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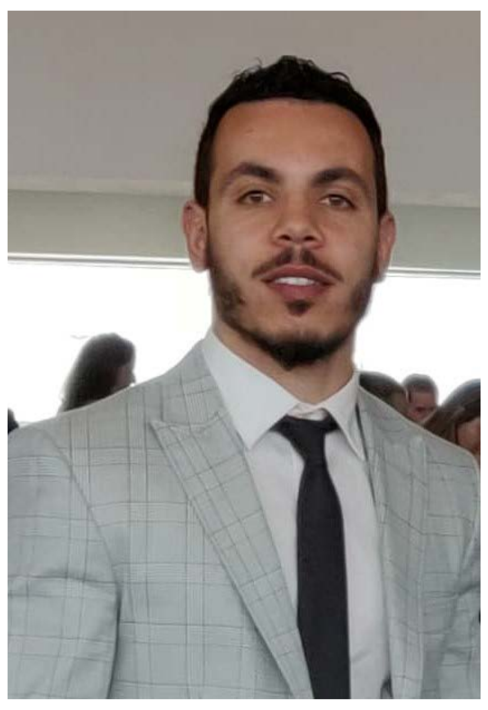

Tumble-Flow Development Through Port Geometry Optimisation and the Influence of Turbulence on GDI Engine Efficiency and Emissions.

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Introduction

The combustion process development is firmly related to cylinder-head design and port geometry, both emissions and combustion performance are connected to turbulent intensity, and the quality of mixture formation [1, 2].

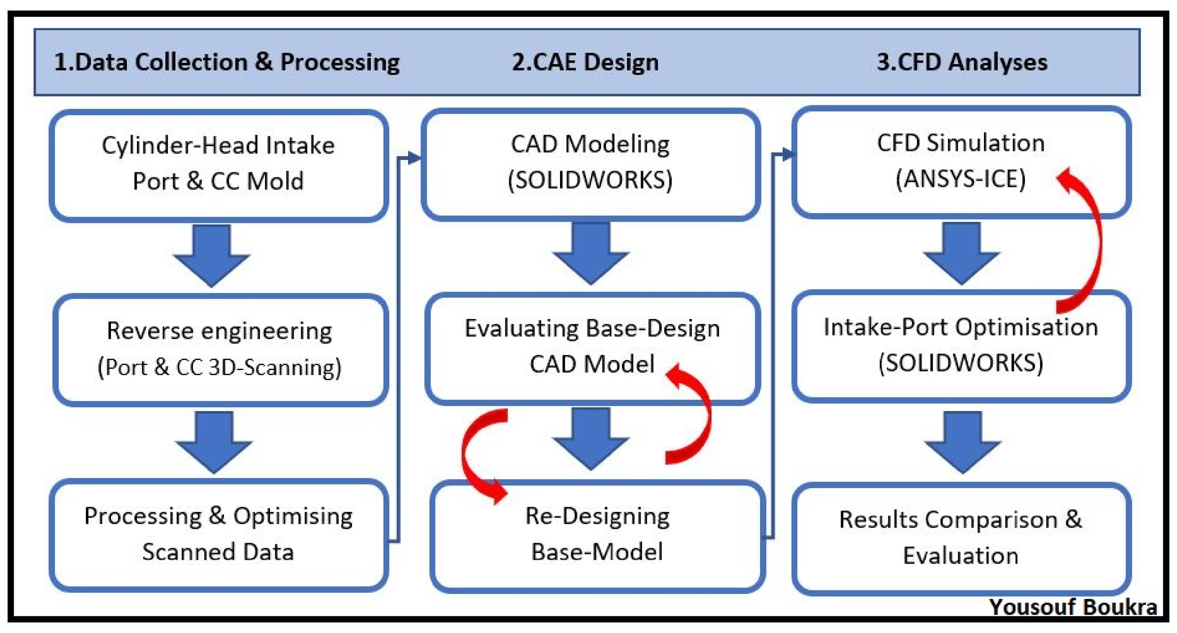
In the present study, a GDI intake port was analysed throughout the application of CAE tools and CFD simulation, to assess the tumble motion and in-cylinder flow structure. Solidworks package was implemented for the design and modelling, and the simulation process was conducted on ANSYS workbench. Extensive validation work was conducted using different turbulence models simulation, experimental flow-bench testing, and analytical verification. Further optimisation work was carried out to alter the tumble charge, by means of geometrical port modification, where the main design parameters comprised port profile angle, chimney height, and port masking.

