The Measurement Comparability Between the PTV 2000 660-nm LED Turbidimeter and the 1720E at a Colorado, Partnership Water Plant

By Michael J. Sadar
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Introduction:

The goal of this study was to collect comparability data between the PTV 2000 660-nm LED turbidimeter and the HACH® 1720E turbidimeter. The instruments were to be set up and run as filter effluent turbidimeters and to capture continuous turbidity measurements through several consecutive filter runs. The second goal was to spike the filter effluent with settled water to study the response level and response time for these two test instruments.

Background:

This comparability study focused on water produced at a Partnership for Safe Drinking Water Filtration Plant is located near the metropolitan of Denver Colorado. The raw water was surface water from the South Plant River Basin that was characterized with high levels of total dissolved solids and micro pollutants such as pharmaceutical residuals. The water was treated through a multibarrier process that included riverbank filtration, aquifer recharge and recovery, precipitative softening, ultraviolet light coupled with advanced peroxidase oxidation, biological activated carbon filtration and activated carbon adsorption. The filtration stage is through a dual media anthracite filter. The water plant was commissioned in 2010 and has a treatment capacity of 50 million gallons per day.

Prior to this study, the plant had been off line to allow for the addition of additional filters. The water plant recently came back on line but was not in what was a considered a state of optimization. The plant has turbidity limit of 0.08 NTU on the filters, and normal operation of the filters is to produce water that is below 0.030 NTU. The filter effluent (FE) from one of the new filters was the monitoring point for this comparability study.

Materials and Methods:

Two instruments were installed side-by-side on the FE sample tap. One instrument was the PTV 2000 660-nm LED Turbidimeter. The second instrument was the HACH® 1720E turbidimeter. Both instruments had less than one month of use. Installation was according to each manufacturer's respective recommendations and included the following important protocols:

- Instruments were run for approximately 7 days prior to the study to allow for proper wetting of surfaces. This ensured that internal bubble reflections were minimized.
- Sample lines were the same distance from the tap and ran parallel to each instrument.
- Sample flow rates were 60-ml/minute on the PTV 2000 and 250 ml/minute on the 1720E.
- Signal averaging was set to the same value on both instruments.
- Bubble removal algorithms were turned on with respect to both instruments.
- The 1720E was allowed to run for 24-hours to ensure lamp stability prior to calibration.
- Both instruments underwent the zero-electronics operation prior to calibration.
- Both instruments were calibrated according to the respective calibration procedures. The 1720E used a fresh prepared 20.0 NTU formazin standard. The PTV 2000 used a fresh prepared 5.0 NTU calibration standard.
- After calibration and prior to data collection both instruments were verified on fresh prepared formazin standards. Two verification standards were prepared, one at 1.0 NTU and the second at 0.6 NTU. Both instruments passed the pass/fail criteria of ±10 % of the value of the standard or 0.03 NTU, whichever was greater. The verification was repeated at the completion of the study, and again both instruments passed the verification protocol.
- Both Instruments were set to the same data log interval, which was once every 15-seconds.
- Measurements were logged via Modbus protocol (digitally) to a dedicated computer

Data and Results:
The measurements from each instrument were recorded for approximately 67 hours of continuous monitoring of the CFE stream. This period encompassed approximately four complete filtration cycles (ripening through backwash). Figure 1 is the graphical presentation of the data from the PTV 2000 and 1720E instruments. The PTV 2000 trace is black and the 1720E trace is light blue. The vertical red lines represent the time the data was valid. Immediately prior and after these lines was when the quality assurance verifications were performed. The graph is scaled from 0 to 0.30 NTU, which represents the maximum reporting level under the USEPA regulations for filter effluent water.

