Contribution ID: **401** Type: **Regular Oral (15m)**

Tracing characteristic evaluation of Spontaneously-Condensed Nitrogen Droplets in Cryogenic Wind Tunnels

Tuesday 23 July 2024 16:30 (15 minutes)

Cryogenic wind tunnels (CWT) provide a means to perform high Reynolds number aerodynamic tests in a cryogenic environment and simulate hypersonic flights. Non-invasive measurement technology is an advanced measurement techniques applicable to CWT. However, the utilization of non-invasive measurement technology in CWT encounters significant challenges due to the absence of appropriate tracer particles. The present study evaluates the possibility of utilizing spontaneous condensing nitrogen droplets as tracer particles in CWT. Visualization experiments of non-equilibrium condensation was conducted to study the formation and distribution mechanism of liquid nitrogen droplets within high-speed airflow. The research revealed that the spontaneous condensing nitrogen droplets results in particle sizes at the micron and sub-micron levels, with a uniform distribution of droplets. Moreover, nitrogen droplets meet the essential criteria to serve as tracer particles of cryogenic flow with controllable condensation process. Accordingly, Euler-Lagrange model was built for the tracing evaluation of LN2 droplets in transonic flow around an airfoil. The results demonstrated that small-sized nitrogen droplets could satisfactorily follow the varying gas flow near the airfoil even with large angles of attack. However, nitrogen droplets experience increased dynamic pressure in high-speed flow fields, leading to greater trajectory deviation. Furthermore, evaluation metrics such as trajectory deviation, velocity matching, response time, and nitrogen droplet dispersion were identified. Subsequently, an evaluation model for the tracer capability of nitrogen droplets was proposed based on the multiple regression analysis for unveiling the interplay between the chosen metrics and the tracing efficiency. This research would provide theoretical support for advancing non-invasive measurement technologies used in CWT.

Submitters Country

China

Authors: HOU, Jiaxin (Huazhong University of Science and Technology); Prof. XIE, Junlong (Huazhong University of Science and Technology)

Co-author: Dr CHEN, Jianye (Huazhong University of Science and Technology)

Presenter: HOU, Jiaxin (Huazhong University of Science and Technology)

Session Classification: Tue-Or6

Track Classification: Tracks ICEC 29 Geneva 2024: ICEC 05: Cryogenic applications: aerospace