Project Aims

- ➢ The main aim of this work was to critically assess the influence of intake-port geometry, on tumble generation, and in-cylinder turbulence. The complex turbulent flow occurring during the intake stroke, has motivated the implementation of CFD engine simulation, which was an imperative technology and has been utilised extensively during this project.
- ➢ The second aim included a comprehensive investigation, regarding turbulence modelling within a 3-D CFD domain, to discover the ideal turbulence model, which accurately predicts the fluid flow structure inside the cylinder.

Methodology

The project was approached using a structured development planning which comprises of three main phases: **1**. collection of data throughout reverse engineering process; **2**. development and evaluation of CAD models; **3**. CFD simulation and flow validation against the experimental benchmark data, and theoretical calculation.



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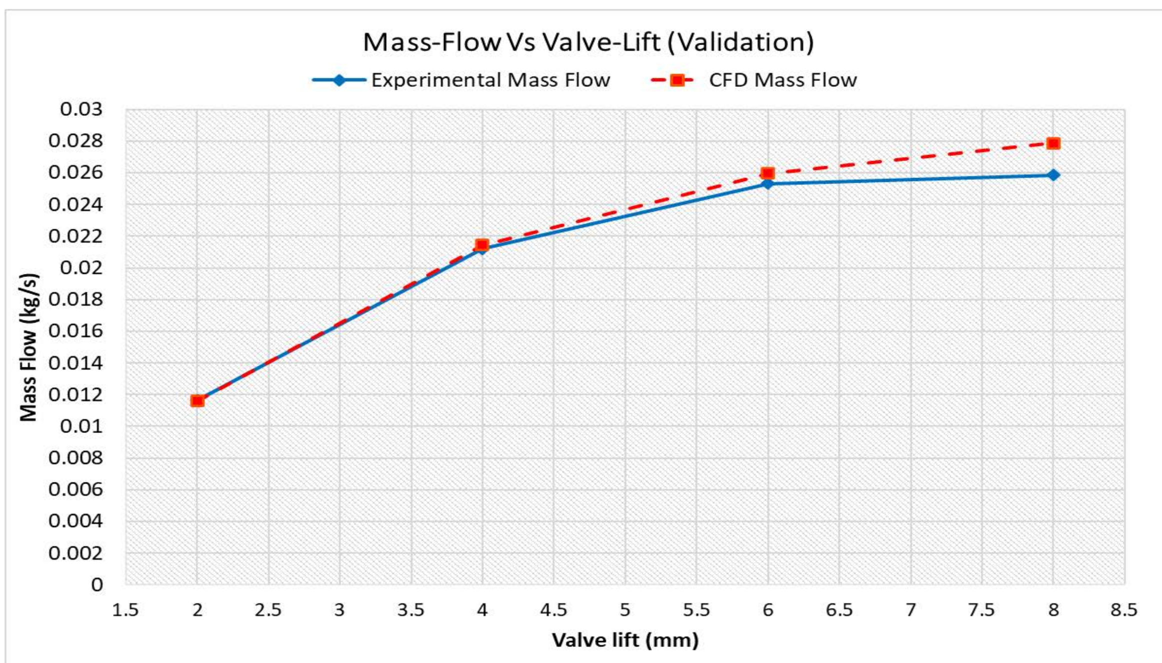
Both Solid-modelling and Surface-modelling techniques were utilised during the design procedure. Six '*K-ϵ*' turbulence models were applied to simulate the flow-charge during the validation process, of which, '***Realisable K-ϵ enhanced wall***' was the most accurate in term of mass-flow-rate and in-cylinder turbulence prediction (98.55% accurate).



