Electrical Discharge Enabled Oxidative Desulfurization of Diesel Fuel

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The primary objective of this work was to examine how non-thermal plasmas generated through electrical discharge (i.e. corona discharge) may be used to drive chemical reactions in microscale reactors. Our work has investigated reactions in both gaseous and liquid media. We will limit the discussion here to liquid phase reactions only, particularly to the oxidative desulfurization of refractory sulfur compounds in fuel-like media. The oxidation of dibenzothiophene to dibenzothiophene sulfone and sulfoxide in fuel-like media has been chosen as a model reaction that is representative of this system's performance. Dibenzothiophene is a refractory sulfur compound in traditional hydrodesulfurization processes related to the oil and gas industry. Efficient oxidation to the sulfone and sulfoxide form allows for advanced separation techniques to be employed in sulfur removal from products like ultra-low sulfur diesel fuel. It has been shown that oxidative desulfurization processes offer improved fuel product quality and energy savings.

Investigating the performance of the non-thermal plasma microreactor in the model chemical reaction will allow for general conclusions to be drawn about the systems performance and will allow for preliminary mathematical modeling. Preliminary work in our labs has demonstrated that the corona discharge activated oxidation of sulfur compounds in fuel-like media takes place. The development of an efficient corona discharge activated microchannel reactor could lead to an efficient approach to diesel desulfurization through advanced oxidation. Additionally, this novel approach to the general activation of chemical reactions through electrically generated plasmas in microreactors could open new processing options for various applications.