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Investigation of Steady Plasma Actuation Effect on Aerodynamic Coefficients of Oscillating Airfoil at Low Reynolds Number

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Abstract

In this work, numerical study of two dimensional laminar incompressible flow around an oscillating NACA0012 airfoil is proceeded using the open source code OpenFOAM. Oscillatory motion types including pitching and flapping are considered. Reynolds number for these motions is assumed to be 12000 and effects of these motions and also different unsteady parameters such as amplitude and reduced frequency on aerodynamic coefficients are studied. For flow control on airfoil, dielectric barrier discharge plasma actuator is used in two different positions on airfoil and its effect is compared for the two types of considered oscillating motions. It is observed that in pitching motion, imposing plasma leads to an improvement in aerodynamic coefficients, but it does not have any positive effect on flapping motion. Also, for the amplitudes and frequencies investigated in this paper, the trailing edge plasma had a more desirable effect than other positions.

Keywords

Airfoil, Flapping, Oscillating, Plasma, Pitching.

Nomenclatures

A	Pitching amplitude, degree
b	Body force
c	Airfoil chord length, m
C_L	Lift coefficient
C_T	Thrust coefficient
E	Electric field strength, V/m
e_c	Charge of the electron, Coulombs
f	Frequency of oscillation, Hz
h	Plunging amplitude, m
k	Reduced frequency = $\pi fc / U_\infty$

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