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Maximilian Hombsch

Film Cooling in Supersonic Flows

Filmkühlung in Überschallströmungen

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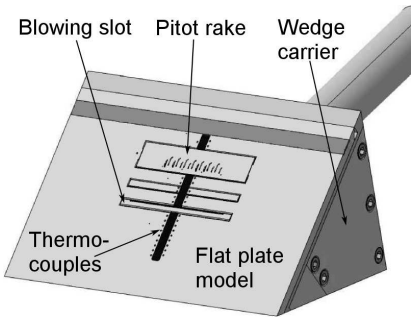
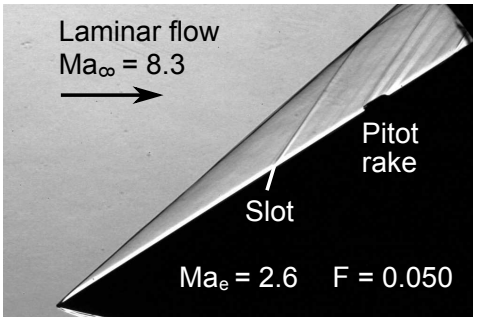
Internet: www.shaker.de • e-mail: info@shaker.de

Film Cooling in Supersonic Flows

One-Page Overview – Maximilian Hombsch

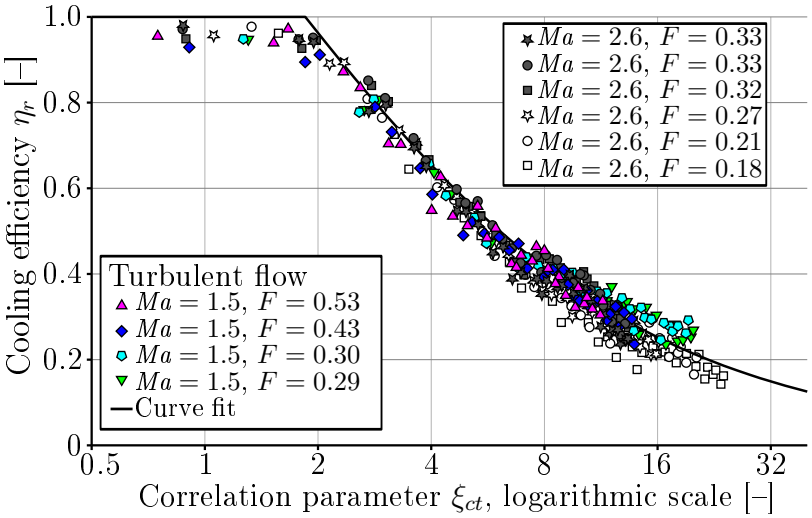
In this work, the film cooling effect in supersonic flows is analyzed. For this purpose, experimental testing has been conducted using a shock tunnel from the RWTH Aachen University. Therefore, models with different slot openings for coolant injection were prepared and equipped with thermocouples and pressure sensors. Additionally, the flow topology has been recorded with Schlieren imaging and the heat flux distribution is visualized using infrared imaging.





Theories from literature yielding a correlation between flow and injection properties on one side and the heat flux on a cooled surface on the other side have been compared and validated with experimental data. One of these theories has been applied and extended in this work, with the goal to provide a unified procedure valid for various flow conditions.

As a result, this leads to curve fit functions for the cooling efficiency in dependency of a correlation parameter. The cooling efficiency is defined as one for a perfectly cooled surface and zero for a surface without cooling. The cooling effect decays over the distance from a coolant slot as the coolant film mixes with the main stream.



The correlation parameter represents this distance from the slot opening, but is scaled with flow properties. This way, the influence of parameters like the coolant mass flux, the boundary layer edge temperature and pressure as well as the Reynolds and Mach numbers are taken into account for the calculation of the cooling effect. Procedures for hypersonic viscous interaction, pressure gradients and foreign gas injection are also discussed.