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# Flow in exhaust valve ports and manifolds

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Abstract

Vehicles with internal combustion (IC) engines fueled by hydrocarbon compounds have been used for more than 100 years for ground transportation. During the years and in particular in the last decade, the environmental aspects of IC engines have become a major political and research topic. Following this interest, the emissions of pollutants such as $NO_x$, $CO_2$ and unburned hydrocarbons (UHC) from IC engines have been reduced considerably. Yet, there is still a clear need and possibility to improve engine efficiency while further reducing emissions of pollutants. This project aims at increasing understanding of the gas flow in the exhaust part of the gas exchange system by computational methods. The flow is shown to exhibit strong unsteady features that may affect the efficiency of the gas exchange system.

## Background

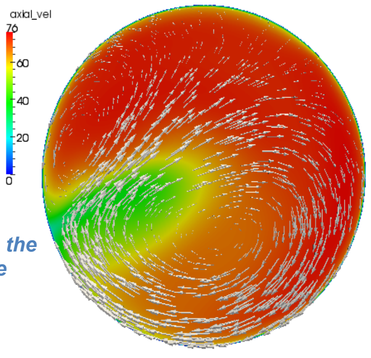
The maximum efficiency of IC engines used in passenger cars is no more than 40% and considerably less than that under part load conditions. One way to improve engine efficiency is to utilize the energy of the exhaust gases to turbocharge the engine. While turbocharging is by no means a new concept, its design and integration into the gas exchange system has been of low priority in the power train design process. One expects that the rapidly increasing interest in efficient passenger car engines would mean that the use of turbo technology will become more widespread. The flow in the exhaust ports and manifold manifold determines the flow into the turbine, and thereby the efficiency of the turbocharging system. This project aims at increasing understanding of the flow in the exhaust port and manifold with respect to unsteadiness, the generation of large scale flow structures and generation of flow losses.

## Method

The flow in these engine components were analyzed by computational methods, both Reynolds Averaged Navier-Stokes (RANS) and Large Eddy Simulation (LES).

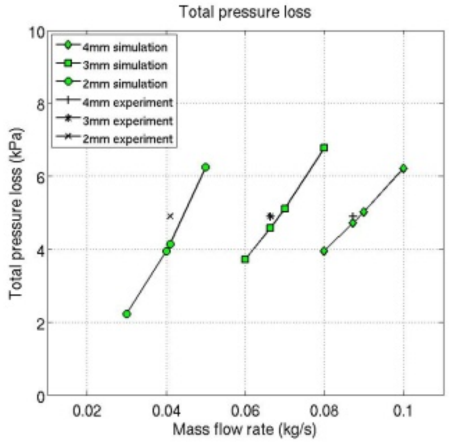
## Results

*Generation of structures at the valve body visualized by the $\lambda_2$ criterion*




*Large scale vortices in the port downstream of the valve*

## Results




*Comparison of experimental and computational results*

## Conclusions

The flow in the exhaust port and manifold is shown to be highly unsteady with strong secondary flows and significant regions of separated flow. These phenomena *can not* be investigated by common engineering methods like RANS and, in order to gain insight and increase the understanding of these flows, more advanced methods (LES) must be used. As a result of the increasing demands of efficiency, design of future gas exhange components will need to account for the unsteady features of the flow in an accurate way and thus use LES as a tool in the design process alongside with RANS.