Micro-explosion and Burning Characteristics of a Single Droplet of Petrochemical Heavy Oils

Krishna Ahuja[1], Yueh-Heng Li[1,2], Guan-Bang Chen[2],Yei-Chin Chao[1], Yu-Ting Yang[1]

1. Department of Aeronautics and Astronautics, National Cheng Kung University, Tainan, 701, Taiwan
2. Research Center of Energy Technology and Strategy, National Cheng Kung University, Tainan, 701, Taiwan

Synthetic oil is mainly the oil after the upgrading of asphalt, and asphalt mixed oil is mainly the natural asphalt oil mixed with diluents. The natural asphalt oil can be divided into asphalt mixed oil (Dilbit), synthetic oil (SCO) or asphalt synthetic oil (Synbit). The asphaltene oil (pyrolysis fuel oil, PFO) is a high-value product extracted from fuel oil, and deasphalted oil (DAO) removes asphaltene from PFO. In the study, the ratios of DAO/PFO and their oxidation reactions are investigated using thermogravimetric analysis. The mixtures of DAO/PFO are less viscous than the heavy fuel oils (HFO). The flash point of these mixtures is less than the HFO. The results are also used to evaluate the characteristic combustion properties such as the ignition temperature, burnout temperature, and combustion characteristics index. The suspended droplet experimental system is also used to explore the micro-explosion phenomenon and combustion modes of petroleum based fuel under different ambient temperatures. The petrochemical heavy oils are a multi-component fuel and have a complex process during the heating process and the micro-explosion occurs, causing the droplet surface distortion. Micro-explosion occurred at 550^{o}C, more volatile vapors are released and the flammable mixture is formed a flame wrapping around droplets after ignition. During the droplet combustion process, the micro-explosion occurred continuously, but the droplet still maintained a sphere-like appearance. The ignitiondelay time of the ordinary HFO is longer than that of the mixtures with the rates of DAO/PFO equal to 1:1, 1:2, and1:4. Droplet experiments of HFO, DAO/PFO1:1, DAO/PFO1:2, DAO/PFO1:4 were performed to investigate the non-steady behavior of the burning droplets. High speed camera is allowed to monitor the various combustion stages. The peak temperatures of the DAO/PFO rates equal to 1:1, 1:2, and1:4 occurred much earlier in time. At 550^{o}C the droplet would completely burn and leave tar behind. The combustion characteristics index(S) of DAO/PFO ratios is better than that of ordinary Heavy fuel oil. Nevertheless, the variation of droplet size generally followed d^2-law.

Keywords: Micro-explosion, Suspended droplet experiment, Thermogravimetric analysis, droplet combustion, DAO/PFO ratios

Correspondence to: kahuja67@gmail.com