STATE-OF-THE-ART FUEL ACIDITY MONITORING

Justyna Widera[†], Jay M. Johnson[‡]

[†]Innovative Scientific Solutions Inc. (ISSI), 2766 Indian Ripple Road, Dayton, OH 45440
jwidera@innssi.com
[‡]University of Dayton Research Institute (UDRI), 300 College Park, Dayton, OH 45469
johnsonjm@udri.udayton.edu

The measurement of acidity in organic liquids is a difficult, but important technique to ascertain the acidity of petroleum products. Information about acid content in fuel or lubricants is crucial, because it is an indicator of the quality of these products. An acidic reading may suggest for example, that an aircraft fuel has undergone thermal oxidation or that a lubricant has completely lost added antioxidants and needs to be replaced. A continuous monitoring of these systems would provide an early warning for failure of these fluids.

The commercially available pH sensors are designed to conduct measurements in the aqueous phase. The measurement of acidity in organic solvent products is much more difficult due to the complex and non-conducting matrix of petroleum products. Currently, the measurements of “Total Acid Number” (TAN) in non-conducting fluids are performed by a tedious, time consuming and solvent intensive ASTM Methods D 3242 or D 664 based on titration (1, 2). Clearly, a chemical sensor that could rapidly and reliably measure TAN in fuels and oils would be of tremendous use in specification testing, for monitoring, as an R&D tool for additive development, and for the smart nozzle application.

This presentation will describe our efforts to develop an iridium oxide based pH sensor suitable for work in low conducting media like Jet fuel for use in these applications. The sensing probe is potentiometric and basically consists of two (IE, RE) electrodes, where IE refers to the indicating electrode and RE to the reference electrode. A novel, iridium oxide electrode is utilized as the indicating electrode. After exposing the sensing probe to the solution containing the analyte of interest, the signal is observed as a change in potential relative to the reference electrode. We have conducted preliminary studies using this detector system and obtained data showing its range of detection of pH in aqueous and non-aqueous solutions. The results are going to be correlated with TAN. The data show that the IrO_x sensor responds to compounds present in fuel that have acid-base character. An off-line IrO_X sensor allows the determination of the acidity of different fuels and to discriminate between neat and thermally stressed fuels (Fig. 1). Experimental results also indicate that the low conductance of fuel and / or the material used for sensor encapsulation may influence the response time of the IrOx sensor (Table 1).

We will show the feasibility of the IrO_x sensor with respect to the potential application as a fast, accurate real-time pH sensor for the testing of fuels and oils.

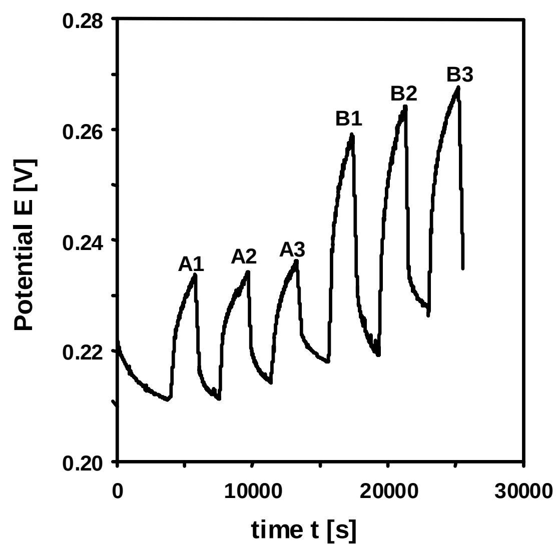

Figure 1. IrO_x sensor response to two aliquots A and B containing 10 mL of acetonitrile and 1 mL of fuel type 2747 neat or stressed, respectively. A1, A2, A3, B1, B2, B3 – consecutive runs in aliquot A and B, respectively.

Table 1. Comparison of Response Time of Bare and Epoxy Encapsulated IrO_x Sensor

3166s	ΔE_{max} @ 90%	Δt @ 90%
IrO_x w/epoxy	0.108	5.50 h
Bare IrO_x	0.168	0.50 h

References:

1. *Annual Book of ASTM Standards, American Society for Testing and Materials* (ASTM), D3242 (2001)
2. *Annual Book of ASTM Standards, American Society for Testing and Materials* (ASTM), D664 (2001)