The Summer Undergraduate Research Fellowship (SURF) Symposium
4 August 2016
Purdue University, West Lafayette, Indiana, USA

Fiber-optic imaging in an internal combustion engine test rig

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ABSTRACT

The formation of particulate matter (PM/soot), nitrogen oxides (NOx), and other byproducts of the combustion process in diesel engines is controlled by spatiotemporally varying quantities within the engine cylinders which traditional sensors cannot resolve. This study explores the use of an advanced sensing technique using an optical probe which can be used to produce highly spatiotemporally resolved in cylinder images of the flame formation during the combustion stroke. Using a fiber optic cable and custom lensing system adapted to fit a pre-existing pressure transducer port, light from within the cylinder can be transmitted through the imaging probe to a high speed camera where high resolution images of the flame are captured. This method enables no modifications to the engine geometry or materials, which ensures that the combustion and heat transfer characteristics are the same in the operating engine as they would be without the sensor implementation. Simulation results of an optical system to meet the desired design constraints are presented and discussed in addition to models of the imaging probe design. These results showed that an effective imaging system could be packaged within a narrow design envelope and produce high resolution images for a wide field of view.

KEYWORDS

Engine Optics, Diesel Engines, Combustion/Flame Visualization, Optical Diagnostics