Use of Particle Counters for Measuring Water Treatment Plant Performance

by: James Dailey

Introduction

The purpose of a Water Treatment Plant is to remove particulates and pathogens from water that may pose a health threat to consumers. The Surface Water Treatment rule established requirements to include a 3-log removal-inactivation of Giardia cysts and a 4-log removal-inactivation of viruses. The upcoming Enhanced Surface Water Treatment Rule will include requirements for Cryptosporidium. These organisms are very resistant to common disinfection practices, therefore emphasis is placed on removing these pathogens in the treatment process. The SWTR requires surface water systems to measure turbidity in filtered samples. Turbidity is an indicator of filtration efficiency for removal of pathogens and the treatability of water by disinfection. Most studies show that Giardia and Cryptosporidium can effectively be removed with an efficient treatment process which includes filtration that reduces turbidity below specific values. Giardia sized particles can pass through the treatment process with no substantial increase in filtered water turbidity noted. This happens because low concentrations of micron-sized particles scatter relatively little light. Therefore, turbidity will not always provide a satisfactory measurement of protozoan cyst-sized particles.

Turbidimeters

Turbidity monitoring of filtered water is presently used as a surrogate measurement to indicate that pathogenic organisms such as Giardia and Cryptosporidium are being removed. In simple terms the interaction between light and suspended particles in water is called turbidity. This interaction is affected by several factors, including size, shape, composition of particles and wavelength of light. An important characteristic of turbidity measurement is that given a mass concentration of particles the turbidity is less for larger sizes . This statement means that larger particles could be in a sample but contribute very little to the turbidity reading. Turbidity is a "relative" measure of water clarity that in not directly relatable to physical parameters. Most turbidimeters illuminate a relatively large view volume of sample water using a tungsten filament light bulb, than detect the light scattered at right angles from a "cloud" of particles in an electronic photodetector. The brightness of the cloud forms the electronic output of the instrument. If the particles are dark, such as carbon fines or have low light scattering ability like algae or pathogenic microorganisms, the light signal can be deficient. On the other hand if there are high populations of very fine particles, which scatter light more efficiently than larger particles then the light signal will be exaggerated.

Particle Counting

Current advances in light generation technology have afforded a more precise method of particulate monitoring i.e. the particle counter. Particle counting technology has long been established in the medical, manufacturing and electronics fields. This technology has recently been adapted for use in the water treatment field. The number, size, shape and composition of particles in a water sample affects the turbidity. Turbidity is therefore more of an index of water quality. Particle counters on the other hand, size and count particles. Particle counting and its technology extends the sensitivity of measuring particles beyond that achievable from turbidimeters. The sensitivity of the particle counter can be utilized to detect the effects on

effluent water quality due to operational procedures, chemical dosage and parametric changes. The particle monitor provides a sensitive indication of low range concentrations of particles in water. The device is extremely sensitive to any particle passing through a sample cell that is greater than 3 microns in size. This sensitivity is especially significant because Giardia and Crypto cysts have been shown to be in the 2 to 8 micron size range. In settled or filtered water Giardia and Crypto can be entrapped in floc particles.

How a Particle Counter Works

The light blocking type of particle counter is the one most commonly used in potable water applications today. A particle monitor consists of a sampling tube, an infrared light-emitting diode (LED) and photodetector . A narrow light beam from the LED is transmitted through a flowing sample. Fluctuations in the light beam are measured by the photodetector. Particles in the sample stream cross the laser beam blocking a portion of the light, thus creating a moment of diminished light and a corresponding electronic signal pulse. This pulse is proportional to the size of the particles and is measured in height and tabulated according to its respective particle size. At the end of the sample period the counts for each specified particle size range are totaled and the particle counts are calculated and presented on a count per milliliter basis. Thus, optical particle counters furnish a direct measurement of physical parameters, i.e. particle counts per milliliter of sample, categorized by particle size range

What Can Particle Counting Tell Us.?

There can be no direct consistent correlation between turbidity as measured in ntu's and particle counts as measured in particles per mililiter. Particle counting provides more information and greater sensitivity since particles are individually sized and counted. What practical use does particle counting have for the water industry? Particle counting provides a precise and vital tool that extends water plant particulate monitoring and analysis to levels far beyond those afforded by turbidity alone. It allows for greater control of particulate removal through more precise monitoring, improved sensitivity, finer resolution and a better understanding of particulate characteristics. Such data has broad applicability for the water treatment process. Particle counting has the potential for

- analyzing raw water particulates so that treatment could be geared specifically to optimize removal as raw water quality changes
- optimizing chemical dosage
- analyses the effectiveness and efficiency of different chemicals alone or in combination in the coagulation process
- measuring particulates in filter effluent
- comparing filter effluent water quality from different filters
- determining filter efficiency in terms of percent removal of particles
- serving as a surrogate measure for removal of pathogens such as bacteria, viruses, Giardia Lambia, and Cryptosporidium
- distinguishing performance between different filter media
- comparing filter effluent quality between different treatment plants.