Flow velocity measurement in a critical flow nozzle using a small thermometer and advancement of gas flow standard

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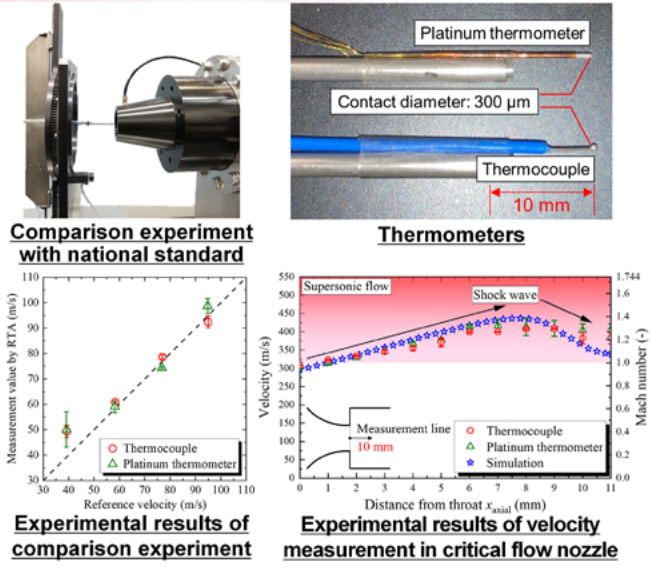
In Japanese gas flow standards, critical flow nozzles, which can generate stable flow rates by providing differential pressure, are commonly used as transfer standards to ensure traceability. Although improvements are being made to promote the use of critical flow nozzles in ISO 9300, there are still issues to be addressed regarding the design of a reasonable shape due to the difficulty of measuring flow velocity in the nozzle.

In this study, we worked on the development of a method for measuring flow velocity using small thermometers (RTA, Recovery Temperature Anemometry). First, experiments were conducted to evaluate RTA based on a national standard for flow velocity, and it was confirmed that the difference between RTA and the velocity standard was within 5 % in the flow velocity range of 60 m/s to 95 m/s. Furthermore, as a result of measuring the flow velocity inside the critical flow nozzle using RTA, the supersonic flow inside the nozzle measured by RTA was in good agreement with the numerical simulation results.



Measurement of flow velocity in a critical nozzle using a small thermometer.

It is noteworthy that low-disturbance and high-spatial-resolution velocity measurements over a wide velocity range were achieved with existing inexpensive small thermometers. In addition, since the measurement principle of RTA is based on a physical model, it is of great social significance in that RTA requires little calibration effort and is easy to use. By understanding the detailed flow field inside the critical flow nozzle and designing a reasonable geometry, it will be possible to generate stable flow at a smaller differential pressure. In other words, large-scale flow facilities can be more efficient and compact, contributing to the supply of sustainable flow standards.

Reference: N.Takegawa et al., Scientific Reports, **11**, 23778, 2021, DOI: 10.1038/s41598-021-02877-w