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Mechanics and Mechanical Engineering Open Access
Volume 22, Issue 4, 2018, Pages 1077-1097

Base pressure behaviour in a suddenly expanded duct at supersonic Mach number regimes using taguchi design of experiments (Article)

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Abstract

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Experimental investigations are carried out to study the control of base pressure without and with the use of micro-jets through suddenly expanded axi-symmetric passage in the supersonic regime. Four micro jets having an orifice diameter of 1mm were located at 90 ° intervals. In the base area, active controls jets have been placed on a pitch of a circle diameter that is 1.3 times the exit diameter of the nozzle. The jets were dispensed abruptly into the axi-symmetric tube maintained at a cross-sectional area of 4.84 times the exit nozzle area. The variation of base pressure as a function of flow control parameters namely Mach number, nozzle pressure ratio (NPR) and length to diameter) ratio (L/D) are evaluated experimentally. This study also assesses the impact of flow control variables on base pressure for two cases viz. with control and without control respectively. An L_9 orthogonal array of Taguchi and the analysis of variance were employed to investigate the percentage of contribution of these parameters and their interactions affecting the base pressure. The correlations between the various factors affecting the base pressure were obtained by using multiple linear regression equations. Confirmation tests were conducted in order to test the developed linear regression equations for their practical significance. Both the regression models were found to be significant and reliable with a percentage deviation lying in the range of –6.12% to 10.26% for base pressure without control and –13.92% to 6.58% for base pressure with control. Analysis of variance was also performed in order to determine the statistical significance of each parameter on the total variability of base pressure. The study concluded that Mach number is the most influential parameter affecting base pressure followed by NPR and L/D. © Technical University of Lodz.

SciVal Topic Prominence

Topic: Nozzles | Mach number | Suddenly expanded

Prominence percentile: 63.870

Author keywords

Length to diameter ratio | Mach number | Micro-jets | Nozzle pressure ratio (NPR) | Taguchi

ISSN: 14281511
Source Type: Journal
Original language: English
Document Type: Article
Publisher: Wydawnictwo Politechniki Lodzkiej

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