Air-Mass Estimation for On-Line Control of SI Engines Based on Cylinder-Pressure Data

Autor: Michael Mladek

Description: In research and development of combustion engines, cylinder pressure measurements are a well-established tool for various applications. The sensors required for these measurements are expensive and their lifetime is rather limited. They are thus unsuitable for use in production engines where cost is an issue.

While modern sensors have become available that could be used in production engine control, existing sensors would have to be replaced by air mass details obtained from cylinder pressure information. Additionally, improvements of existing solutions are desirable.

The estimation of the air mass in the cylinder based on cylinder-pressure measurements has two main advantages: It allows the production-type air mass flow measurement to be replaced, and the air/fuel ratio control can be improved by using a cylinder-individual approach.

Since the majority of all combustion engines are based on the concept of spark ignition engines running at stoichiometric conditions, this is the main focus of this project. Furthermore, only this type of engine requires precise information about the air mass inducted.

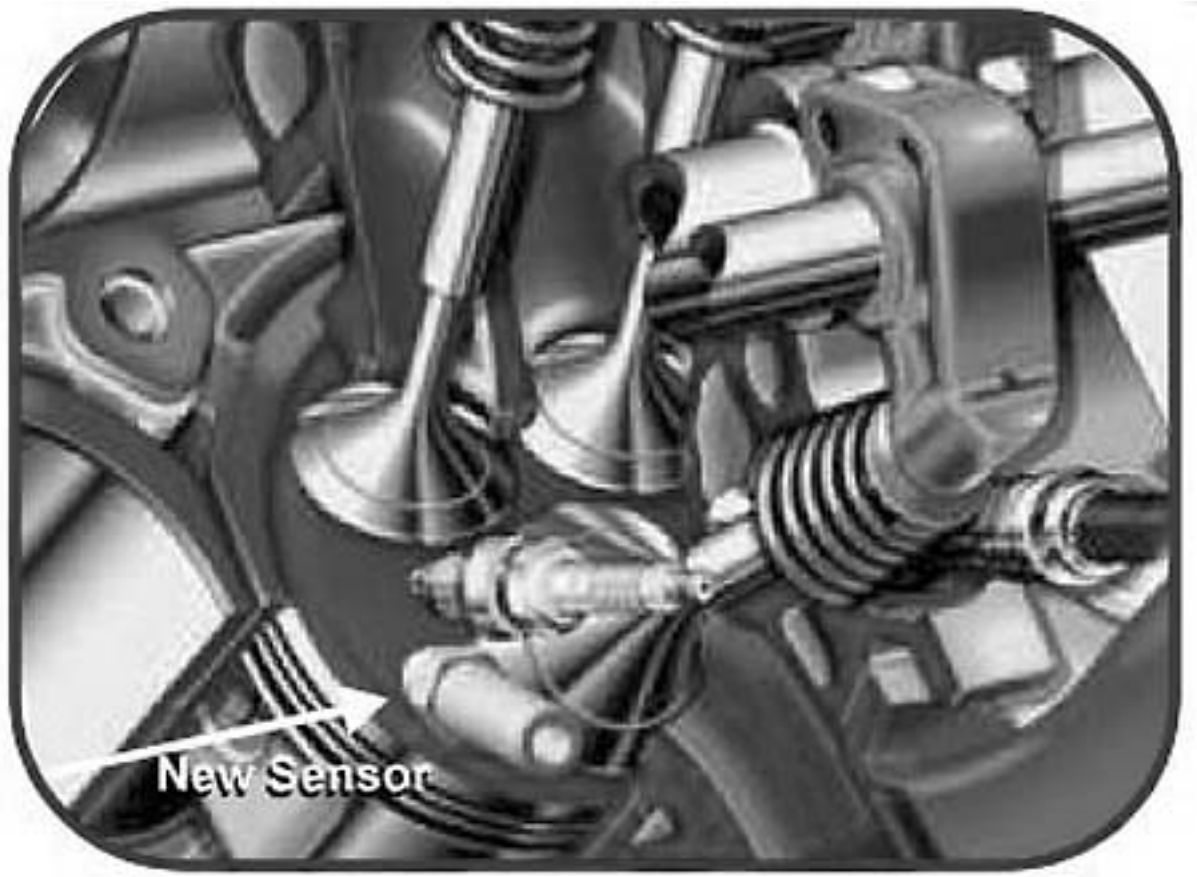
To allow for easy applicability of the method to different engines, strictly model-based methods are used.

