

Analysis and identification of biomarkers and origin of blue color in an unusually blue crude oil

Priyanka Juyal^a, Amy M McKenna^b, Andrew Yen^a, Ryan P Rodgers^b, Christopher M Reddy^c, Robert K Nelson^c, A. Ballard Andrews^d, Oona Korkeila^d, Stephan J Allenson^a, Oliver C Mullins^d and Alan G Marshall^b

^aNalco Energy Services, 7707 Hwy 90A, Sugar Land, TX-77478

^bIon Cyclotron Resonance Program, National High Magnetic Field Laboratory, Florida State University, Tallahassee, FL32310

^cWoods Hole Oceanographic Institution, Woods Hole, MA 02543-1543

^dSchlumberger-Doll Research, 1 Hampshire Street, MD A375, Cambridge MA-02139

(* corresponding author: pjuyal@nalco.com)

Mono Ethylene Glycol (MEG) reclamation units (MRU) are often used to recover glycol in hydrate treatment. A Gulf of Mexico platform experienced filter plugging issues in the MRU and produced unusually blue (in color) oil with a viscosity approximately that of diesel (API gravity ~24). The MEG recovery unit deposit was clear and waxy. Here, we describe the comprehensive analysis and characterization of the blue oil and filter deposit by advanced analytical techniques to identify the deposit composition and the species responsible for the oil's distinct blue color.

Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR MS) and comprehensive two-dimensional gas chromatography (GC X GC) identify the species responsible for the MRU deposit. 2D Fluorescence spectroscopy identifies the source of the blue color, results also supported by APPI FT-ICR MS. The filter deposit is comprised mainly of high-molecular weight multi-ring biomarkers that originate from the blue oil. The most abundant component is identified by GC X GC as 17 α (H), 21 β (H)-25-norhopane (Figure 1).

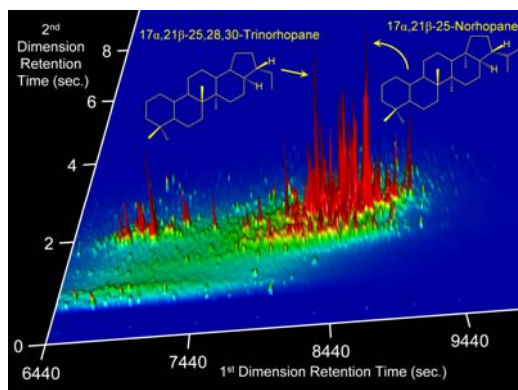


Fig. 1. Suite of 25-norhopane homologues and Perylene identified by GC X GC in the deposit

The APPI FT-ICR broadband positive-ion mass spectra for the crude oil and deposit reveal a high relative abundance of species between $350 < m/z < 450$ that are assigned to the hydrocarbon (HC) class centered at DBE = 5, characteristic of hopanoid biomarkers. The deposit is greatly enriched in these species relative to the whole crude. Presence of 25-norhopanes in a crude oil is considered as a diagnostic benchmark for severe biodegradation.

The blue color of the hydrocarbon is attributed to the presence of polycyclic aromatic hydrocarbons (PAH) that are known to fluoresce. Based on 2D fluorescence spectroscopy, perylene is confirmed to be the source of the blue color in the crude oil (Figure 2). Perylene has one of the highest quantum yields of any PAH molecule, reportedly almost unity at room temperature in *n*-hexane. Similarities in the EEM spectra of the crude oil to standard solutions of 0.5 ppm perylene lead us to infer that perylene at a ppm levels is most likely responsible for the blue color.

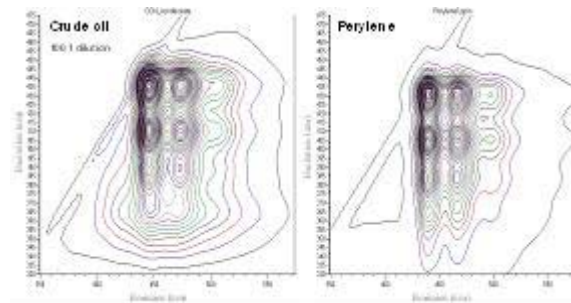


Fig 2. 2D-EEM of crude oil matches that of 1ppm of perylene.

Further evidence for the low concentration of perylene in the crude oil is supported by APPI FT-ICR MS results shown in Figure 3.

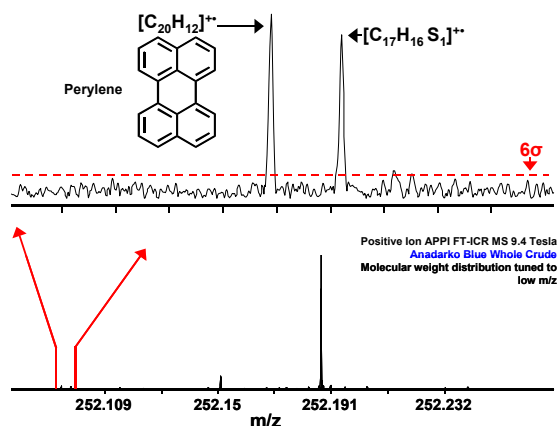


Fig 3. Mass scale-expanded segment (m/z) 252 of the positive ion APPI FT-ICR mass spectrum of the blue crude oil reveals a low abundance species with the elemental composition of perylene.

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