

Profile optimization of the teeth of the double rack-and-pinion gear mechanism in the MCE-5 VCRI engine

AUTHORS

Dr. Matthieu DUCHEMIN, MCE-5 DEVELOPMENT S.A.
Vincent COLLEE, MCE-5 DEVELOPMENT S.A.

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ABSTRACT

MCE-5 DEVELOPMENT has developed its variable compression ratio engine (VCRI) for over a decade aiming at reducing fuel consumption and pollutant emissions.

In order to transmit power from the piston (combustion) to the crankshaft, the MCE-5 VCRI technology is based on three innovative components: a gear wheel and two racks. This transmission is used in nonstandard conditions: the direction of rotation is reversed repeatedly, and the parts are submitted to high and rapidly varying loads. To avoid interference and alteration caused by high contact pressure at high load, and ensure a regular transmission at low load, the profile of the teeth is carefully considered. A crowning shape is placed on the teeth in the direction of the gear axis, and a correction is applied on the teeth root and the teeth crest.

A Design of Experiment (DOE) is realized on a light Finite Element 2D model in order to highlight the influence of the length, depth and type of correction on the maximum stress in racks and wheel teeth, contact pressure on the teeth surfaces, and speed ratio between the gear and racks. A refined Finite Element 3D model is developed in order to obtain more accurate results concerning the contact pressure and the stress on the teeth, and to take into account the crowning shape.

After endurance experiments on a test bench, a single cylinder engine and a multi-cylinder engine, first observations of the teeth show good correlation with the simulation.

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