The project is a collaboration of the Swiss Federal Institute of Technology and DaimlerChrysler.

Status: In a first step, measurements using high-quality pressure transducers were taken on a four-cylinder naturally aspirated engine. The data was analysed using thermodynamic simulation tools that provide information on the thermodynamic properties of the engine process. The results of this analysis were used for the development of the air mass estimation.

Since the algorithm developed relies on knowledge of the burn rate, the model uses a burn rate estimation which can be used for controlling the spark advance as well. The air mass estimation algorithm is based on the first law of thermodynamics, the ideal gas law, the polytropic relation, and certain engine characteristics acquired by test bench experiments.

This algorithm was implemented and tested in a six-cylinder engine equipped with production-type sensors and a computing environment for engine control based on cylinder-pressure data. The results derived are promising, but further work is needed to attain the accuracy of a production-type air mass flow measurement.



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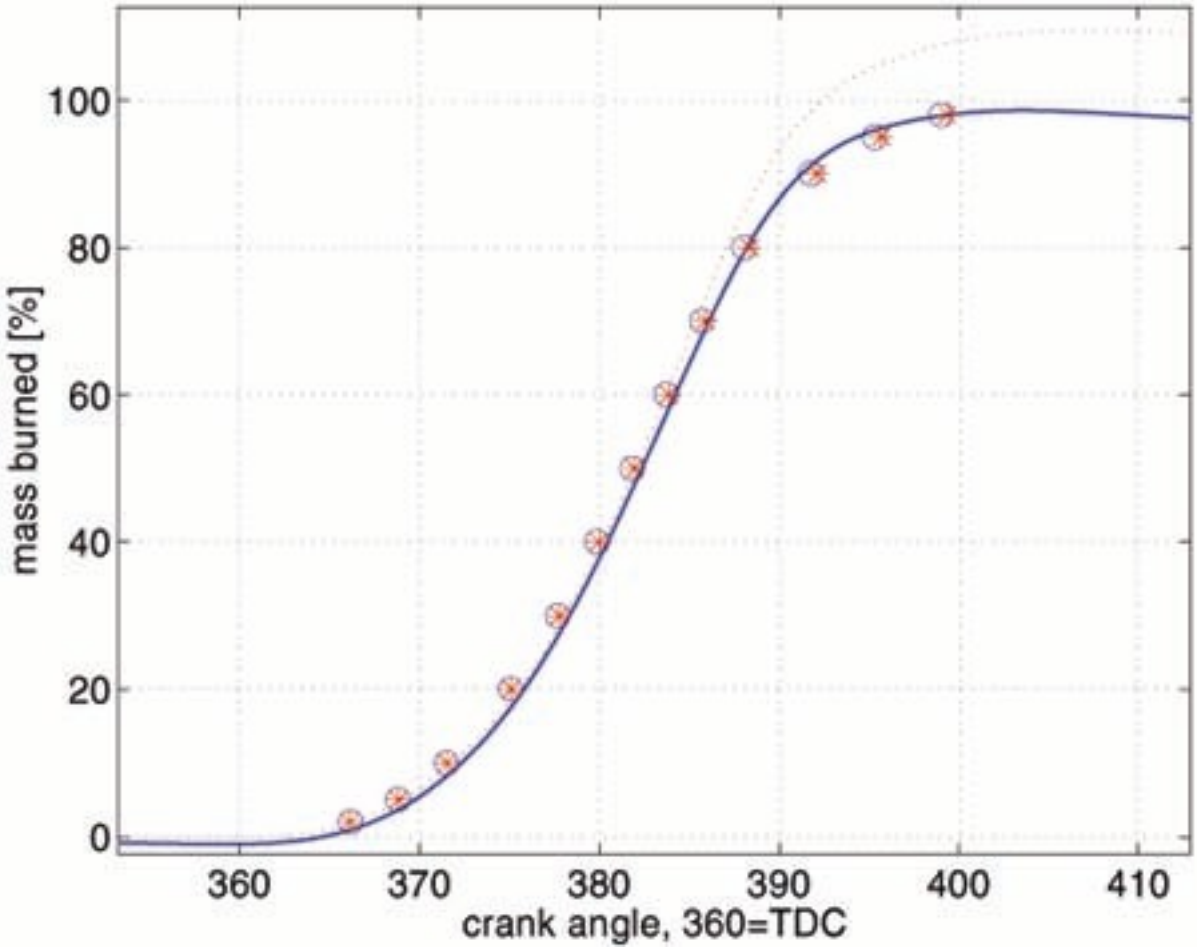