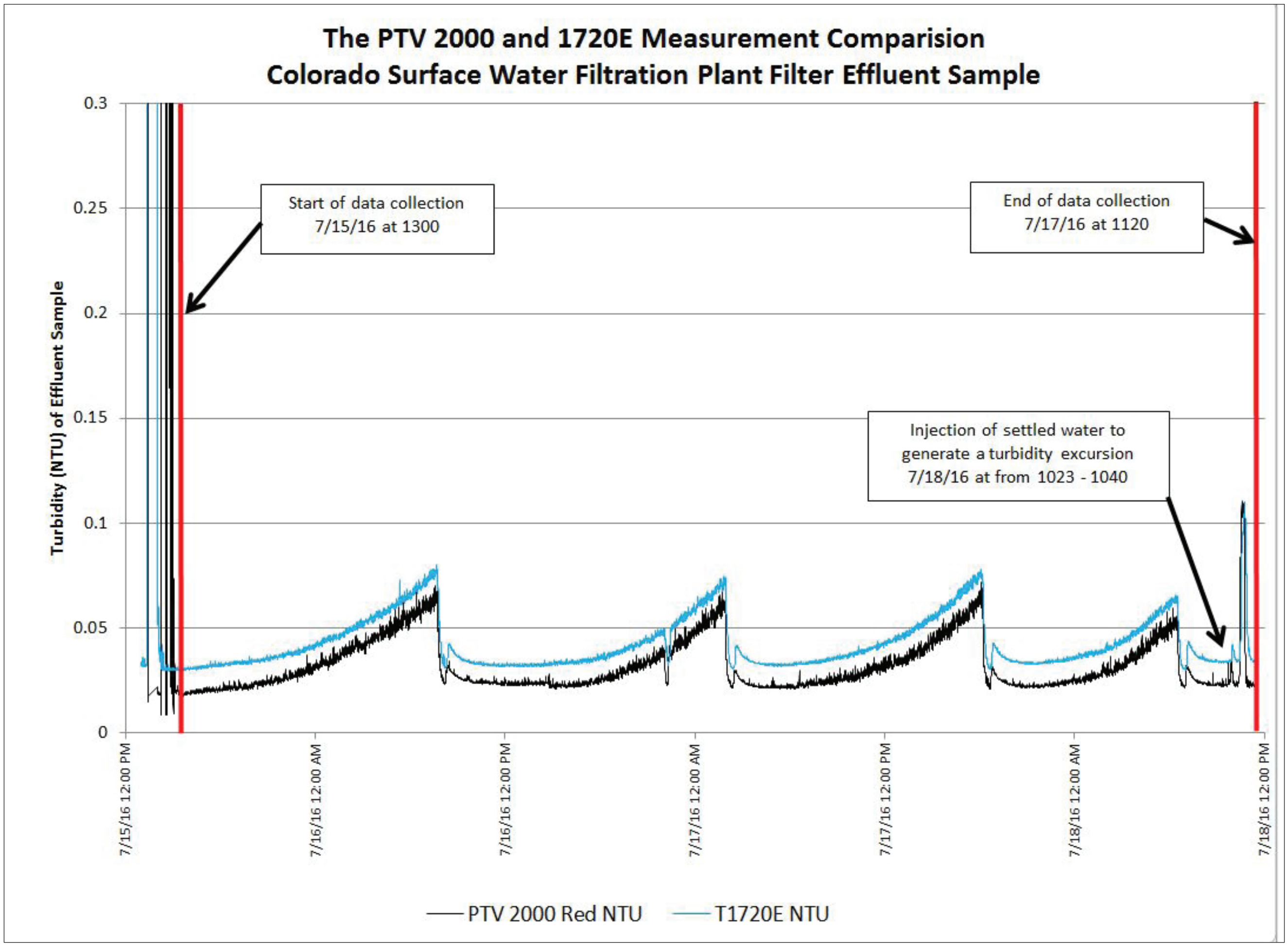

Figure 1 - Graphical Presentation of the On-line monitoring of filter effluent sample using the PTV 2000 and 1720E Turbidimeters.

Figure 1 illustrates that both instruments track each other over the course of this study. This included the changes in turbidity that were expected through ripening, on-line production and termination of the run. The turbidities ranged from a low of approximately 0.020 NTU to a high of approximately 0.1 NTU. The graph contains 16085 data points for each instrument. From a statistical perspective, the averaged PTV 2000 reading was 0.0322 NTU and the 1720E was 0.0429 NTU. The net difference was 0.010 and was primarily attributed to the lower stay light of the PTV 2000 instrument. Both instruments demonstrated similar precision, with respect to the overall standard deviations. Table 1 below provides a summary of the study.

	1720E (NTU)	**PTV 2000 (Red LED) (NTU)**
Average	0.0429	0.0322
Standard Deviation	0.0122	0.0122
N	16085	16085

This study also included a simplistic spike of a small quantity of settled water into the effluent stream. The intent of the spike was to generate a change in turbidity that would be subject to detection between the two turbidimeters. Figure 2 is a graphical illustration of the spike itself. The black trace is the PTV 2000, and the light blue trace is the 1720E. The y-axis is scaled from 0 to 0.30 NTU. Both instruments demonstrated the response to the spike of settled water, but the magnitude of the response was 0.010 NTU higher in on the PTV 2000.

