Prediction of Base Pressure in a Suddenly Expanded Flow Process at Supersonic Mach Number Regimes using ANN and CFD

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JOURNAL OF APPLIED FLUID MECHANICS
Volume: 13 **Issue:** 2 **Pages:** 499-511
DOI: 10.29252/jafm.13.02.30049
Published: MAR 2020
Document Type: Article
View Journal Impact

Abstract

Sudden expansion of flow in supersonic flow regime has gained relevance in the recent pasts for a wide run of applications. A number of kinematic as well as geometric parameters have been significantly found to impact the base pressure created within the suddenly expanded stream. The current research intends to create a predictive model for base pressure that is established in the abruptly extended stream. The artificial neural network (ANN) approach is being utilized for this purpose. The database utilized for training the network was assembled utilizing computational fluid dynamics (CFD). This was done by the design of experiments based L-27 Orthogonal array. The three input parameters were Mach number (M), nozzle pressure ratio (NPR) and area ratio (AR) and base pressure was the output parameter. The CFD numerical demonstrate was approved by an experimental test rig that developed results for base pressure, and used a nozzle and sudden extended axis-symmetric duct to do so. The ANN architecture comprised of three layers with eight neurons in the hidden layer. The algorithm for optimization was Levenberg-Marquardt. The ANN was able to successfully predict the base pressure with a regression coefficient R-2 of less than 0.99 and RMSE=0.0032. The importance of input parameters influencing base pressure was estimated by using the ANN weight coefficients. Mach number obtained a relative importance of 47.16% claiming to be the most dominating factor.

Keywords

Author Keywords: Base pressure; Mach number; Artificial Neural Network (ANN); Computational Fluid Dynamics (CFD)
KeyWords Plus: ACTIVE CONTROL

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Publisher

ISFAHAN UNIV TECHNOLOGY, MECHANICAL ENGINEEING DEPT, JAFM OFFICE, ISFAHAN, 84156-83111, IRAN

Journal Information

Impact Factor: Journal Citation Reports

Categories / Classification

Research Areas: Thermodynamics; Mechanics
Web of Science Categories: Thermodynamics; Mechanics

Document Information

Language: English

Accession Number: WOS:000517208300010
ISSN: 1735-3572
eISSN: 1735-3645

Other Information

IDS Number: KQ8YR
Cited References in Web of Science Core Collection: 25
Times Cited in Web of Science Core Collection: 0

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Cited References: 25

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