TURBIDITY STUDIES AT THE NATIONAL WATER QUALITY LABORATORY

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EXTENDED ABSTRACT

Turbidity interference caused by color: The U.S. Geological Survey National Water Quality Laboratory (NWQL) observed different results for sample turbidity measured on 1st and 2nd generation instruments manufactured by the same vendor. The NWQL purchased a Hach * 2100AN nephelometer to replace the Hach 2100A instrument that had been used, and the two instruments were compared in the laboratory. The turbidity of formazin standards and purchased references was comparable for both instruments (U.S. Geological Survey, 2000), as shown in Figure 1. Different turbidity results, however, were generated for environmental samples with turbidity greater than about 25 nephelometric turbidity units (NTU) (Figure 2). The cause of these differences is discussed in the following paragraphs.

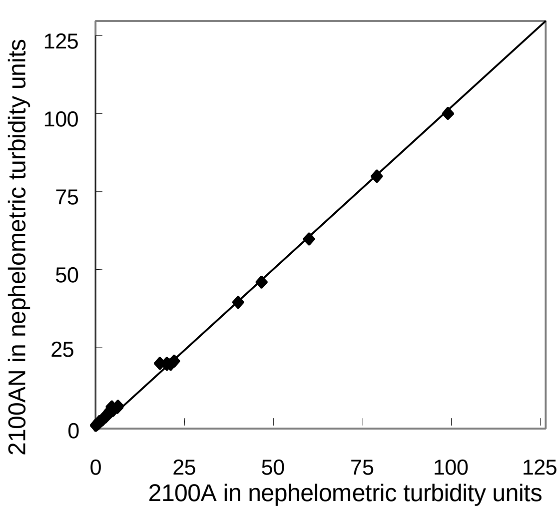

Figure 1. - Reference check

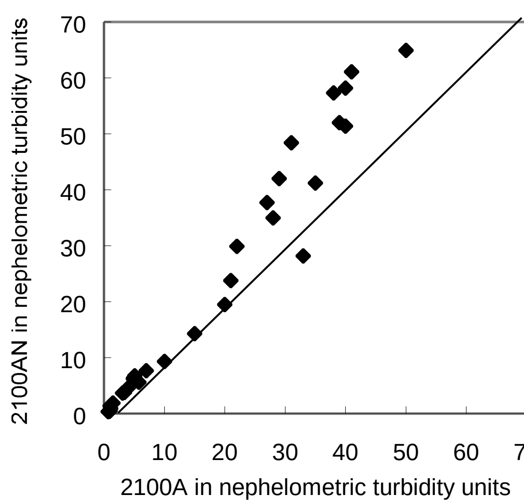

Figure 2. - Hach 2100A < 50

The major difference between the two instruments is the number of light detectors. The Hach 2100AN has several detectors, with the main detector at 90 degrees to the incident light. The secondary detectors measure light that is transmitted, forward scattered, and backward scattered. The signals from these detectors are combined (ratioed) mathematically to calculate the turbidity. The older instrument (2100A) had only one detector at 90 degrees to the incident light. Both instruments satisfy Standard Methods (American Public Health Association and others, 1998)

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* The use of trade, product, or firm names in this report is for descriptive purposes only and does not imply endorsement by the U.S. Government.

and U.S Environmental Protection Agency (1999) design criteria by using a tungsten filament lamp source and measuring scattered light at 90 degrees to the incident light.

The tungsten-filament lamp emits light in a wide band of spectral wavelengths. The advantage gained is the ability to see a large range of particle sizes (Sadar, 1998). The disadvantage is that color typically produces negative interference with turbidity measurement. Turbidity is defined by the amount of light that is scattered at 90 degrees, and so any light that is absorbed in the sample cannot be scattered to the detector. The color may derive from dissolved material that produces a colored matrix or from particles that are colored, or both. Two benefits are gained from using the ratioing detectors: (1) they effectively compensate for color as an interference, and (2) they extend the operational range of the instrument so that fewer dilutions of turbid samples are required.

We added varying amounts of IHSS Nordic Aquatic fulvic acid to samples of formazin at an initial concentration of 58 NTU and measured them on both instruments to evaluate the effectiveness of the ratioing nephelometer (Figure 3). Samples were measured on both instruments at NWQL for about 8 months and the results were compared (Figure 4). No universal correlation could be made between the two instruments and the different results. All the variability in results seemed to be site specific.

