocimeter (LDV) measurements of droplet velocities outside the LJ arein reasonably good agreement with the results of the simulation.

Key words supersonic gas-droplet two-phase flow; interfacial momentum transfer; velocity slip; relaxation time; numerical simulation; laser Doppler velocimeter measurement

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