8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

THREE-DIMENSIONAL ICE MODELLING WITH ELECTRO-THERMAL ICE PROTECTION SYSTEMS

ANDY PRESS

Advanced Technology Centre
BAE Systems
P.O. Box 5
Filton, Bristol. BS34 7QW
andrew.press@baesystems.com

Key Words: *CFD, In-flight Icing, ice modelling, ice protection, electro-thermal.*

ABSTRACT

Integrated Wing[1] is a UK national collaborative technology programme aimed at addressing 'Sustainable Aviation' issues (acquisition, operating and maintenance costs, reduced fuel burn and environmental impact) as they relate to wing technologies and configurations. The Ice Protection work package aims to define validated processes and tools for designing the next generation of wing ice protection systems whilst considering the constraints of advanced wing structures and performance. As part of this process, the ICECREMO 3D ice accretion code is being re-written to allow the efficient modelling of multi-layered structures with embedded heater mats. The code has been implemented in a fully parallel framework, allowing rapid modelling of watch-catch and of the time-dependent, fully-unsteady 3D water-flow/ice accretion process with varying power input to heater distributed across the configuration. The code is implemented in an object-orientated C^{++} framework based around the BAE Systems SOLAR CFD suite.

In addition to the basic code development, significant effort and resource have been expended within the Integrated Wing project to obtain high-quality validation data using a specifically designed and constructed large-scale model tested within the CIRA Icing Tunnel. This high-quality data will be invaluable in validating the design processes and modelling of ice protection systems both in anti-ice and de-ice modes.

This paper will outline the significant developments performed within the ICECREMO code to enable it to efficiently predict the characteristics of low-power ice protection systems. This includes the discretisation of the underlying structure and any potential ice growth, to enable the correct thermal characteristics of the system to be modelled. Results will be illustrated for the thermal characteristics of a multi-layered composite structure with embedded heater mats in both in dry air and with impinging water on the surface. A range of predictions for the configuration operating in anti-ice and de-ice modes will be presented. Results show the effect of both spanwise and chordwise heater mat gaps on the operational characteristics of the system.

REFERENCES

[1] Integrated Wing Programme Public Internet Site, www.integrated-wing.org.uk