Challenges of Turbocharging a Two-Cylinder Engine – A Computational Analysis of a Turbocharger Turbine by Transient CFD Methods

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Long Abstract

Introduction

Today's drive train development is being pushed by continuous demands for reduced emissions and growing expectations for driving dynamics coupled with declining fuel consumption. Downsizing in combination with turbocharging has proven to be a key technology to ensure increased power density and efficiency, both at reduced emission levels. Up to now quasi-steady behavior of the turbocharger has been assumed in the turbocharger design. However, the inflow conditions for radial turbines are actually quite different at real pulsating engine operation, compared to steady and quasi-steady conditions [1]. The aim of scaling down the fuel consumption by reducing the number of cylinders, as is currently being done, leads to a further change in the boundary conditions for the turbocharger [6]. As a result, the quasi-steady behavior, especially in two cylinder engines, does not seem to be valid and has to be taken into account during the design process [2], [3]. This paper shows the importance to consider the special flow characteristics for the optimization process of the turbocharger used in two-cylinder engines.

1. Methods

A sufficient time resolution of the mass flow and temperature is experimentally restricted and only feasible up to a certain degree [4], [5], [6]. Therefore, the advantages of CFD are used to analyze numerically the aerodynamics of an exhaust gas turbocharger turbine.

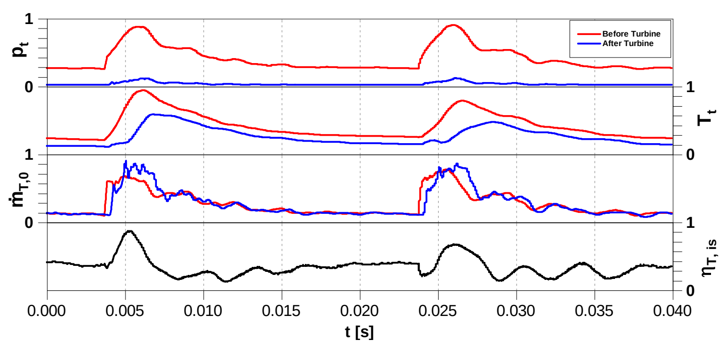

Figure 1. Flow behavior during a pulse

Two different cases, a two-cylinder and a four-cylinder engine setup, are used for the presented simulations. The aim of the study is to determine the effects of the fluid dynamics in relation to the cylinder number. The boundary conditions for the CFD have been created by a GT-Power model. The GT-Power results were previously validated by measurements from an engine test bench. The exhaust enthalpy is kept constant in both simulation cases to ensure that only the aerodynamic effects differ, while keeping the exhaust enthalpy of the gas constant for both cases.

References

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