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## Client Advisory: Laboratory Experiments on Crude Oil Detection using *ECO* Fluorometers

Laboratory tests were carried out using WET Labs' ECO fluorometers to ascertain their effectiveness in detecting various concentrations of crude oil.

### Summary:

Laboratory testing confirms:

- 1) The ECO CDOM fluorometer effectively measures crude oil. The signal is in addition to any other CDOM signals.
- 2) Relative fluorescence response is a function of the source oil.
- 3) Dilution series demonstrate that crude oil emulsions can be detected at concentrations < 1 ppm, both using CDOM fluorescence and backscattering (NTU).

The presence of both scattering and fluorescence is an excellent indicator of the existence of an oil emulsion. These sensors are effective crude oil fluorometers because crude oil has extremely broad absorption and emission spectra and the emission wavelength of the CDOM fluorometers is centered at the primary crude emission peak.

### Details:

WET Labs' instruments tested:

- 1) ECO FLCDs
- 2) ECO FLCDr<sub>t</sub> 2000 m rated
- 3) ECO FLNTUs

The first two instruments measure CDOM using a 370 nm excitation light source and detection at 460 nm. The FLNTU uses 470 nm excitation and 695 nm emission. The backscattering (NTU) is measured at 700nm.

Various crudes were tested using the Crude Oil Test Kit: ONTA Crude Oil Set #2,

<http://www.onta.com/>

Emulsions were prepared using de-ionized water with added NaCl to simulate sea water. Heat and sonication were used to create an emulsion with reasonable stability. Initial response activity was confirmed using a simple bench top set up with different samples in a vial in the ECO imaging volume. See figures 2 - 3 below. Various crude oils from the test kit gave fluorescence values that varied over approximately an order of magnitude.

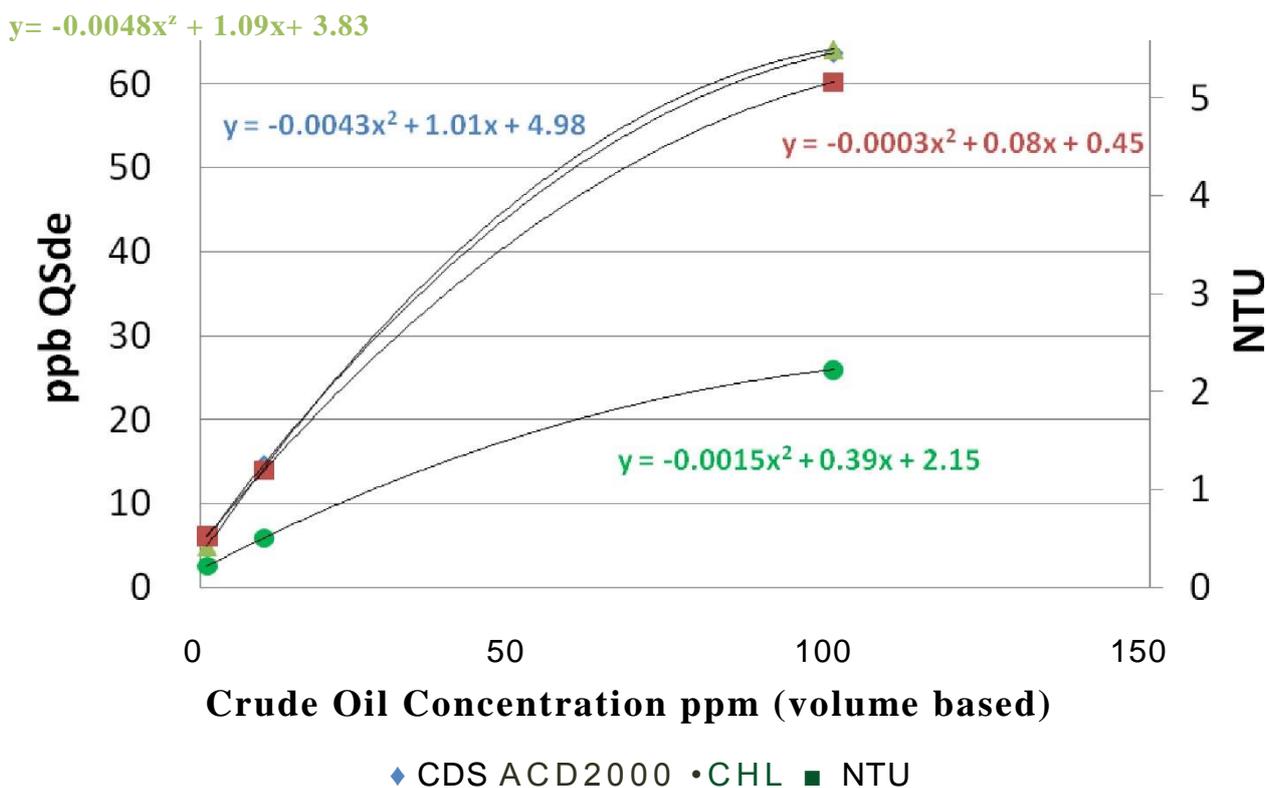
A dilution series experiment for samples of crude oil at concentrations of 1, 10 and 100 ppm by volume was performed to establish relative response curves. In this test the ECOs were immersed in the calibration tanks. Absolute response varied with the type of crude oil in the sample, but with a similar curve. Figure 1 below describes the relationships seen using the Louisiana Light Sweet sample.

