Performance Evaluation of a Pulse Detonation Engine Using Vortex Generators as Obstacles in the Combustion Chamber

Mukesh Yadav (✉ mukesh7541@gmail.com)

Department of Mechanical Engineering, Delhi Technological University, Delhi 110042, India

<https://orcid.org/0000-0003-2199-3921>

Avhishek Jha

Delhi Technological University

Manish Bista

Delhi Technological University

BB Arora

Delhi Technological University

Research

Keywords: Pulse Detonation Engine, Ansys Fluent, DDT, Supersonic combustion

Posted Date: September 30th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-81993/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Propulsion based engines have been known for their exemplary thrust but also for lower fuel efficiency and speed of operation which is limited to subsonic and the level of intermittent vibrations produced. Pulse Detonation Engine (PDE) is similar to a Pulse Jet Engine (PJE) except for the fact that the flame formed inside the combustion chamber of PDE travels at supersonic speed, whereas in PJE, it is subsonic. The supersonic speed of flame front in PDE is because of the detonation wave formed during the combustion of the fuel mixture which is in the order of 2000 m/s and is based on constant volume combustion. A process called Deflagration to Detonation Transition (DDT) can be used for which turbulence has to be created inside the combustion chamber. The obstacles used in this study were vortex generators and the CAD model of the engine and the obstacles assembly was made in SOLIDWORKS 19.0 software. ANSYS (FLUENT) 16.0 was used for the simulation of the combustion inside the combustion chamber using the Species Transport Model for the performance evaluation.

Full Text

This preprint is available for [download as a PDF](#).

Tables

Due to technical limitations, table 1-4 is only available as a download in the Supplemental Files section.

Figures

Figure 1

General PDE experimental setup with Shchelkin spiral [12]

Figure 2

A two-dimensional mesh of an ideal PDE tube

Figure 3

Various shapes of vortex generators.

	Variable Meaning	Value at Sea Level
$Re = \frac{\rho V x}{\mu}$	ρ = Air density [kg/m ³]	1.205
	V = Stall speed [m/s]	-
	x = Chord length [m]	-
	μ = dynamic viscosity [kg/m-s]	1.983*10 ⁻⁵

Figure 4

The equation for the Reynolds Number Calculation

CAD MODELS

Figure 5

(a) Isometric View of the combustion chamber with Shchelkin Spiral (b) Isometric View of Shchelkin Spiral

Figure 6

(a) Isometric View of PDE with Vortex Generator; (b) Isometric view of Vortex generator

Figure 7

Total number of Iterations

PRESSURE

Figure 8

Initial conditions for the ideal PDE tube with pressure contour

Figure 9

ZND Temperature profile

Figure 10

Wave velocity profile

Figure 11

Figure12(a). Change of velocity wrt time 12(b) Change of velocity wrt tube length

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [tables.pdf](#)