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Extended Abstract

Experimental investigation of the air–fuel charging process in a four-valve supercharged two-stroke cycle GDI engine

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Abstract

Fuel consumption standards imposed in several countries for the next years have prompted the development of hybrid passenger cars with ever smaller internal combustion engines. In such powertrain, fuel consumption is as important as engine packaging and power density, so two-stroke engines may be an option due to their higher combustion frequency compared to four-stroke engines. Therefore, the present research investigates the air–fuel charging process of an overhead four-valve direct injection supercharged engine operating in the two-stroke cycle. The optimum start of fuel injection was evaluated for commercial gasoline by means of indicated and combustion efficiencies where a trade-off was found between early and late fuel injections. By advancing the injection timing, more fuel was prone to short circuit to the exhaust during the valve overlap, while late injections resulted in poor charge preparation. The gas exchange parameters, i.e. charging and trapping efficiencies, were obtained from seventy operating points running at fuel-rich conditions. The Benson–Brandham mixing-displacement scavenging model was then fit to the experimental data with a coefficient of determination better than 0.95. With such model, the air trapping and charging efficiencies could be estimated solely based on the scavenge ratio and exhaust lambda, regardless of the engine load, speed, or air/fuel ratio employed. Further twenty-five different lean-burn testing points were tested to certify the proposed methodology applied to the poppet valve two-stroke engine. The in-cylinder lambda was calculated and found different from the exhaust lambda due to mixing between burned gases and intake air during the scavenging process.Due to the gradual reinforcement of emission regulations, exhaust gas after-treatment systems have become more complicated, and various engine control algorithms have been applied to diesel engines. However, the misuse of advanced exhaust gas after-treatment systems could cause additional problems. For instance, diesel vehicles that use of a diesel particulate filter (DPF) generally require periodic active regeneration. While operating active regeneration by in-cylinder post-injection, the fuel impinging on the cylinder wall would become the cause of oil dilution. Furthermore, if, in the event of excessive oil dilution, engine oil overflows in the engine oil pan, engine stalling or unintended acceleration (engine over-run) can occur, as lube oil flows into the combustion chamber through the intake manifold. The present study tested engine overrun by overflowing engine oil diluted with fuel on various engine operating conditions and clarify the engine control factors effect on engine stalling or unintended acceleration using regression analysis. Vehicle tests based on engine test analysis were also conducted to evaluate and reproduce the influence of unintended acceleration by automotive lube oil backflow in real driving. Vehicle test results indicate that unintentional acceleration could occur due to oil dilution, which put the driver at risk.Many researchers have considered air quality degradation due to the emission of fine particles from industrialized and urban areas during recent decades. Recently, the European Parliament has had concerns about ensuring a healthy human environment. Therefore, the experimental and theoretical investigations of the dynamics of fine particulate matter are for determining efficient monitoring and cleaning air from industrially generated air pollutants. These investigations also imply the use of alternate methods that stimulate fine particle agglomeration. One of the methods is the use of acoustics. Many experimental investigations of particles with a diameter between 1 and 10 μm have proven that the use of acoustic agglomeration increases the particle size. Then, conventional air filters can be used to collect the larger particles. This process improves the collection efficiency of the particles. Particulate agglomeration chamber consisting of an acoustic field generator and an inner part was created for the test particles of diesel engines (range from 0.3 to 10 μm). Modeling of its elements was performed using Comsol multifunctional software. This sound pressure level is enough [1] to lead the acoustic agglomeration process of particles in the measurable range from 0.3 to 10 μm. The sound pressure level reach this value (130–140 dB) at the acoustic agglomeration zone.

Additionally, the theoretical evaluation of the agglomeration time of two sub-micron particles enabled the estimation of efficient agglomeration of particles with sizes between 0.3 and 10 μm during the measurement period. A starting value of 136 dB of sound pressure level (SPL) was created in the experimental chamber with the turbulence condition, where SPL values were measured by using the Bruel&Kjaer measurement system “Type 9727” with hydrophone 8104. The observation concentrations of diesel engine exhaust particles in the experimental chamber with and without acoustic influence were performed using Particle Concentration Analyzer 4 APC

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ErgoTouch Pro 2.The results of experimental research shows that the acoustic agglomeration effect formed the proper conditions for the agglomeration of particles of all diameters (0.3, 0.5, 1.0, 3.0, 5.0 and 10 μm).The performance of electrical discharge machining (EDM) primarily depends on the spark quality generated in the inter-electrode gap (IEG) between the tool and workpiece. A method for obtaining accurate information about the spark gap is required to effectively monitor the EDM process. The rise and fall of thermal energy in the discharge zone at a rapid rate during the dielectric breakdown produces high-pressure shock waves. This work explores the suitability of using acoustic emission (AE) generated from these shock waves and the elastic AE waves released on the workpiece due to the induced stress to monitor the performance and spark gap in EDM. The information content of the AE signals acquired at various machining conditions was extracted using AE RMS, spectral energy and peak amplitude. These features were able to well discriminate the machining condition, tool material, workpiece material, flushing pressure, current density, the initial surface roughness of the tool. Additionally, the AE signal features had a good and consistent correlation with the performance parameters, including material removal rate, surface roughness (Ra and Rq) and tool wear. The findings lay the groundwork to develop an effective, non-intrusive in-situ AE-monitoring system for performance and IEG condition in EDM.

Keywords: Two-stroke cycle engine · Overhead poppet valves · Fuel injection timing · Gasoline direct injection · Benson–Brandham scavenging model · Lean-burn combustion