AC Impedance and Gravimetric Techniques Applied to Assess the Corrosion Behavior of Carbon Steel and Degradation Processes of Soybean Methyl Biodiesel and Biodiesel/Petrodiesel B5 Blend

Eduardo Cavalcanti [(1)] , Thais M. Fonseca[(1)] , Lisiane G. Lima[(1)] and Hugo G. Jimenez [(2)]
[(1)] Corrosion and Degradation Division, National Institute of Technology, Rio de Janeiro, Brazil
[(2)] Institute of Energy and Environment, San Pablo University, Arequipa, Peru

In the present work AC impedance technique coupled to gravimetric and physicochemical standardized recommended practices were used in order to investigate the eventual corrosion and degradation behaviors of pure biodiesel (B100) and 5% biodiesel/petrodiesel blend. Static immersion tests were conducted at laboratory ambient temperature conditions (25 ºC ± 2 ºC) and at 43 ºC ± 0,1 ºC oxidizing conditions using a precision controlled water bath for six weeks. Test solutions were: S 500 grade petrodiesel (B0), soy methyl pure biodiesel (SOMB100) and 5% (SOMB5) biodiesel/petrodiesel blend. Qualitative and quantitative assessment of the state of the surfaces (using an optical 3D digital surface analysis – IFM) and physicochemical characterization of the test solutions were carried out before and after immersion. A closer attention was given to oxidation stability index, specific gravity at 20 ºC, appearance (turbidity) and water content determinations that were periodically monitored. Quantitative weight changes using quadruplicate 40 mm x 25 mm x 2 mm AISI 1020 type corrosion coupons and carbon steel common rail injection system components (screw and plate) were determined. They were weighed up to an accuracy of ± 0.1 mg and ASTM G1 and G31 procedures were followed to determine the corrosion rates in mm/yr. Results obtained revealed no evidence of uniform corrosion as well as no significant extent of localized attack. Pitting was not observed under the limits of detection of the digital optical device (< 2μm) for all specimens and devices. Very little amount of corrosion attack was found under all testing conditions (< 0.01 mm/yr). Surface tarnishing was only observed in the samples maintained in contact with SOMB100 at 43ºC for 6 weeks giving a corrosion rate of 0.012 mm/yr, which still means an outstanding behavior. AC impedance was applied to the above mentioned media firstly using two systems of two electrode cell set up showing a higher constant cell (0,1cm^{-1}). A second one was a smaller constant cell using an special sampler holder with two-parallel facing electrodes made of AISI 1020 carbon steel. The results have shown a non-faradaic behavior of all fuels studied under controlled ambient temperature conditions (21 ºC ± 2 ºC) as well as for selected fuels samples examined at higher temperature showing different stages of degradation. AC impedance technique was also found to be sensitive to monitoring the degradation extent of biodiesel as well as for the quality control of aging biodiesel deterioration processes. On top of that in the presence of free water droplets the AC impedance plots have changed considerably. In summary: AC impedance technique was demonstrated to be very useful for monitoring degradation and for assessing the corrosion behavior of steel in pure biodiesel and B5 blend.