Physiochemical Property Characterization, Azeotropic Volatility Behavior, and Soot Tendency of Hydrous and Anhydrous Ethanol Gasoline Mixtures

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Water removal from bio-ethanol obtained from fermentation is highly energy intensive. At the azeotrope point, the mixture can no longer be separated via fractional distillation, requiring expensive and energy intensive methods for further purification. Hence, there is an interest in using hydrous ethanol at the azeotrope point to improve the energy balance of fuel ethanol production. In this study, gasoline as a reference fuel was blended with 10 %, 15 % and 30 % by volume of anhydrous and hydrous ethanol named as E10, E15, E30, H10, H15, and H30. Hydrous ethanol was prepared by blending 96 vol. % of anhydrous ethanol with 4 vol. % of deionized water. The distillation curve, Reid vapor pressure, vapor lock index, viscosity, density, copper strip corrosion, haze and phase separation points, and lower heating value were measured for all samples to characterize hydrous and anhydrous ethanol blending effects on gasoline properties. In addition, droplet evaporation and direct injection engine models were exploited to understand how non-ideal volatility behavior of these blends can inhibit complete fuel-air mixing and potentially contribute to soot formation in direct injection systems. Results showed that properties of low and mid-level hydrous ethanol blends are not significantly different from those of anhydrous ethanol blends with viscosity and phase separation temperatures showing the most sensitivity to water. Thus, based on these results, hydrous ethanol blends have the potential to be used in current systems as a drop-in fuel with little to no adjustments.