Document details

International Journal of Mechanical Engineering and Robotics Research
Volume 7, Issue 4, 1 July 2018, Pages 428-432

Low-cost base drag reduction technique (Article)

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Abstract

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A simple, low-cost, drag reduction device has been developed for applications in high-speed flows. This low-cost technology is expected to decrease fuel consumption (e.g., for high-speed vehicles such as rockets traveling from a highly overexpanded flow at the sea level to a highly underexpanded flow in outer space). Somewhere in between the over and the underexpansion, the rocket experiences perfectly expanded flows. In this study, only overexpanded and perfectly expanded flows have been considered. A single cylinder with a diameter of 2 mm is rotated clockwise inside the recirculation zone (e.g., in high-speed vehicles) to act as a controller. The base pressure in the dead zone and the wall pressure along the square duct length have been measured with and without control. Experiments were carried out for nozzle pressure ratios (NPRs) of 2, 3, 6 and 7.8. When the cylinder was rotated clockwise as an active controller, the base pressure was found to increase by as much as 56% in the perfectly expanded case and up to 17% in overexpanded flows. This drastic increase in the base pressure is correlated to an equivalent drag reduction. In addition, adding an active control had no negative impact on the main flow field. This is important as any disturbance in the main flow field at high speeds may lead to increased oscillations and vibrations, which if not checked may cause material failures. Rotating the cylinder in the clockwise direction near the wall was found to be very effective for higher NPRs. © 2018 Int. J. Mech. Eng. Rob. Res.

Author keywords

Active control | Base pressure | Mach number | Nozzle pressure ratio | Wall pressure

ISSN: 22780149
Source Type: Journal
Original language: English

DOI: 10.18178/ijmerr.7.4.428-432
Document Type: Article
Publisher: International Journal of Mechanical Engineering and Robotics Research

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