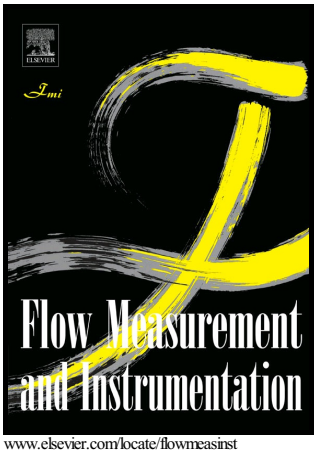

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Towards in-cylinder Chemical Species Tomography on large-bore IC engines with pre-chamber

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Abstract

A feasibility study is presented and the achieved key design milestones towards the first application of Chemical Species Tomography by Near-IR Absorption Tomography on a heavy duty, large-bore marine engine to visualise relative mixture strength are described. The engine is equipped with pre-chamber ignition and operates using Liquefied Natural Gas with > 88.9 % methane content. Operation of the engine under maximum-load conditions is a key design requirement, with peak cylinder pressure and mean temperature exceeding 127,510 Torr (170 bar) and 850 K respectively. The near-IR spectroscopic behaviour of methane is examined for suitable absorption and reference regions for the above application. In particular, the spectroscopic absorption around the 2ν3 transition region near 1,666 nm is approximated by simulation using data from the HITRAN database under worst-case conditions. The simulation results are compared with methane spectra experimentally acquired at high temperature and ambient pressure. Interference from other chemical species as well as measurement linearity is also investigated. A 31-laser beam tomographic imaging array is proposed, which has been optimised to achieve higher spatial resolution performance in the vicinity of the pre-chamber's orifices. To enable optical access, a novel, minimally-intrusive method is presented, utilising standard fibre-optics and collimators.

Keywords: Chemical Species Tomography, in-cylinder engine diagnostics, marine engine, pre-chamber, infra-red absorption spectroscopy

1. Introduction

Internal Combustion (IC) engines are currently in widespread application and will remain so for the foreseeable future. The combustion process of fossil fuels to drive these engines produces a multitude of reaction products, many of which are released into the atmosphere as gaseous and particulate emissions. Due to the detrimental effects of these emissions on the