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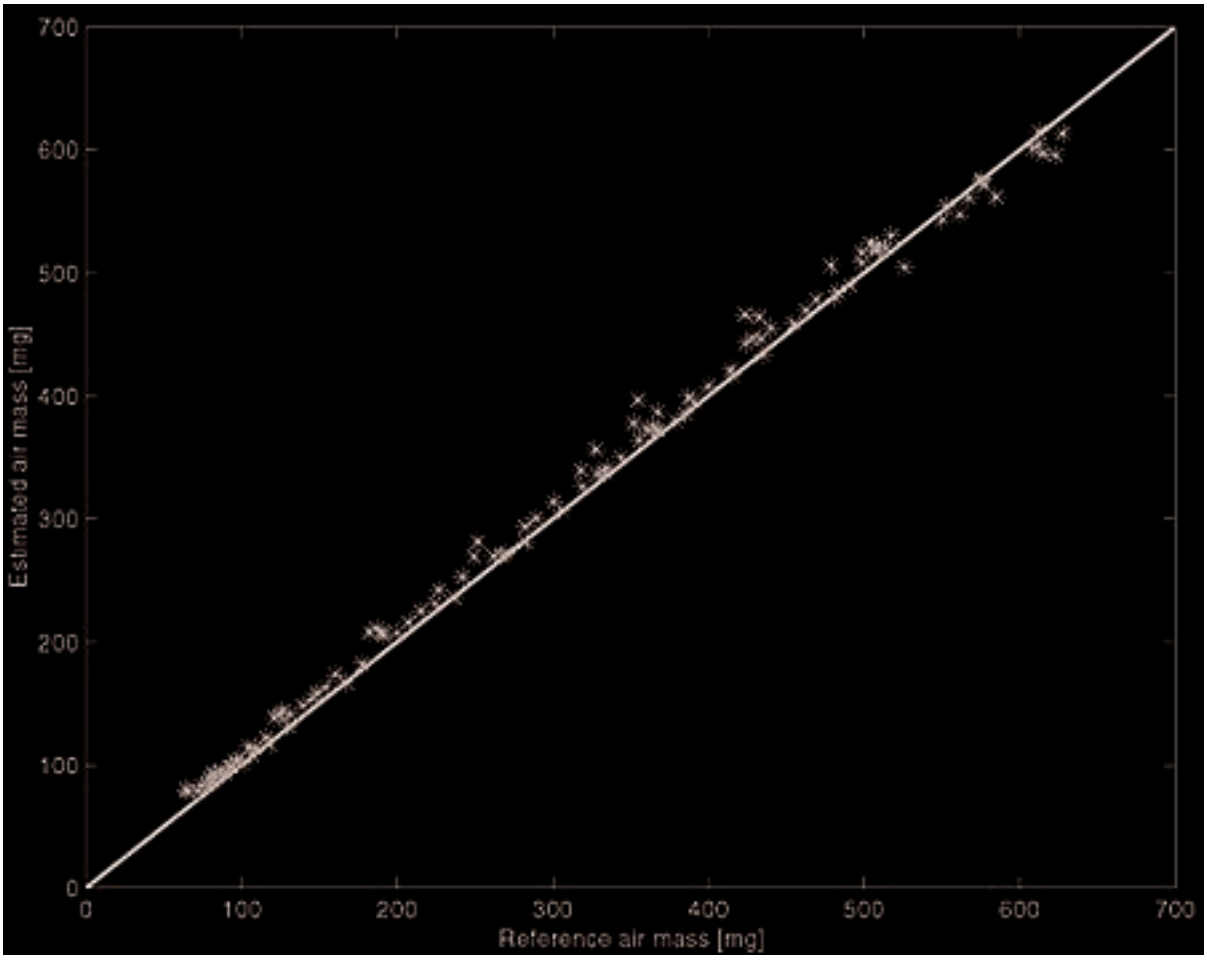

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