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Numerical Analysis of Piezoceramic Actuators for Aeronautical Engine Applications

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The reduction of emissions is one of the most important targets for the development of the next generation aircraft engines. The use of smart materials and innovative design solutions could improve the efficiency of future engines with a reduction of the pollution caused by the air traffic. The present work, performed in the frameworks of the EU FP7 project AeroPZT, is devoted to the numerical analysis of innovative actuators based on piezoceramic materials. The performances of these materials could fulfill the requirements of the next generation fluid control units.

An advanced numerical tool based on the Carrera Unified Formulation was used to perform the numerical analysis of the device. A refined one-dimensional structural model was used in the analysis in order to provide accurate results with a low computational cost. An Amplified Piezoelectric Actuator (APA) was considered to increase the stroke of the Multi-Layered Actuator (MLA) used in the device, see Fig. 1. In the first part of the work, the advanced numerical approach was used to investigate the performances of the Multi-Layered Actuator (MLA), and the model was assessed. The tuned model was used to provide an accurate design of the APA configurations and to verify if the selected configurations was able to provide the performances, in terms of free stroke, blocking force and frequency response, required by the combustion process. The effects of the thermal loads, see Fig. 2, were included and the presence of an actuator encapsulation devoted to the protection of the device by the fluid was considered.

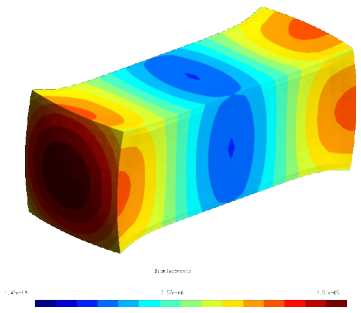

Fig. 1: Displacement of the piezo-cermaic stack actuated.

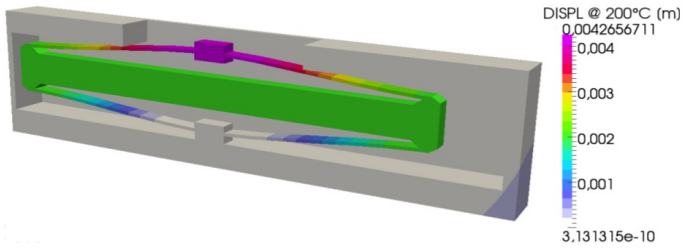

Fig 2: Displacement of the actuator due to the thermal loads (@200°C)

The results obtained in the assessment activities show the reliability of the numerical model considered. The numerical tool was able to provide accurate results and to consider the APA complex configuration, including thermal effects. The final design of the new actuator improves the performances of the classical fluid control unit therefore it appears to be promising for future application in aeronautical engines.

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