Two dimensional numerical Modeling of nanosecond plasma Actuators, a preliminary study of application in propulsion systems

M. Abdollahzadeh, J. Páscoa, P. Oliveira

[1] University of Beira Interior, Department of Electromechanical Engineering, Center for Aerospace Sciences and Technology, Portugal, Covilhã
email: mm.abdollahzadeh@yahoo.com

Abstract

For future huge airships, which are being designed to fly at very high altitude (as in the case of MAAT project), efficiency increase is a crucial subject. For such airships, any increase in propulsion system efficiency will lead to a decrease in energy consumption through a decrease in size, length and mechanical complexity of propulsion system, thus also lowering the initial investment. At the blades of a propulsion system, separation causes significant total pressure loss causing a reduction in overall efficiency.

Surface dielectric barrier discharges (SDBDs) can modify the boundary layer of a flow and are studied as possible actuators for flow control. The purpose of this study is to present a numerical modeling of a surface dielectric barrier discharge in air which uses a nanosecond voltage pulse generator. A two-dimensional fluid model of the DBD is used to describe the plasma dynamics. The model couples fluid discharge equations with compressible Navier–Stokes equations including momentum and thermal transfer from the plasma to the neutral gas. The 2D fluid model of the discharge in air provides the space and time evolution of the charged particle densities, electric field and surface charges The model is numerically solved using asynchronous time integration technique coupled with an automated adaptive mesh refinement technique. A validation of the model is presented in order to assess the capabilities of the developed computational code.

Keywords: *Flow control; Plasma actuator; Dielectric barrier discharge; Separated airflow; MAAT Project;*

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