Lovibond® Water Testing

The Laser Advantage

By Michael J. Sadar
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Laser turbidimeters, such as the Lovibond® PTV 6000, possess highly improved optical qualities to yield a very stable process measurement system. This enhanced stability provides additional information that can be deciphered from the laser turbidity measurement itself and used as a separate parameter to further improve the limit of detection to breakthroughs in filtration systems.

The PTV 6000 has a 660 nm Laser diode incorporated into its optical system. This serves as the incident light source. This laser output is a highly collimated and concentrated beam of energy. The concentrated energy is in a much smaller volume when compared to a typical light source for turbidity measurement.

A conventional turbidimeter, without the use of a high-density beam, is capable of detecting particles of approximately 1.0-µm or larger. A laser turbidimeter is capable detecting particles as small as 0.01-µm. This enables the laser turbidimeter to detect very small breaches in a filter such as a pinhole.

Turbidity is an aggregate measurement of all the insoluble materials (mostly particulates) that are detected within a defined volume of light. This volume is referred as the analysis volume of the light scatter detector. An analysis volume will have numerous particles at any given moment of time, which collectively scatter the incident light. When the concentration of materials is stable, the light scatter is also stable, and hence, the turbidity reading is stable. When the concentration of materials changes, the turbidity reading will as well.

If the influx of particles into the analysis volume increases more than the outflow of particles exiting, the result in an increase in the turbidity. Further, the fluctuation of the measurement itself will increase as the turbidity condition changes. This fluctuation is typically measured as the standard deviation or relative standard deviation (RSD). Using RSD as a parameter has been shown to also enhance the sensitivity of detection of minor breakthroughs in different filtration systems.[1] Using RSD as a parameter should be based on each water treatment plants design and operational parameters. A general guideline is that RSD values that are less than 1% indicate stable filtration operation. Values exceeding 1% can indicate particle leakage through a filtration system.

If the sample is stable and virtually void of particles, a small change in particle concentration will not have much impact on the net light scatter within the analysis volume. This is because the slight increase in particle concentration is spread out over the large view volume, which dilutes the sensitivity of the detected measurement. This makes it more difficult for a turbidimeter with a large view volume to detect a very small change in turbidity.

However, with a laser, the analysis volume is much smaller and the beam density within this analysis volume is much higher. It is small enough that when a single particle enters this view volume, the quantity of scattered light energy is much higher than it would be with a traditional turbidimeter. The result is a higher laser response to the small change in turbidity. In essence, the laser turbidimeter takes on a characteristic of a particle counter in that it can detect the presence of single particles as they travel through the analysis volume. The observable measurement is a sharp spike in the measurement signal as the particle scatters the laser light.

The frequency of these spikes can then translate to a change in the particle concentrations that are in a very clean sample, where a non-laser turbidimeter may not detect such a change. Under these conditions, the turbidity baseline does not increase, but the fluctuation of the baseline does increase.

This ability to effectively scatter light from single or very low concentrations of particles is a distinct advantage that a laser turbidimeters have over traditional turbidimeters (i.e. those with white light or LED sources). Laser turbidimeters have been found to be more effective in low turbidity applications such as membrane effluent performance, or conventional filtration practices with optimized performance goals. These applications require more sensitive particle detection tools than the traditional turbidimeter can provide.