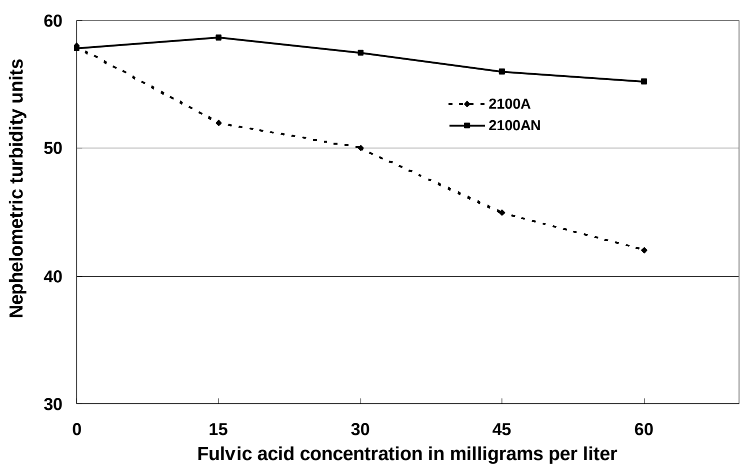

Figure 3. Formazin with fulvic acid added

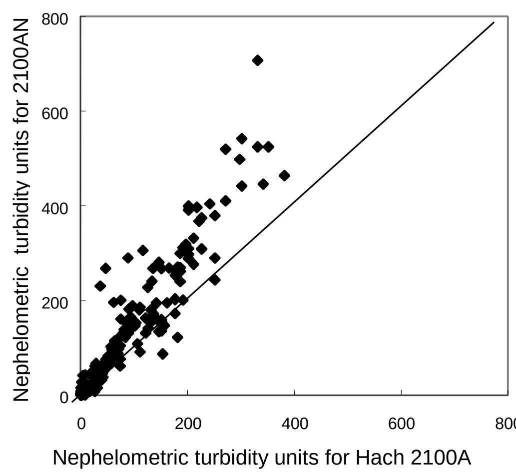

Figure 4.- long term comparison of instruments

<u>Wavelength studies</u>: As a follow-up to the initial study concerning differences in turbidity caused by changes in the number of light detectors, the NWQL also studied the effect that changing the wavelength of the light source has on turbidity measurements. The International Organization for Standardization (1990), in the International Standard (ISO 7027) for measuring diffused radiation, requires that the light source be at the specific wavelength of 850 nanometers (nm), with a spectral bandwidth of less than or equal to 60 nm. At this wavelength, light absorption caused by naturally occurring color usually is not a concern. As with the Standard Methods 2130 B (American Public Health Association and others, 1998), light is measured at 90 degrees to the incident light. Diffused radiation, turbidity, measured under ISO 7027 instrument criteria, is expressed as formazin nephelometric units (FNU).

An 860-nm filter was placed in the Hach 2100AN and then the instrument was calibrated with formazin standards. The 860-nm filter effectively allowed only light at about 860 nm to be read by the detectors. The results for samples were compared to results obtained from a YSI 6920 sonde field monitor with a light-emitting diode light source that also was calibrated with formazin standards. The YSI and the Hach instrument that was calibrated with the 860-nm filter (both FNU) had good agreement, but usually were higher than results obtained by using the Hach instrument and USEPA filter (NTU).

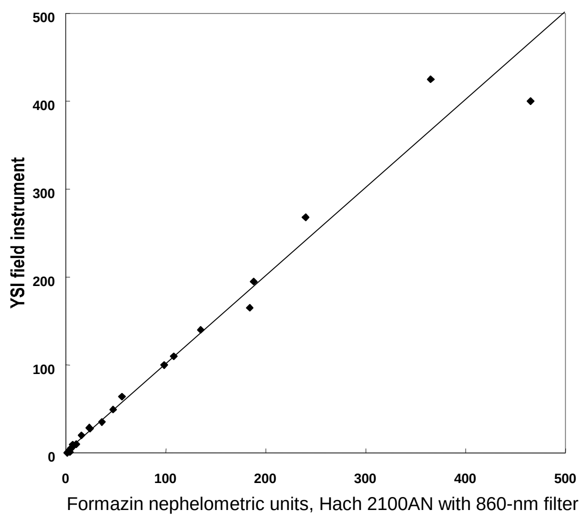

Figure 5. – Comparison of Hach to YSI field instrument

These studies show the importance of clearly limiting the variables and defining the instrument characteristics used to measure turbidity.

REFERENCES

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