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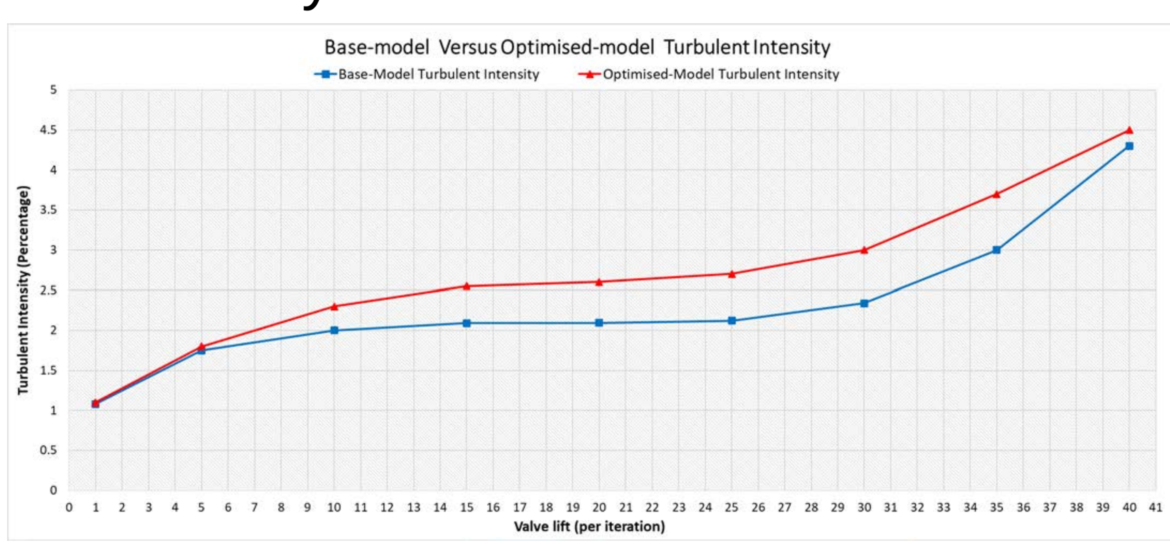
Results

Despite the minimal decrease in the mass flow rate (2.3%), the optimised-port which prompt higher tumble-motion during the intake stroke, significantly enhanced turbulent intensity by 7.72%. Consequently, turbulent kinetic energy increased by 17.8%.



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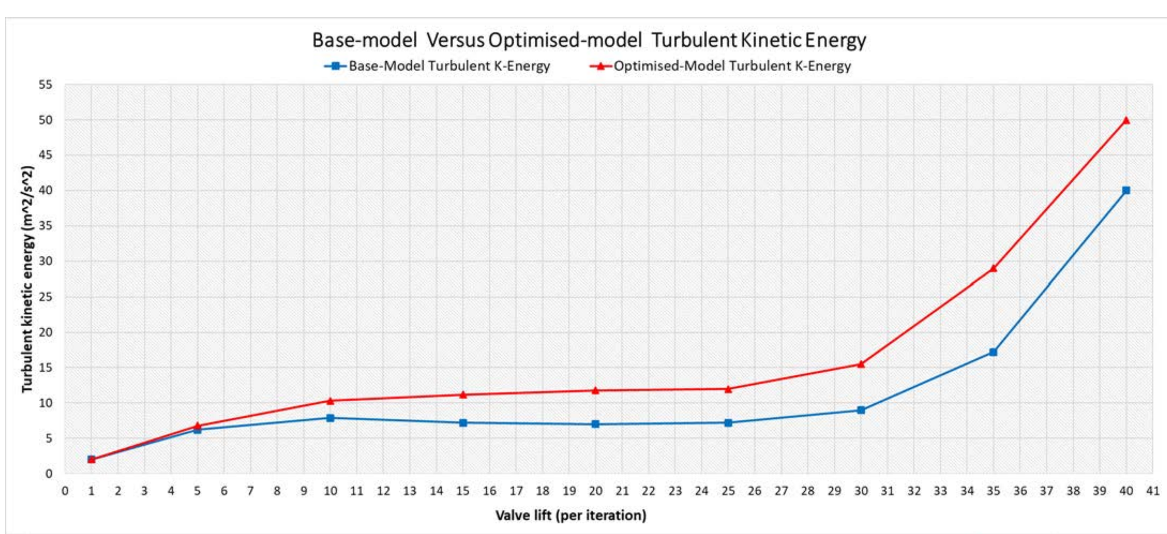

