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Heat Release Calculation of Internal Combustion Engines by Analyzing the Flame Radiation with Crankshaft Angle Resolution

Abstract:
Improving efficiency and reducing emissions are the principal challenges in developing new generations of internal combustion engines. Different strategies such as downsizing or sophisticated after-treatment of exhaust gases are pursued. Another approach aims at optimizing the parameterization of the engine. Correct adjustments of ignition timings, waste gate position and other factors have significant influence on the combustion process. A multitude of application data is generated during the development process to predefine appropriate settings for most situations. Improvements in regards to the application effort and the quality of the settings can be achieved by measuring the combustion process and optimizing the parametrization in a closed loop. However, cylinder pressure sensors that are used during the development process are too expensive for series applications. This paper focuses on an affordable combustion sensor based on the measurement of the electromagnetic radiation of the combustion flame. The intensity of electromagnetic radiation by chemiluminescence is a good indicator for the status of the combustion as it is primarily dependent on the number of excited molecules. A characteristic spectral band is emitted by the OH
radical, which is created in the flame front and corresponds to the number of reactants that are
burned. A research engine was equipped with an access for an optical measurement system for
chemiluminescence and light emission in general. To achieve sufficient amplification and temporal
bandwidth, a special detector circuitry was designed. The measurement data was used to analyze
the quality of different light emission signals and to investigate their qualification for heat release
calculations.