Investigation and back-propagation modeling of base pressure at sonic and supersonic Mach numbers

By: Afzal, A (Afzal, Asif)[1]; Khan, SA (Khan, Sher Afghan)[2]; Islam, MT (Islam, Md Tariqul)[3]; Jilte, RD (Jilte, R. D.)[4]; Khan, A (Khan, Ambareen)[5]; Soudagar, MEM (Soudagar, Manzoore Elahi M.)[6]

View Web of Science ResearcherID and ORCID

PHYSICS OF FLUIDS
Volume: 32 **Issue:** 9
Article Number: 096109
DOI: 10.1063/5.0022015
Published: SEP 1 2020
Document Type: Article
View Journal Impact

Abstract

The experimental analysis of base pressure in a high-speed compressible flow is carried out. The flow is made to expand abruptly from the nozzle into an enlarged duct at fifteen sonic and supersonic Mach numbers. The analysis is made for variation in the nozzle pressure ratio (NPR), length to diameter ratio, and area ratio. The effect of active micro-jets on the base and wall pressure is assessed. The data visualization of the huge experimental data generated is performed using heat maps. For the first time, six back-propagation neural network models (BPMs) are developed based on input and output possibilities to predict the pressure in high-speed flows. The experimental analysis revealed that depending upon the type of expansion, the base pressure changes. A jet of air blown at the base using micro-jets is found to be effective in increasing the base pressure during the under-expansion regime, while the wall pressure remains unaffected. The data visualization provided an insight into the highest impact on the base pressure by the NPR. The six BPMs with two hidden layers having four neurons per layer are found to be most suitable for the regression analysis. BPM 5 and BPM 6 accurately predict the highly non-linear data of the base and wall pressure.

Keywords

KeyWords Plus: SUDDENLY EXPANDED FLOWS; ACTIVE CONTROL; EXPANSION

Author Information

Reprint Address:

Visvesvaraya Technological University Visvesvaraya Technol Univ, Dept Mech Engn, PA Coll Engn, Mangalore 574153, India.

Corresponding Address: Afzal, A (corresponding author)

+ Visvesvaraya Technol Univ, Dept Mech Engn, PA Coll Engn, Mangalore 574153, India.

Addresses:

+ [1] Visvesvaraya Technol Univ, Dept Mech Engn, PA Coll Engn, Mangalore 574153, India

[2] IIUM Malaysia, Fac Engn, Dept Mech Engn, Kuala Lumpur 50728, Malaysia

+ [3] Univ Queensland, Sch Chem Engn, Brisbane, Qld 4072, Australia

+ [4] Lovely Profess Univ, Dept Mech Engn, Phagwara 144411, Punjab, India

+ [5] Univ Sains Malaysia, Sch Aerosp Engn, Nibong Tebal 14300, Penang, Malaysia

+ [6] Univ Malaya, Fac Engn, Dept Mech Engn, Kuala Lumpur 50603, Malaysia

E-mail Addresses: asif.afzal86@gmail.com

Publisher

AMER INST PHYSICS, 1305 WALT WHITMAN RD, STE 300, MELVILLE, NY 11747-4501 USA

Journal Information

Impact Factor: Journal Citation Reports

Categories / Classification

Research Areas: Mechanics; Physics

Web of Science Categories: Mechanics; Physics, Fluids & Plasmas

See more data fields

1 of 1

Cited References: 36

Showing 30 of 36 **View All in Cited References page** *(from Web of Science Core Collection)*

1. **Parallelization Strategies for Computational Fluid Dynamics Software: State of the Art Review** **Times Cited:** 19
By: Afzal, Asif; Ansari, Zahid; Faizabadi, Ahmed Rimaz; et al.
ARCHIVES OF COMPUTATIONAL METHODS IN ENGINEERING Volume: 24 Issue: 2 Pages: 337-363 Published: APR 2017

2. **Resilience of physiological attributes of wheat (*Triticum aestivum* L.) to abiotic stresses.** **Times Cited:** 4
By: Ahmed, M.; Asif, M.; Fayyaz-ul-Hassan; et al.
Scientific Research and Essays Volume: 7 Issue: 35 Pages: 3099-3106 Published: 2012

3. **BASE PRESSURE AND NOISE PRODUCED BY ABRUPT EXPANSION OF AIR IN A CYLINDRICAL DUCT** **Times Cited:** 29
By: ANDERSON, JS; WILLIAMS, TJ
JOURNAL OF MECHANICAL ENGINEERING SCIENCE Volume: 10 Issue: 3 Pages: 262 -& Published: 1968

4. **Strong dynamic interactions of grid-connected DFIGs with power systems caused by modal coupling** **Times Cited:** 1,133
By: [Anonymous].
IEEE Transactions on Power Systems Volume: PP Pages: 1 Published: 2017
D. W., C. X. and W. H

5. **Fuzzy c-Least Medians clustering for discovery of web access patterns from web user sessions data** **Times Cited:** 2
By: Ansari, Zahid; Faizabadi, Ahmed Rimaz; Afzal, Asif
INTELLIGENT DATA ANALYSIS Volume: 21 Issue: 3 Pages: 553-575 Published: 2017

6. **U.S. Renal Data System** **Times Cited:** 2
Group Author(s): Bethesda
USRDS 2012 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States Volume: 2 Pages: 237-246 Published: 2012
Chapter 3

7. **Misterele identitatii** **Times Cited:** 2
By: Eliade, M.
Dilemateca Volume: II Issue: 10 Pages: 50 Published: martie 2007
2007

8. **Control of ideally expanded and under expanded nozzle flows with micro jets** **Times Cited:** 1
By: Fharukh Ahmed, G. M.; Baig, M. A. A.; Bashir, M.; et al.
IOSR J. Mech. Civ. Eng. Volume: 16 Pages: 83-89 Published: 2016
[Show additional data]

9. **The impact of caesarean section on breastfeeding initiation, duration and difficulties in the first four months postpartum** **Times Cited:** 98
By: Hobbs, Amy J.; Mannion, Cynthia A.; McDonald, Sheila W.; et al.
BMC PREGNANCY AND CHILDBIRTH Volume: 16 Article Number: 90 Published: APR 25 2016

10. **Control of suddenly expanded flow** **Times Cited:** 18
By: Khan, S. A.; Rathakrishnan, E.
AIRCRAFT ENGINEERING AND AEROSPACE TECHNOLOGY Volume: 78 Issue: 4 Pages: 293-309 Published: 2006

11. **An investigation of base flow control by wall pressure analysis in a suddenly expanded nozzles** **Times Cited:** 4
By: Khan, S. A.; Bashir, Musavir; Fharukh Ahmed, G. M; et al.
International Journal of Scientific Research and Development Volume: 3 Issue: 5 Pages: 1-6 Published: 2016
[Show additional data]

12. **Active Control of Base Pressure in Supersonic Regime** **Times Cited:** 7
By: Khan, S. A.; Rathakrishnan, E.
Journal of Aerospace Engineering, Institution of Engineers, India Volume: 87 Pages: 1-8 Published: 2006
May