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Modeling and Validation of Base Pressure for Aerodynamic Vehicles Based on Machine Learning Models
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Abstract
The application of abruptly enlarged flows to adjust the drag of aerodynamic vehicles using machine learning models has not been investigated previously. The process variables (Mach number (M), nozzle pressure ratio (η), area ratio (α), and length to diameter ratio (γ)) were numerically explored to address several aspects of this process, namely base pressure (β) and base pressure with cavity (βcav). In this work, the optimal base pressure is determined using the PCA-BAS-ENN based algorithm to modify the base pressure presetting accuracy, thereby regulating the base drag required for smooth flow of aerodynamic vehicles. Based on the identical dataset, the GA-BP and PSO-BP algorithms are also compared to the PCA-BAS-ENN algorithm. The data for training and testing the algorithms was derived using the regression equation developed using the Box-Behnken Design (BBD). The results show that the PCA-BAS-ENN model delivered highly accurate predictions when compared to the other two models. As a result, the advantages of these results are two-fold, providing: (i) a detailed examination of the efficiency of different neural network algorithms in dealing with a genuine aerodynamic problem, and (ii) helpful insights for regulating process variables to improve technological, operational, and financial factors, simultaneously.

Author Keywords
High speed flow; Mach number; machine learning; PCA-BAS-ENN algorithm

Index Keywords
Aerodynamic drag, Learning algorithms, Mach number, Machine learning, Vehicles; Area ratios, Base pressure, High speed flows, Machine learning models, Machine-learning, Modeling and validation, Nozzle pressure ratio, On-machines, PCA-BAS-ENN algorithm, Process Variables; Aerodynamics

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