Application Note AN-PCNT1

Particle Counting in a Municipal Drinking Water Treatment Plant

Particle counters sense, measure, and count individual particles, providing the number and size of particles per unit volume. This information is very useful for determining the efficiency of a filter, and optimizing its performance.

Unlike turbidity, which provides a general view of water clarity, particle counters give quantitative results on water purity by measuring the amount of particles of a given size in a representative sample.

Particle counters have been used for decades to measure particle concentrations not only in drinking water, but also in many fluids and lubricants, including air and ultra-pure water in industrial applications.

Overview of Filter Monitoring

Log Reduction

The main function of filters in a modern drinking water treatment facility is to minimize risk to human health by removing dangerous organisms such as viruses, giardia, and cryptosporidia. These three biologic contaminants pose tremendous risks to the health of the consumer. By designing and operating a filter properly, these organisms can be virtually eliminated. The Surface Water Treatment Rule (SWTR) requires a three-log reduction in giardia and a four-log removal of viruses. The log reduction can be calculated by using the following equation:

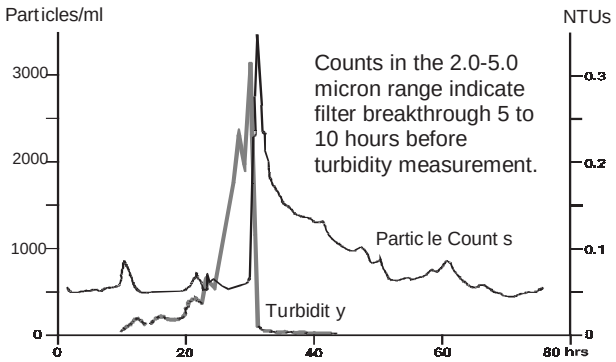
$$\text{log removal} = \log_{10}\left(\frac{\text{upstream cumulative counts/ml}}{\text{downstream cumulative counts/ml}}\right)$$

In practice, this means two particle counters need to be installed for each filter calculation, one measuring the influent raw water and the other measuring filter effluent. By comparing the two results, a water system operator can adjust flocculent feed rates and filter backwash intervals until the greatest reduction in particulate matter is achieved.

Filter Breakthrough

Particle counters play an important role in the proper control of filters in drinking water treatment plants. Filters strain water through pore spaces within the filter media. As those pore spaces become congested with filtered sediments, they lose efficiency. Ultimately, filter breakthrough occurs. At this point, material that is normally retained by the filter passes through areas within the filter media. These particles are usually few enough in number that they are not immediately detected by a change in turbidity of the filtered water. With a particle counter in place, the raw number of particles of a given size will increase substantially, providing an alert to filter breakthrough. Figure 1 shows this relationship.

Figure 1 Filter Breakthrough (Particle Counts versus Turbidity)



If enough time is allowed to pass between the filter breakthrough and filter rehabilitation, the turbidity of the filtered water will increase. At that time, however, filter performance has diminished considerably, and more time and energy is required to properly backwash the filter bed.

Collecting a Representative Sample

Since it is impossible to monitor every drop of water that is processed by a filtration plant, a representative sample must be obtained and analyzed. It is vital that the sample be properly obtained so as to represent water quality as a whole. The best location to obtain a representative sample is from the main process pipe, with the sample inlet placed near the middle of the pipe. This collection method avoids the troubles of sampling next to the pipe wall, where elevated counts due to air bubbles and material slough-off can be detected. Figure 2 illustrates sampling points to avoid and the best sampling point, which is on the side of the process pipe with the sample line inserted into the process pipe up to its centerline.

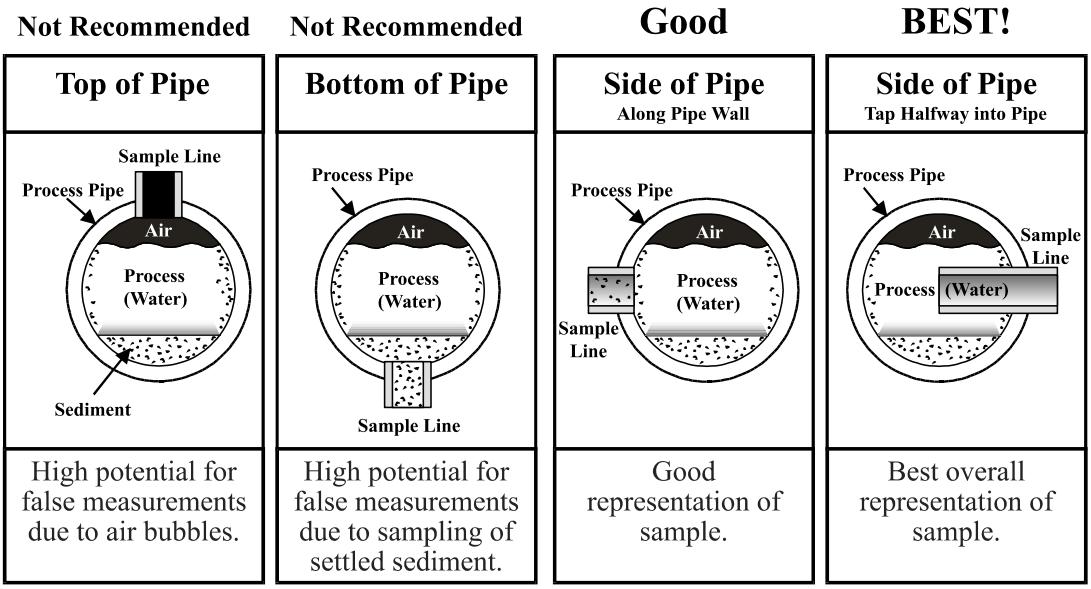
Summary

There are many different reasons for monitoring and controlling particle count data in a municipal water treatment plant. To a great extent, the most important reason is public safety assurance by ensuring that filtration efficiencies are maintained. Other important reasons to monitor particle count data include:

- Determining proper chemical dosage at the flash mixers
- Establishing filter backwash cycles
- Detecting filter breakthrough
- Controlling water quality at the influent and effluent points of the treatment plant

With an understanding of the processes used to treat drinking water, it is readily apparent that particle counting is an essential and vital measurement for public water systems filtering surface water.

Figure 2 Process Pipe Sampling Point Guidelines



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