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CFD model for turbocharger journal bearing performances

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ABSTRACT

Whether due to the Kyoto protocol or the European regulation to come in 2015, but also due to customer requirements, fuel consumption, and hence CO_2 emissions, have become one of the major issues for car manufacturers.

One of the most efficient ways to reduce the fuel consumption is to downsize the engine, specifically by increasing the engine-specific power and torque, as well as reducing the engine displacement and using turbochargers.

To achieve this target efficiently, the assembly of an engine and a turbocharger has to be well tuned. Turbocharger characteristics for low speeds are not provided by turbocharger manufacturers because compressor maps for low speeds cannot be set up with "ordinary" test benches. Unfortunately, in urban conditions, for engines operating at low speeds (1500 rpm) and low torque, the turbocharger speed is about 30000 rpm. In order to improve the performance of the turbocharged engine, the knowledge of the whole compressor map is required.

The knowledge of compressor performances in the low speed area could be improved by a better understanding of mechanical efficiency.

This paper proposes a 3D CFD model to compute power friction losses due to journal bearings. Computations were carried out for various oil entrance temperatures and rotational speeds. Results are presented and discussed, making comparisons with some sets of experiments carried out in the CNAM laboratory using a special turbocharger test rig equipped with a torque meter.

1. Introduction

This paper presents a 3D CFD model for turbocharger journal bearing friction losses.

When analysing a journal bearing, the generalised Reynolds equation [1] is used. This equation, issued from mass continuity and momentum conservation, has been solved in a non dimensional form, with various values of L/D ratio and eccentricity ratio [2]. the turbocharger's journal bearing [3]. Although, the calculated Sommerfeld number was too high to be included in this table, a linear approximation was considered between friction number and the Sommerfeld number but this approximation did not give the expected results. The computed power is too high and the approximation is unreliable.

Then, it was decided to solve the Reynolds equation by a finite difference method using the Gauss–Seidel iterative method in the