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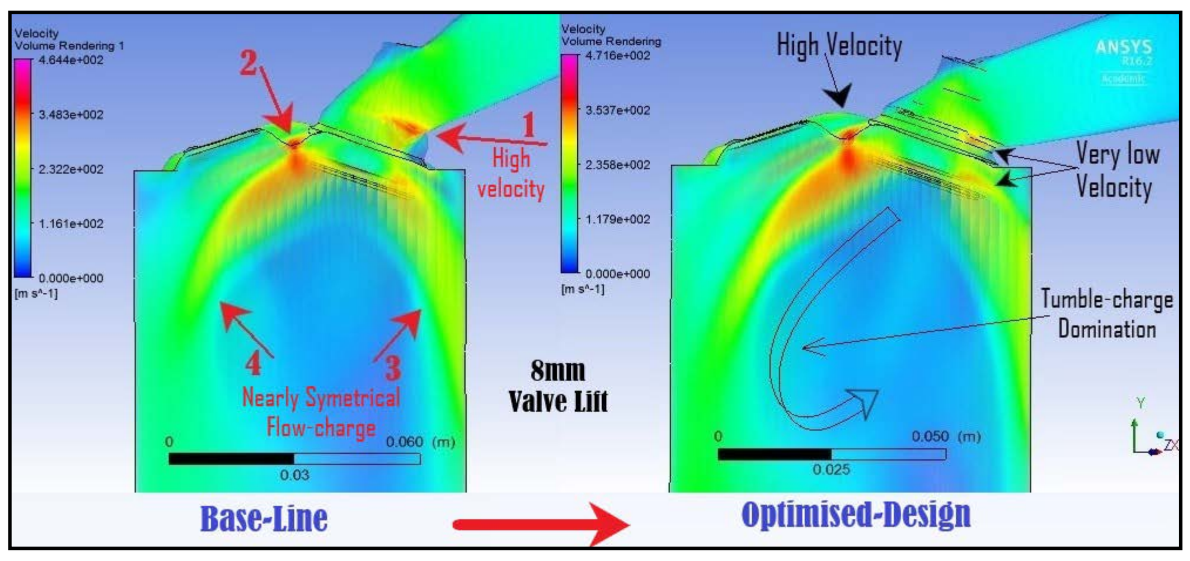

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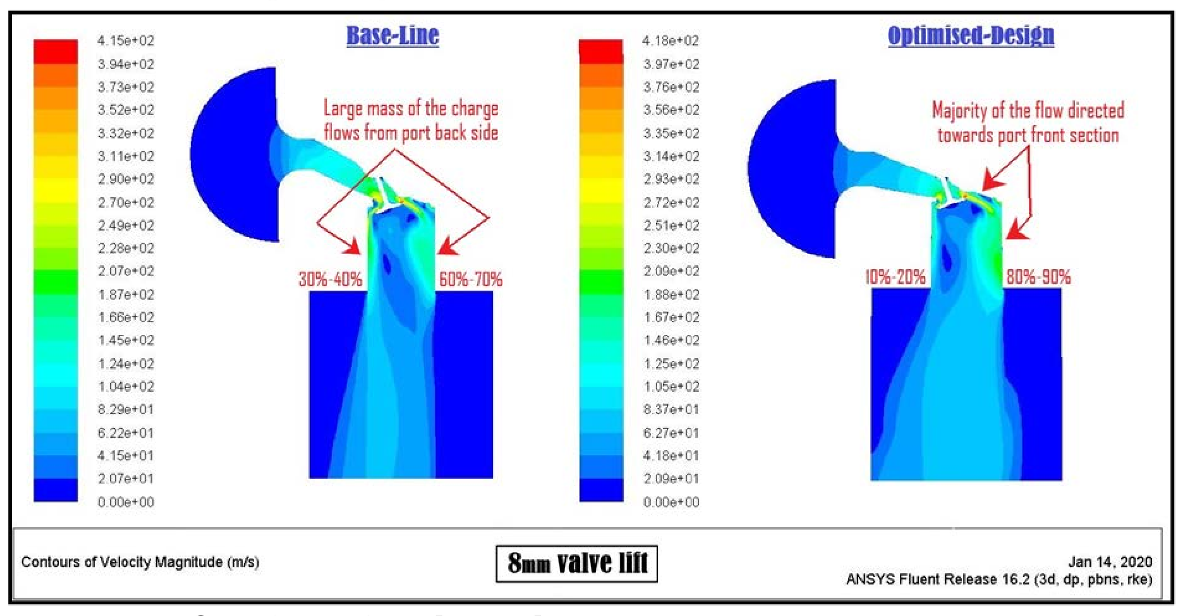
It was evident throughout this study, and by many researchers [3, 4], that an optimised high-tumble port, significantly improve the in-cylinder turbulence, and subsequently, the overall engine performance level.



