These water separability tests are vital to the proper characterization of jet fuels as even the slightest change to fuel composition can affect the performance of filter-separator equipment. Notably, fuel purification efficiency is reduced by certain fuel additives and even trace amounts of surfactants [4]. If even a small amount of water is to pass through filtration above a certain allowable threshold, it can freeze within the fuel system of an aircraft potentially causing serious damage to it. Thus, ASTM D3948 and ASTM D7224 were created to detect the traces of refinery treating residues and additional substances picked up during handling or transportation such as the presence of surfactants, and characterize the separation of water from standard aviation turbine fuel and kerosene-type aviation turbine fuel, respectively. These test methods create a water-fuel sample emulsion in a syringe with a high-speed mixer, which is then expelled at a specific rate through a fiberglass coalescer. Afterwards, the effluent is analyzed for uncoalesced water via light transmission measurement. The results are then scaled from 0 to 100 with the minimum passing rating of 85 without static dissipater additive (SDA) or 70 when SDA is required. ASTM D3948 in particular has been a mandatory test method according to ASTM D1655, JIG Bulletin 125, CAN/CGSB 3.23 and 3.24 with over 40 years of testing for aviation safety. 

Another recently developed test method, ASTM D8073, utilizes a different method by which to characterize the water separation of aviation turbine fuel. ASTM D8073 creates fluorescent dye and water mixture which is then sonicated with jet fuel to create a water-fuel sample emulsion. The emulsion is pumped to both a sample chamber which bypasses the filter and the filter directly. An instrument would then measure the fluorescence of the dye of the samples which bypassed the filter and that of the sample which was filtered to create a measurement of the jet fuel’s water separation properties. ASTM D8073 similarly rates the results on a scale from 0 to 100, however, the minimum passing rating is 88 whether or not SDA is required for the jet fuel. The main issue lies in the reactivity of the fluorescent dye with surfactants since the fluorescence of this dye is directly measured during the process to characterize the fuel. The fluorescent dye utilized for ASTM D8073 was created in reference to an anionic surfactant doxyl sulfosuccinate sodium salt (AOT). As such ASTM D8073 is highly tuned to AOT but shows weak performance when it is attempting to characterize fuels that contain surfactants which are not classified as anionic. Thus, the selectivity of the fluorescent dye in ASTM D8073 has been shown to produce inconsistent test results in relation to ASTM D7224 despite being labelled as an equivalent test method. The only means to ameliorate this issue is if the fluorescent dye is matched appropriately to the surfactants to be measured a feat which is easier said than done. Another issue regarding ASTM D8073 is the sonication required to emulsify the water-fuel sample. When utilizing sonication for the emulsification process particles tend to clump together creating agglomerations of varying sizes, which further obscures test results, producing inconsistencies. 

When comparing the various ASTM test methods, it is clear that ASTM D8073 is not as well rounded as ASTM D3948 or ASTM D7224. The irregularity of ASTM D8073 makes it difficult to utilize for the proper characterization of jet fuel and until these irregularities are ameliorated ASTM D8073 cannot compare to ASTM D3948 or ASTM D7224. Thus, the Emcee Electronics Inc. water separability testers such as the Micro-Separometer instrument, rely on the tried and truly effective ASTM D3948/
ASTM D7224 to properly characterize jet fuel. The Emcee water separability tests are the only ones voluntarily performed by hundreds of labs under the ASTM Proficiency Testing Program. As a result, the Emcee Electronic Inc. water separability instruments are rigorous and apply to a variety of jet fuel; in fact, the Emcee Micro-Separometer Instrument can not only test jet fuel but also detect the presence of refinery treating chemicals left in diesel and biodiesel blends up to B20 and B100.

References:


About the Authors

Dr. Raj Shah is a Director at Koehler Instrument Company in New York, where he has worked for the last 25 years. He is an elected Fellow by his peers at IChemE, STLE, AIC, NLGI, INSTMC, The Energy Institute and The Royal Society of Chemistry. A Ph.D in Chemical Engineering from the Pennsylvania state University and a Fellow from the Chartered Management Institute, London, he is also a Chartered Scientist with the Science Council, a Chartered Petroleum Engineer with the Energy Institute and a Chartered Engineer with the Engineering council, UK. An ASTM Eagle award recipient, Dr. Shah recently coedited the bestseller, “Fuels and Lubricants handbook”, details of which are available at https://www.astm.org/DIGITAL_LIBRARY/MNL/SOURCE_PAGES/MNL37-2ND_foreword.pdf


Isaac Kim is part of a thriving internship program at Koehler Instrument company and a student of chemical engineering at State University of New York, Stony Brook, where Dr. Shah is a volunteer adjunct professor and the head of the External advisory board of directors.

Mr. Allan Barberio is part of the senior leadership team at Emcee electronics, which is based in Florida.