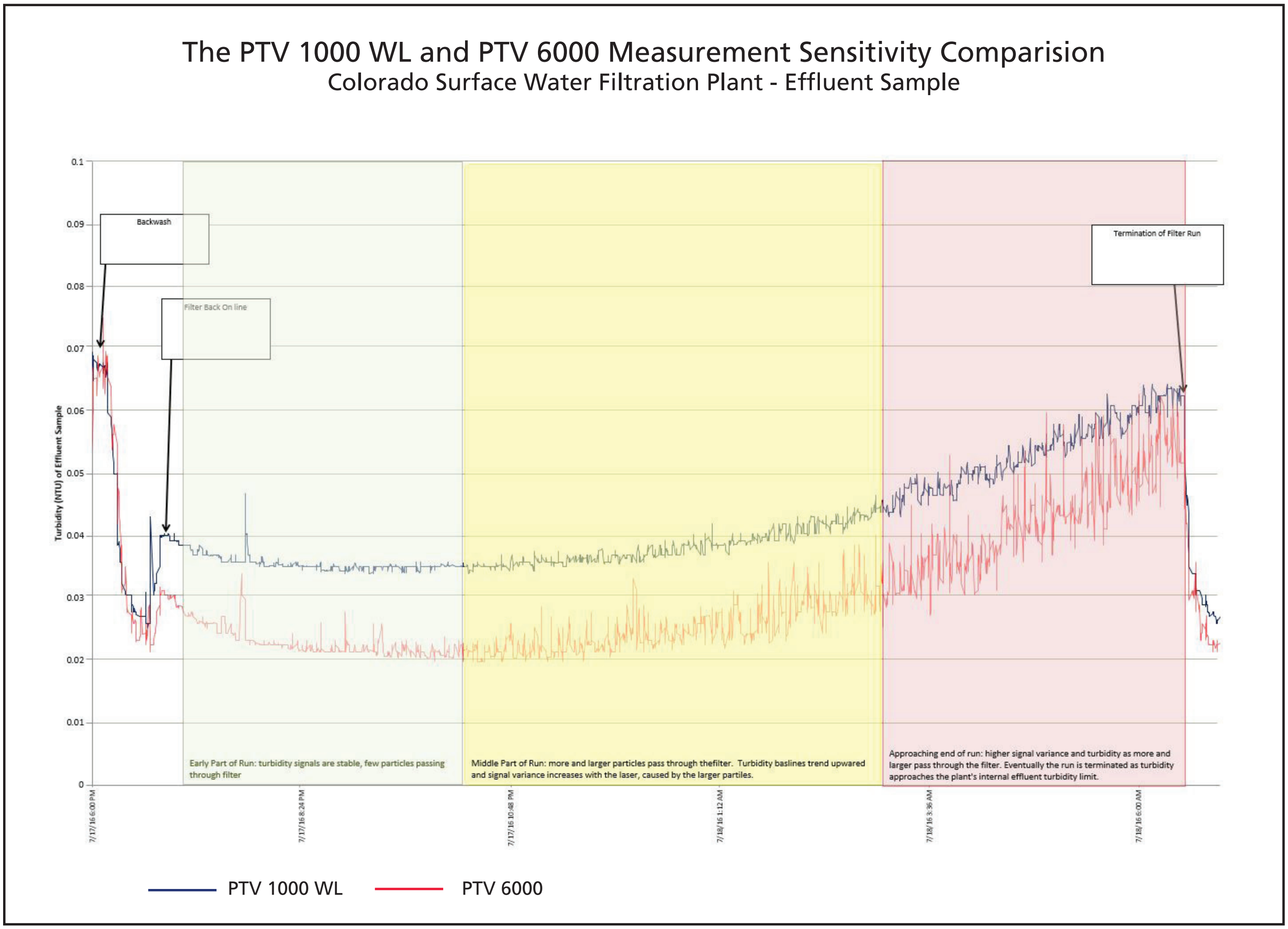

Figure 1 -This shows the progression of a filter run. Towards the end of the run higher higher signal variance and turbidity values are observed as more and larger pass through the filter.

The figure above provides a filter run application that was monitored by a traditional and a laser turbidimeter. The filter effluent water was monitored by both instruments from the initiation of the filter run, through its termination. In the first part of the run, both instruments provided a stable turbidity measurement. The baselines were different, which was a direct function of the respective instrument's stray light.

As the run progressed, both instruments showed an increasing trend of the turbidity measurement and the function of each baseline began to increase. This increased fluctuation was due to larger particles that passed through the filter and into the effluent stream. The particles caused a higher spike of response on the laser turbidimeter than on a traditional turbidimeter. As the filter run continued up through its termination, the passage turbidity through the filter increased, as did the number of larger particles. Thus, the fluctuation of the laser turbidimeter baseline continued to increase in addition to its overall upward trend.

This figure also shows that the stray light difference between traditional and laser turbidimeter was retained through the filter run. For plants that terminate their filter run based on the turbidity, the lower stray light instrument (the laser turbidimeter) provides the water utility with a more accurate and lower turbidity measurement. This would allow the filter run to proceed slightly longer than if the run were based on a lower accuracy measurement that would be caused by higher stray light.

Sources:

1. Sadar, M and Bill, K., 2001. Using Baseline Monitoring Techniques to Assess Filter Run Performance and Predict Filter Breakthrough. Proceedings from the 2001 Water Quality Technology Conference, Nashville, Tennessee.

Tintometer GmbH.
Tel: +49 (0) 231/94510-0
sales@lovibond.com
Germany

Tintometer Brazil
sales@lovibond.us
Brazil

Tintometer Inc.
Tel: +1 941 756 6410
sales@lovibond.us
U.S.A.

Tintometer AG
info@tintometer.ch
Switzerland

The Tintometer Ltd.
Tel: +44 1980 664800
water.sales@lovibond.uk
UK

Tintometer South East Asia
sales@lovibond.com
Malaysia

Tintometer India Pvt. Ltd.
Tel: 1800 102 3891
indiaoffice@lovibond.in
India

Tintometer China
sales@lovibond.com
China