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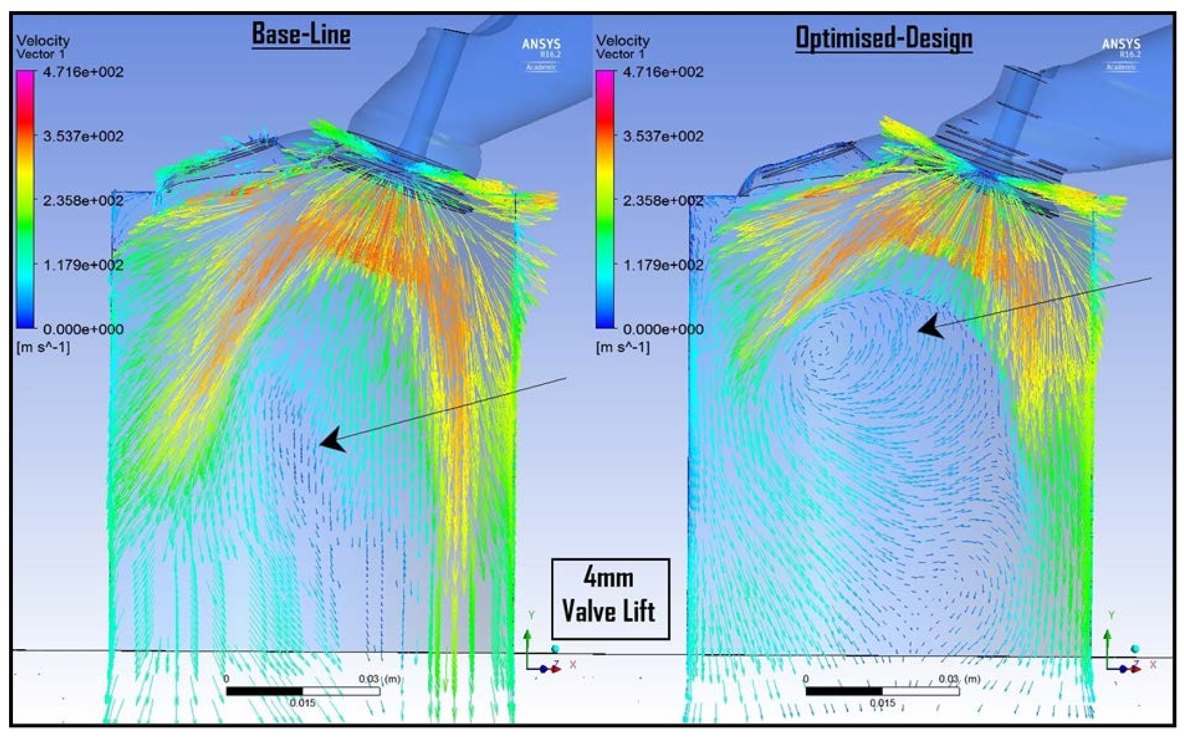

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Conclusion

In the current research, a 1.6 Ford Ecoboost intake-port has been investigated, throughout the application of reverse engineering tools, CAE design, and CFD simulation, aided by experimental validation and theoretical work. The study aimed to analyse the influence of port geometry on the tumble-motion and introduce a new optimised design, where the results revealed, 7.72% and 17.8% increase in TI and TKE, respectively.

References

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