APPLICATION NOTE

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Effects of Water Color on OBS® Measurements

CAMPBELL SCIENTIFIC, INC.®
WHEN MEASUREMENTS MATTER

Effects of Water Color on OBS® Measurements

This application note provides results of tests on dissolved organic and inorganic near infrared (NIR) absorbing substances found in water.

Overview

In principle, water color does affect OBS® measurements. However, in practice, the effects are very small in most applications because the concentration of dissolved, near infrared (NIR) absorbing matter is very low in the environment. Absorption of light by materials dissolved in a sample affects the value of turbidity and suspended solids concentration (SSC) indicated by an OBS sensor because absorption reduces the light energy available to be scattered by particles as well as the intensity of scattered light that escapes from the sample. Other things being equal, absorption by dissolved matter results in lower scattered light intensity and lower indicated SSC for an absorbing samples than for non-absorbing one.

Test Procedure and Results

D & A Instrument Company conducted tests with dissolved organic and inorganic materials to identify the threshold conditions where OBS function is substantially impaired. They defined substantial as a 10% reduction in indicated turbidity. OBS sensors operate in the NIR band so they are color blind. That is color perceived by an operator has no direct influence on OBS function. However, color can indicate the presence of materials that are strongly absorbing in the operating spectrum. The inorganic absorber was a blue, Copper +2 dye with an absorptivity, ε, of 23 cm^{-1} M^{-1} and the organic dye was a brown, haemin-based compound with an ε = 1450 cm^{-1} M^{-1} (see Figure 1).

Figure 1. Water used in the test was colored blue with copper and brown with Haemin.

The absorptivity indicates that a one-molar solutions of the compound will have absorption coefficients of 23 and 1450 cm^{-1} (pure water has an absorption coefficient of 0.06 cm^{-1} at 875 nm). It, therefore, takes a miniscule concentration of these materials, less than 100 μM l^{-1}, to strongly affect sample absorbance and SSC. This is illustrated in Figure 2, which shows the decline of OBS response to silt-size clear-plastic sphere with increasing dye concentration.

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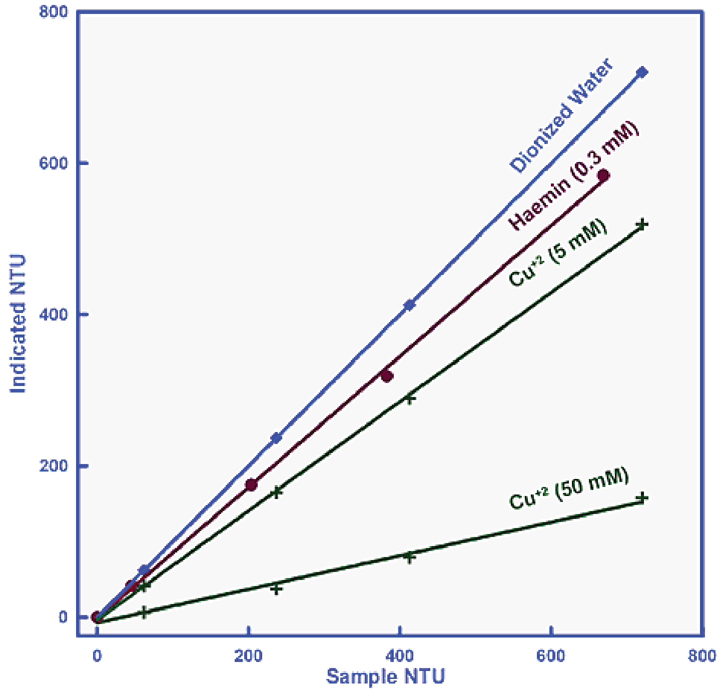

Figure 2. This graph shows that it takes a miniscule concentration of these materials, less than 100 μM l^{-1}, to strongly affect sample absorbance and SSC.

Significance of Absorption

The significance of absorbance depends on the ε values of dissolved matter in real water samples as well as their environmental concentrations. While ε values for natural and man-influenced waters are rarely reported, environmental concentration of like materials are published. Assuming that dissolved copper and dissolved organic matter, DOM, have ε values similar to the analogs (they are likely to be considerably lower), D & A Instrument Company compared the concentrations of Copper+2 and Haemin needed to reduce the OBS signals by 10% with those for copper and DOM in the environment (see Figure 3). This showed that in all but one situation, environmental concentrations of dissolved matter are at least 100 times lower than the level needed to produce a 10% reduction in OBS signal. When monitoring runoff from certain activities, such as mine tailings, the absorption by dissolved material can depress the turbidity level measure by an OBS sensor.

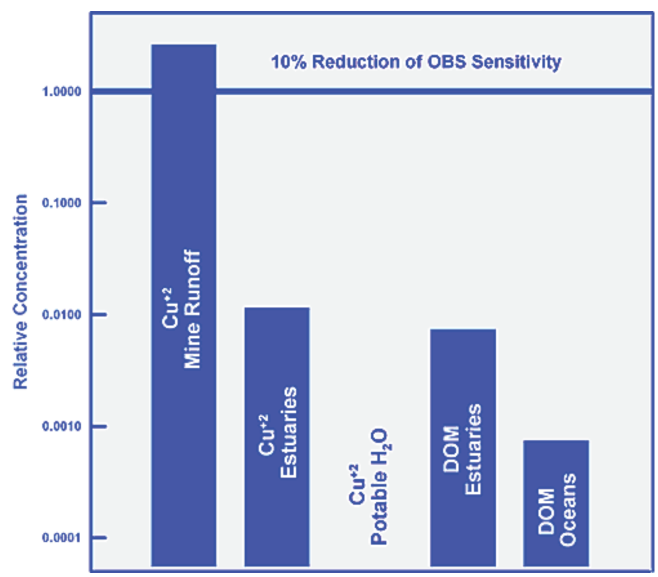

Figure 3. Except for mine runoff, dissolved matter is at least 100 times lower than the level needed to produce a 10% reduction in OBS signal.

Reference

John Downing and W.E. Asher. The Effects of Colored Water and Bubbles on the Sensitivity of OBS Sensors. American Geophysical Union, 1997 Fall Meeting, San Francisco, CA.

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