All the relationships are significant but not linear. Divergence from linearity may be a function of the test or an attribute of the oil. Further work needs to be done to determine the control parameters.

The CDOM fluorometer response for the two instruments used is essentially the same. The ECO FLNTU shows response in both the backscattering (turbidity) and chlorophyll signals. Visually the 1000 ppm sample had similar scattering to a 4.2 g/L of Arizona Road Dust, a commonly used scattering standard.

We would expect that with time and degradation (bacterial, light, etc.) the relationship between the response curves would change. Further, aggregation and disaggregation, ballasting with other particulates stripped from the water column, and changes in size distribution of the emulsion will also lead to response changes with time within a given plume volume.

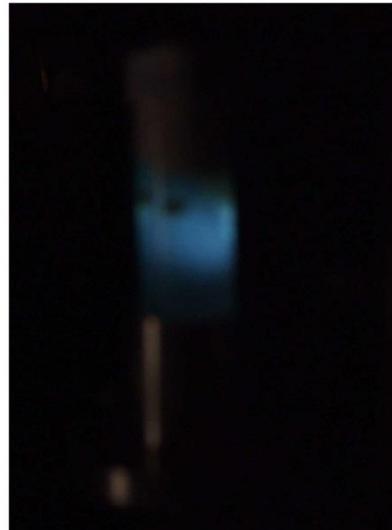
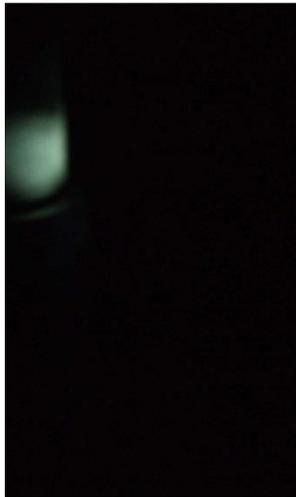
**South LA Crude Oil (#2, 0.839 g/mL density)  
emulsions in salt water(24 g/L)**



**Figure 1.** Response curves for a series of Louisiana Light Sweet crude oil dispersions for CDOM fluorescence, Chlorophyll fluorescence and backscattering (turbidity). Symbols refer to: ECO FLCDs (CDS); ECO FLCDrt 2000 m rated (CD2000); ECO FLNTU (CHL and NTU).



**Figure 2.** Set up for initial response testing of emulsions.



**Figure 3.** Visible response to ECO CDOM (370 nm excitation) for two crude oil samples.