

Study of Thermal-Fluid Analysis of Pitot-tube

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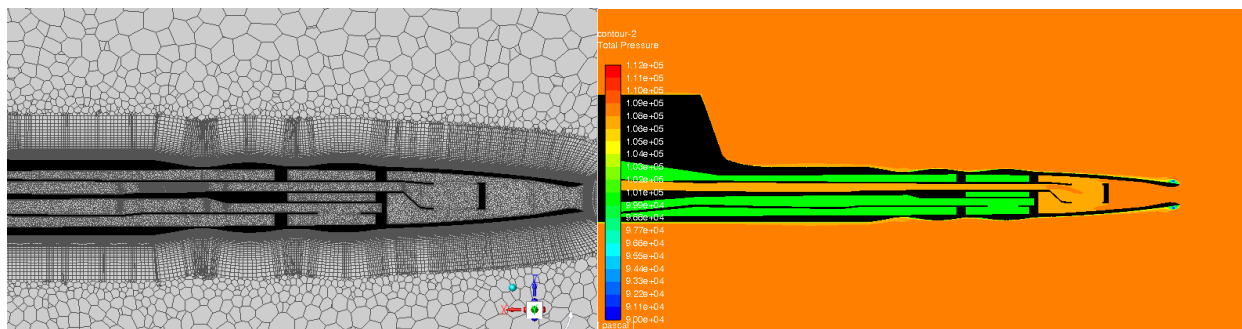
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This study is a study on pitot-tube, an instrument to measure speed in aircraft. In the case of pitot-tubes, it is a device that measures speed using Bernoulli's principle and using the difference between total pressure and static pressure. In addition, since it is forced to use in high-altitude and high-speed situations according to the operating conditions of the aircraft, a heating device for preventing condensation of water vapor is essentially included. This means that the conditions of the flow also change due to heat generation, and it is important that the internal/external structure is not affected.

Commercial pitot-tubes have several complex internal structures and several static pressure holes to prevent measurement errors. In addition, as described above, an electromagnetic coil for preventing condensation of water vapor is embedded to generate heat. This means that not only the complexity of internal flow, but also heat generation due to electromagnetic induction, structural heating by heat, and fluid heating by structural heating should be kept in mind.

There are three shapes of pitot-tubes used in this study, and for each shape, flow analysis and wind tunnel tests for internal/external flow were performed. In addition, the difference in external flow for each shape was analysed, and the difference in measurement of pressure values according to the shape was analysed. In particular, in order to analyse instrument errors and installation errors that occur when mounted on an aircraft, the difference from the actual flow speed was analysed using various methods. In addition, by performing the analysis of the angle of attack and the angle of sideslip, the error in measuring the speed of the aircraft maneuver situations was studied, and a plan to correct it was introduced. In addition, the thickness of the boundary layer according to the external shape also affects the pressure measurement, and to verify this, the effect on the thickness of the boundary layer was identified by performing an analysis on variable shapes.

This study adds thermal analysis and structural analysis by electromagnetic induction in the future to perform thermal-structure-fluid interaction analysis, and based on this, suggests an optimal shape to reduce installation errors and instrument errors.



References

1. Rendall, T., Rodrigues, J., Grey, S., & Azarpeyvand, M., Acoustic Reflectometry for Pitot Tube Blockage Detection. *Journal of Aircraft*, Vol. 55(1), pp. 325-338 (2018)
2. John. D. Anderson Jr., *Fundamentals of Aerodynamics* (6th ed.), McGraw Hill (2016).
3. Rex Klopfenstein Jr., Air velocity and flow measurement using a Pitot tube, *ISA Transactions*, Vol. 37(4), pp. 257-263 (1998)
4. J. S. Arora, *Introduction to Optimum Design* (4th ed.), Academic Press (2016)