Fast spatially resolved exhaust gas recirculation (EGR) distribution measurements in an internal combustion engine using absorption spectroscopy.

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Appl Spectrosc. 2015 Sep;69(9):1047-58. doi: 10.1366/14-07796. Epub 2015 Aug 6.

Abstract

Exhaust gas recirculation (EGR) in internal combustion engines is an effective method of reducing NO_x emissions while improving efficiency. However, insufficient mixing between fresh air and exhaust gas can lead to cycle-to-cycle and cylinder-to-cylinder non-uniform charge gas mixtures of a multi-cylinder engine, which can in turn reduce engine performance and efficiency. A sensor packaged into a compact probe was designed, built and applied to measure spatiotemporal EGR distributions in the intake manifold of an operating engine. The probe promotes the development of more efficient and higher-performance engines by resolving high-speed in situ CO_2 concentration at various locations in the intake manifold. The study employed mid-infrared light sources tuned to an absorption band of CO_2 near 4.3 μm, an industry standard species for determining EGR fraction. The calibrated probe was used to map spatial EGR distributions in an intake manifold with high accuracy and monitor cycle-resolved cylinder-specific EGR fluctuations at a rate of up to 1 kHz.

"….The Signal LED, centered at 4.15µm (Ioffe, LED42Sr via Boston Electronic Corp.), measures CO_2 absorption and non-absorption losses such as scattering and attenuation, e.g. from soot-fouled optics. The Reference LED, centered at 3.8µm (Ioffe, LED38Sr via Boston Electronic Corp.), measures only non-absorption losses…."