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Spatiotemporal flame mapping in a large-bore marine diesel engine using multiple high-speed cameras

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Abstract

A calibrated multiple high-speed camera arrangement recording the flame emission from three different directions has been demonstrated on an engine. From the multiple views the flame position inside the engine cylinder can be spatially mapped, allowing quantitative studies of the dynamics of ignition, flame development and propagation. Through space carving the three-dimensional (3D) flame contour can be estimated. From this contour properties like flame length, flame height, ignition locations and flame directions can be extracted. The technique is demonstrated by measurements on diesel flames inside a marine two-stroke engine with a bore diameter of 500 mm. It is found to be a valuable tool for spatiotemporal flame mapping in this asymmetric industrial combustion system.

Keywords

high-speed, multiple cameras, engine, optical diagnostics, 3D, flame, diesel engine

Introduction

Optical and laser diagnostics have been used for many years in order to gain knowledge about fundamental combustion processes or to extract information from inside internal combustion engines. The techniques that have been developed over the years are robust and often offer high spatial and temporal resolution of flows, stoichiometry, temperature probing and chemical species imaging to name a few. Approaches like flame emission imaging and planar laser induced fluorescence (PLIF) have worked exceptionally well and are still the established evaluation methods. Although many imaging systems and diagnostic alternatives exist, most commonly the data acquired is two dimensional in nature, from a single point of view and often the signal is line-of-sight integrated. When it comes to practical combustion devices like internal combustion engines, the flame morphology is most often highly asymmetric and is perturbed by factors like in-cylinder