DEVELOPMENT OF SKIN FRICTION MEASUREMENT TECHNIQUE FOR HIGH SPEED FLOW

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The evaluation of skin friction is really important in many domains. For example, for a subsonic transport aircraft at cruise conditions, 50 % of the drag is skin friction drag and it is not easily evaluated. Knowing skin friction is also a good way to validate computational simulation of turbulent flows. The usual way to evaluate skin friction is to measure the velocity profiles in the boundary layer. This is an undirect and intrusive method. The purpose of this project was to develop at VKI the Thin Oil Film Interferometry Method, especially for high speed flow. This method provides a direct and non intrusive measurement technique for skin friction.

The Thin Oil Film Interferometry method is based on the direct relation between the thinning rate of an oil film submitted to a shear stress and the shear stress itself. The measurement of the evolution of the oil film thickness is realized by interferometry.

Experimental setups have been developed and tested in different VKI wind tunnels (L7+, S4, H3). Different data processing methods have also been implemented and compared. It was shown that the method is easy to use and works well in subsonic case with constant skin friction. With supersonic flows, variable oil viscosity due to change of surface temperature has to be taken into account. In case of complex flow, a spatially variable skin friction is also more complex to treat.

Results in term of shear stress have been obtained in both subsonic and supersonic conditions. Those results were compared with theoretical predictions and other experimental results. Example of fringes obtained and results in term of skin friction for a subsonic turbulent boundary layer over a flat plate are shown below.

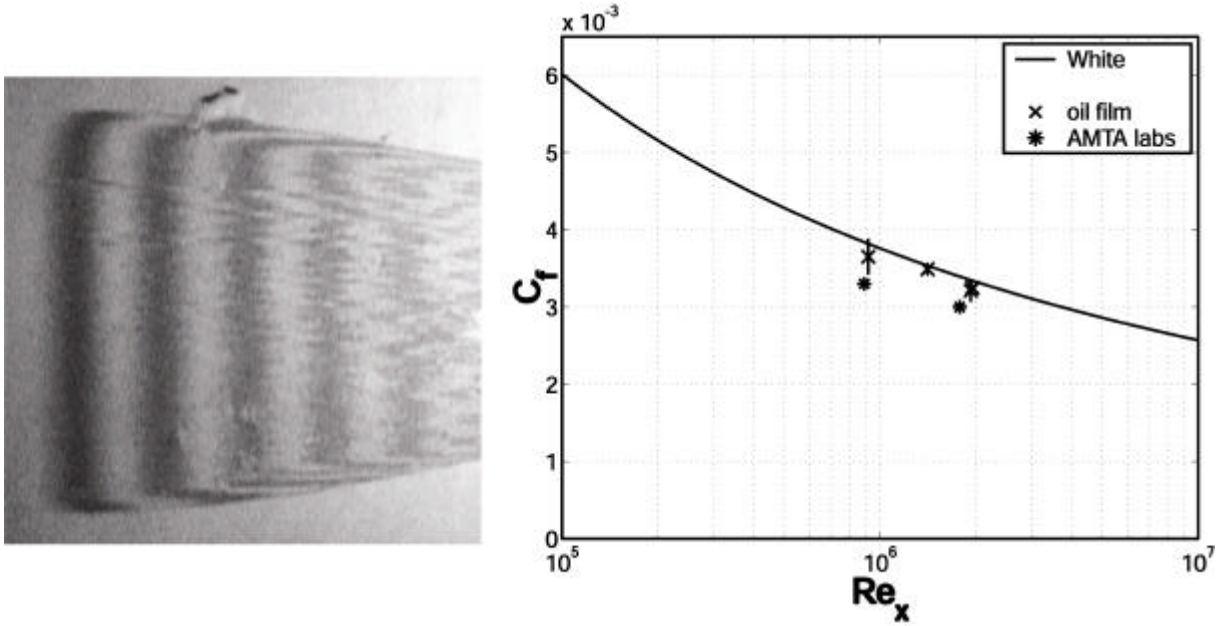

Figure 1: Fringe pattern resulting from an incident light over an oil film with constant slope and comparison of results from velocity profile measurement, Withe empirical fit and oil film method