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Corresponding author: HOTHAZIE Mihai Vlăduț
e-mail of corresponding author: hothazie.mihai@incas.ro
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Title

Investigating the Effectiveness of Vortex Generators in Aviation through High-Fidelity CFD Analysis

Authors

Mihai HOTHAZIE [1], Ionuț BUNESCU[,2], Mihai-Victor PRICOP [3]*
** Corresponding author*
[1] National Institute for Aerospace Research "Elie Carafoli", 061126 Bucharest, Romania: hothazie.mihai@incas.ro
University Politehnica of Bucharest: Faculty of Aerospace Engineering, 060042 Bucharest, Romania
[2] National Institute for Aerospace Research "Elie Carafoli", 061126 Bucharest, Romania: bunescu.ionut@incas.ro
University Politehnica of Bucharest: Faculty of Aerospace Engineering, 060042 Bucharest, Romania
[3] National Institute for Aerospace Research "Elie Carafoli", 061126 Bucharest, Romania: pricop.victor@incas.ro

Abstract

Vortex generators are passive flow control devices that are used to generate small-scale vortices in the boundary layer region to delay the flow separation point. These vortices help to mix the high-momentum fluid from the freestream with the low-momentum fluid near the surface, leading to improved aerodynamic performance and reduced fuel consumption. The present study focuses on the parametric analysis of vortex generators positioning in turbulent boundary layer flow. Our research focuses on the importance of numerical simulations in understanding the behavior of vortex generators in complex flow environments.

The use of high-fidelity CFD analysis shows that the positioning of vortex generators has a significant impact on the effectiveness of turbulence and the resulting aerodynamic performance of an aircraft. Our numerical simulations provide valuable insights into the underlying flow physics and the impact of vortex generator positioning on flow physics. The results of the simulations also highlight the need for new methodologies to evaluate the effectiveness of vortex generators in real-world conditions. To address this need, we have developed new methodologies to quantify the effectiveness of vortex generators using CFD analysis. The methodologies involve the use of turbulence and energy analysis to quantify the impact of vortex generator-generated vortices on the boundary layer and to identify the optimal positioning of vortex generators for improved aerodynamic performance.

We have focused on the mechanics of vortex generator-generated vortices, including the impact of the vortices on the boundary layer and the evolution of the vortices as the flow advances. This has been confirmed through various studies in the literature, for example: [1], [2] and [3]. Also, our simulations indicate that the generated vortices have a significant impact on the turbulent kinetic energy of the flow and that the positioning of vortex generators plays a crucial role in determining the effectiveness of the vortices.

In conclusion, the present study highlights the importance of considering the positioning of vortex generators in the design of passive flow control devices for turbulence management. The findings of the study provide valuable insights into the shape or positioning optimization of vortex generators for improved performance and efficiency in various engineering applications. The results can be used to guide the design of vortex generators for specific flow conditions, enabling engineers to achieve the desired level of turbulence enhancement for specific applications.

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