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Thermography in Aerodynamics

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1. Introduction

Noninvasive techniques such as thermography can aid the investigation of the boundary layer flows, especially in cases when traditional techniques cannot be used (e.g., in flight experiments). The paper presents applications of infrared and liquid-crystal thermography in different wind-tunnel tests conducted in Institute of Aeronautics and Applied Mechanics.

2. Measurement Technique

In experiments thermographic CEDIP long wave camera was used with a matrix of 320x240 microbolometric detectors and sensitivity 0.08C@30C. The HELLCRE ST liquid crystals change colour starting from 30C, red starts at 30.2C, green at 30.8, blue at 35.4, measurement range 6C.

3. Investigation of standard flows

The flow structure around the aircraft wing is well known and thermography is rutinely used in such cases to visualise the region of laminar-turbulent transition [1], [2]. Typical flow structure that also needs to be identified is a laminar separation bubble. The Institute of Aeronautics and Applied Mechnics leads a “flying lab” program (see figure 1) aiming to investigate fuid dynamic phenomena in real conditions. Traditional measurement techniques cannot be used in this case. Thermography is seen as a new tool allowing to identify flow features. The following pictures show correlation between the pressure distribution and thermograms obtained using camera - figure 2a as well as liquid crystals - figure 2b. Both thermographic methods are able to show in detail the position as well as the extent of the separation bubble.

Fig. 1. *“Flying lab” PW-6 glider*

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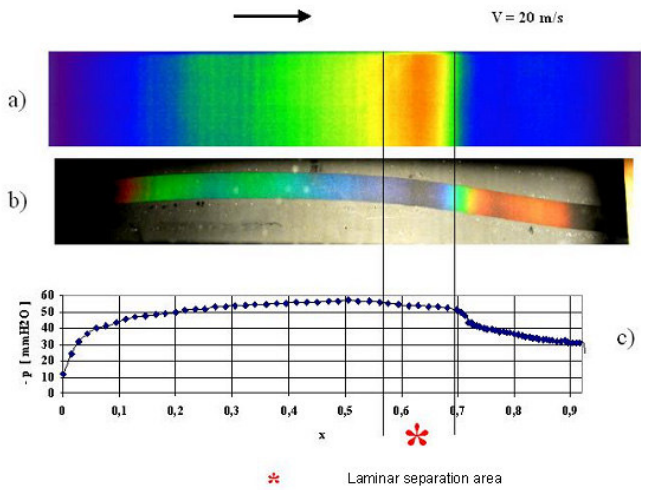

Fig. 2. *Correlation between the pressure distribution and thermograms obtained with camera (a) as well as liquid crystals (b)*

4. Investigation of complex 3D flow

The investigation of fully 3D flows is very demanding both for experiment as well as for numerical simulation. In this case the use of thermography was motivated by the high cost and complexity of the traditional techniques (e.g. saltation technique which is used for environmental flows). Figure 3 shows thermograms corresponding to the flow around group of model buildings located in the wind-tunnel. Both pictures are made for the same flow velocity of 5m/s, but differ in the relative position of the model buildings. In order to find correlation between thermograms and the flow features additional experiments will be performed with oil and PIV (Particle Image Velocimetry) visualisation.

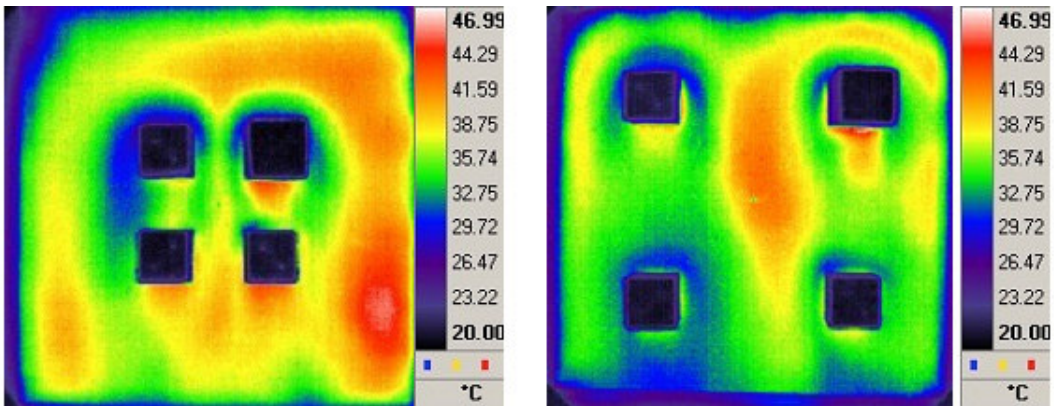

Fig. 3. *Flow around group of model buildings located in the windtunnel – thermograms*

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