Quantitative Analysis of Engine Deposit Formation and Intensive Sustainability Study

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A single cylinder spark ignition engine has been used to study the formation mechanism of combustion deposits on a combustion chamber and exhaust pipe. The accumulation of deposit is a complex process that involves multiple factors initiated from fuel, oil, and additives, as well as various engine operating conditions. This work focuses on investigating the impact of these factors on the early stage of deposit formation, where a sample plug and a sample tube are used for deposit collection from a cylinder head and an exhaust pipe, respectively. Typical engine operating parameters are selected during a bench test to represent various working conditions. Accordingly, quantitative analysis is carried out to identify the effects of fuel, oil, and additives on deposit formation. In particular, a thermogravity analysis has been employed, so that weight changes of combustion deposits could be measured qualitatively while being heated. This dual gas method has been shown to be effective in calculating the change in deposit weight when shifting atmospheric gas from nitrogen to oxygen during a heating process, by which the amount of organic and inorganic substances can be differentiated. Volatilization of deposits is observed through the weight loss process, which makes it easy to distinguish different thermal events via the actual 2D curves of weight loss vs. temperature. In addition, theoretical analysis is performed to determine the role of combustion deposits on emissions, fuel economy, and engine power. The issue of sustainability is then discussed on both chemical and mechanical bases. A sustainable close-loop structure is also proposed in terms of ideas for a model reference adaptive control for enhancing engine performance with the presence of combustion deposits.

Combustion deposit formation on a SI engine is a complex phenomenon which relies on numerous factors of fuel, oil, additives, and engine. The objective of this study is to examine the actual effects of operating conditions, gasoline, lubricating oil, and additives on deposit formation. Both experimental investigation and theoretical analysis are conducted on a single cylinder SI engine. Consequently, the impact of deposits on engine performance and exhaust emissions (HC, NOx) has been indicated. Using samples taken from the cylinder head and exhaust pipe, as well as switching gases via the dual gas method (N_2, O_2), the deposit formation mechanism is thoroughly investigated in terms of a thermogravity analysis approach, where the roles of the organic, inorganic, and volatile components of fuel, oil, and additives on deposit formation are categorized via several equilibrium levels and related substance percentages on thermogravity curves, along with the heating temperature. A sustainable close-loop design method via adaptation is proposed for potential engine emission control and performance optimization.