KTH CCGEX

Valve Strategies and Exhaust Pulse Utilization

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This project aims to improve the understanding of how pulsating exhaust flow from the internal combustion engine interacts with the exhaust turbine of the turbocharger. Variable valve actuation is used to influence the exhaust pulse properties to increase turbine efficiency and thereby improve fuel efficiency. The interaction will be primarily studied with 1-D simulation software supported by experiments on a single-cylinder diesel engine equipped with a hydraulic variable valve actuation system and a six-cylinder diesel engine equipped with a fixed geometry turbocharger.

Motivation

One way to improve the fuel efficiency of turbocharged internal combustion engines is to reduce the pumping loss, i.e. the work required induct fresh air in to the cylinder and expel the exhaust gasses. This is a difficult system to optimize as turbines are fundamentally steady flow devices with a narrow operating range and piston engines produce an unsteady exhaust flow over a wide operating range. This project will investigate how the turbine efficiency can be influenced through changing the pulsating exhaust flow by controlling the exhaust valves.

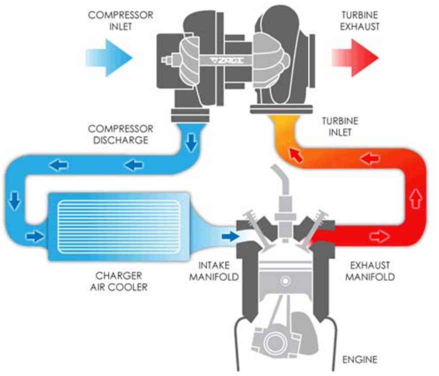


Figure 1. Schematic drawing of turbocharged internal combustion engine.

Experiments

To vary the exhaust pulse shape at the turbine inlet a custom manifold was constructed. The overall manifold volume was varied by adding cylindrical volumes to bends welded to the standard exhaust manifold. During the test campaign different volume configurations were investigated, for example using four volumes or two volumes at various positions. The exhaust manifold was then installed on a Heavy-Duty Scania engine and the effect on turbine efficiency investigated at different operating conditions.

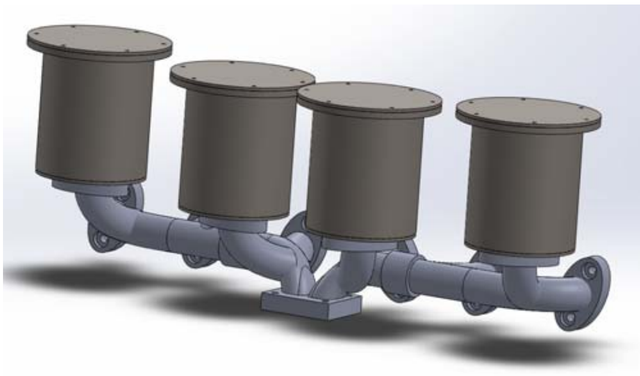
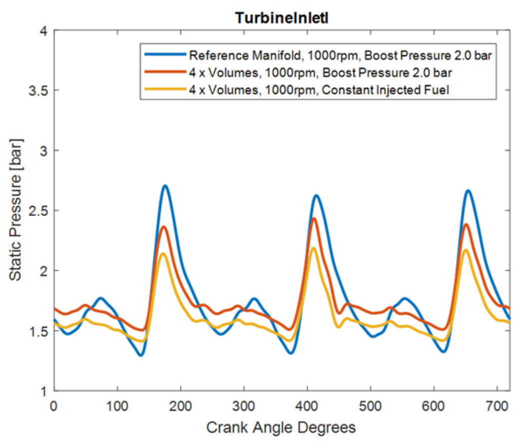


Figure 2. Exhaust manifold with four cylindrical volumes added.

Preliminary Results

The effect of the larger exhaust manifold volume didn't influence the exhaust pulse shape at the turbine inlet as expected. One-dimensional simulations performed before the experimental campaign predicted a more attenuated pressure signal when increasing the exhaust manifold volume. The source of this discrepancy is unknown at this time. When matching boost pressure by increased fuelling , neither the rate of pressure rise nor the peak pressure amplitude was influenced significantly. This will be further investigated by calculating the turbine efficiency for the different test cases.



Preliminary Conclusion

The increased exhaust manifold volume appears to have a limited influence on the pulse shape, the rate of pressure rise and peak pressure is comparable to the reference manifold when matching boost pressure.

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