Editor’s Note: Advances and new trends in next generation of fuels and engines

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The new stringent regulations on emissions and a fast paced technological advancements call for a serious breakthrough in both engine system modification and also the fuel composition. In this regard, for sustaining the engine power and low emissions homogeneous charge compression ignition (HCCI), premixed charge compression ignition (PCCI), and reactivity controlled compression ignition (RCCI) engines have been proposed during recent years to take over conventional SI and diesel engines to somehow be responsive for the demand of higher power generation and low emission restrictions. Although some of these engine types could not been manufactured or were not practical in reality and some showed serious drawbacks, the researchers and engineers are still working theoretically, and numerically to obviate these problems. Another important achievement was to make the engine adaptable to operate in dual-fuel mode. RCCI engine is among these kinds of engines, which gives more flexibility on controlling the combustion with two fuels of different reactivity, one with lower reactivity tendency to increase the time for mixing, and the other with high reactivity injected just before ignition. There have been several examples of dual-fuel engine operation such as diesel-gasoline, diesel-ethanol, methanol-diesel, natural gas-diesel, etc.

On the other hand, alternative fuels especially with bio based origin are becoming a new trend, which is aligned with the concept of Green Energies. The most frequent fuels used in diesel engines are Di Methyl Ether (DME), n-heptane, and methane. These fuels have different lower heating values (LHVs), density, viscosity, boiling point, flash point, and other physiochemical quantities. The chemical and molecule bonds of the alternative fuels lead to release of various amounts of energy and combustion heat. The chemical reactions have products and byproducts that sometimes the gases are hazardous to environment and have healthy related implications. It is proved that biofuels have lower smoke and soot, but due to higher content of oxygen in fuel composition, the NOx emission is comparatively higher than conventional diesel and the energy density of biofuel is lower than that of diesel. According to released statistics on Biodiesel & Renewable market of U.S. [1], the biodiesel industry has a steady growth over years such that in 2016, the market of biofuels hit a record mark and there was a 2.8 billion commercial activity. This growth and promising outlook is outlined in Fig. 1, according to EPA source.

The wide application of nano-particles in the wide range of engineering, medical, and industrial area and its wonderful effects is proven nowadays. Adding these nano scaled particles to fuels and combustion of blended and nano contained fuels demonstrated new features in engine performance and emissions reduction features, although yet noneconomic. The particles could be Cerium oxide (CeO₂) and Aluminum oxide (Al₂O₃), or other nano particle, which meddle in composition of fuels and have the important influence particularly in spray breakup and weakening the surface tension and liquid surface wavelength, which ultimately can ease the liquid jet column disintegration. The nano-additives are in general effective in emission reduction, although little has been proven to show engine performance boost.

Altogether based on what indicated above, it can be predicted that general direction of future research aims toward application of next generation of engines offering reliability in reduced emissions and increased efficiency. This includes using even boundary breaking adventures such as blend of biofuels with nano additives to experience the ultimate fuel composition, giving extra power and yet below international emission par.
Figure 1. Consumption of biodiesel and renewable fuel source annually in U.S. (EPA reported data)

References


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