INDIAN SOCIETY FOR TECHNICAL EDUCATION, NITK CHAPTER

Analysis and Numerical Prediction of Cavitation in Fuel Injectors

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Project Objectives

To investigate the multiphase cavitating flow of diesel through fuel injectors. Study the influence of geometry/size, temperature, fuel property, pressure gradient on vapour fraction and cavitation. Predict cavitation number using ML model with data obtained from simulations.

Introduction

Cavitation is the process of formation of the vapour phase of a liquid when it is subjected to reduced pressures at constant ambient temperatures. It affects the spray characteristics, can cause effects like material damage, vibration and engine performance.

Theory

The sharp corners in the orifice of nozzle force internal flow change direction quickly and suddenly, resulting in steep pressure drop and consequently the occurrence of cavitation is produced as the vapour phase in a liquid grows and collapses.

Methodology/Procedure

A CFD Multiphase simulation of flow with different geometries and physical parameters.
Tabulated data of Vapour fraction, Cavitation number and mass flow rate.
Used ML model to predict Cavitation number with obtained data

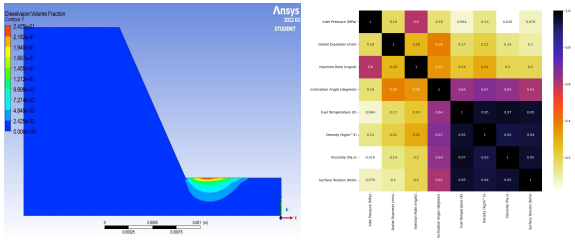
Project Outcomes

To simulate and solve a general fluid flow problem using ANSYS.
To use ML model for numerical prediction from obtained data through simulations.

Results

The Plots of Vapour fraction and Cavitation number with different angle of inclination, pressure and was in accordance with theoretical reasoning.
The ML model predicted Cavitation number with 80% accuracy over a data set of more than 100 data points.

Figures/Block Diagrams



Project Relevance

The increasing awareness of efficient fuel combustion and automobile emission reduction has promoted the study of the flow behaviour of the fuel injector nozzles. Exhaust emissions can be reduced by improving the performance of modern direct injection engines

Conclusion & Future Scope

The influence of geometry and physical parameters on the inception of cavitation has been studied. For a specific collection of criteria, a numerical prediction model using linear regression has been developed to forecast and evaluate cavitation impacts.