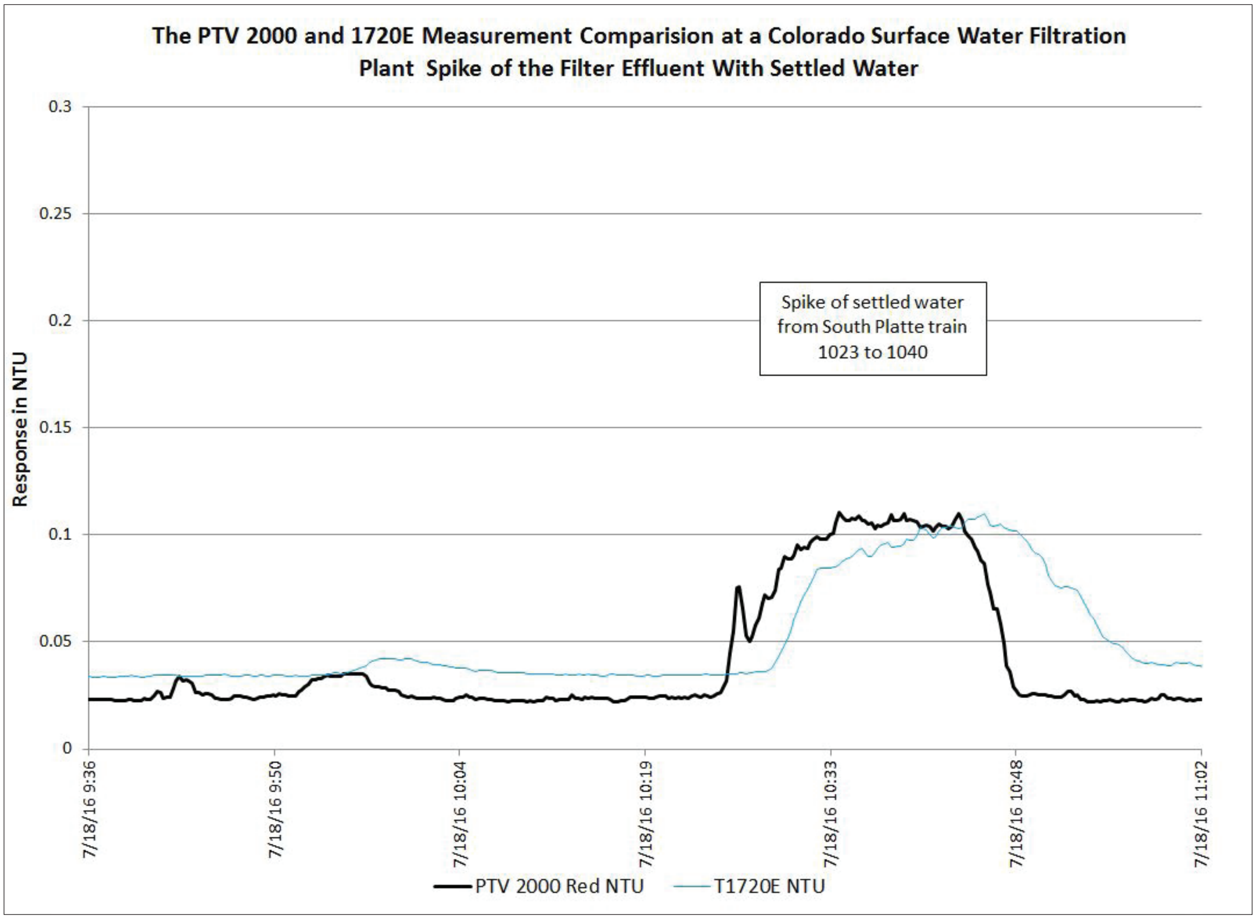

Figure 2 – Graphical plot of the PTV 1000 and 1720E responsiveness to a spike of settled water into the filter effluent stream.

The graph illustrates that the PTV 2000 does have a faster response and recovery to the spike when compared to the 1720E turbidimeter. This is a factor of the flow rates to the each instrument, but it is important to note that even though the 1720E has more than 4 times the flow rate of the PTV 2000, its response time is still slower (250 ml/minute flow for the 1720E and 60 ml/minute for the PTV 2000). This can play an important role as water plants use every means necessary to conserve water both internally and externally.

Conclusions:

The comparability study between the PTV 2000 660-nm LED turbidimeter and the Hach 1720E turbidimeter was successfully carried out at a highly recognized drinking water filtration plant. The instruments continuously monitored and logged turbidity data for several continuous filter runs, collecting more than 16,000 consecutive data points for each instrument. Over the duration of the study, the PTV 2000 measured 0.010 NTU lower than the 1720E, which was attributed to lower stray light in the PTV 2000 instrument. The study demonstrated that a significant spike of turbidity observed by both instruments, but the magnitude of response by the PTV 2000 was about 0.010 NTU higher than the 1720E. This is an example that the PTV 2000 has lower stray light but higher sensitivity than the 1720E with respect to this spike. The spike of settled water did demonstrate that the PTV 2000 required a sample flow rate that was for times lower than the 1720E to yield an equivalent response time. This will have a substantial impact on sample consumption over time.