THE USE OF THE PARTICLE COUNTING FOR THE EVALUATION OF FILTER PERFORMANCE

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Extract

BACKGROUND

The measurement of particulate matter in water treatment is critical for the assessment of:

- Source Water Quality
- Finished Water Quality
- Unit Process Performance
- Total Treatment Efficiency

Perhaps one of the most important goals of water treatment is to separate out solids or particles from the raw influent. Currently, turbidity and suspended solids measurements are used in the water industry to measure light scattered by suspended material in a water sample and suspended solids expressing the weight of solids suspended in a sample. While valuable, these measurements have their limitations. Both are gross and indirect indicators. Neither gives information about the size, and concentration of the individual particles in the water. This information can only be obtained through the use of Particle Size Analysis.

This paper will present data which suggest that particle size and distribution analysis can provide a more sensitive measurement of particulates in water. and as such, can be a very valuable analytical tool for the evaluation of filtration performance. Knowledge of the number, size, and distribution of the particles present in water, before and after treatment, can provide a better means of selecting, and subsequently optimizing treatment processes.

IMPORTANCE OF PARTICULATE REMOVAL IN DRINKING WATER

Not only does particulate matter make a water aesthetically unpleasant because of actual cloudiness, but many of the contaminants of concern to the water industry are either particulates or are associated with particles. For example, clays and silts, inorganic metals, biological contaminants including bacteria, viruses and cysts are all particulate matter. Furthermore, particulate matter has been shown to shield organisms from disinfectants. Most recently, Berman, Rice, and Hoff reported up to 20 to 50 fold increases in the time required for inactivation of particle-associated coliforms depending not only on type of disinfectant, but also on the size of the particles.

Recent regulatory directives will make it even more critical that we learn more about the particulate matter present in water. The Surface Water Treatment rule apparently will require that any facility using surface source water must produce an effluent 95% of the time with a turbidity of .5 ntn or less. Further, under certain circumstances a utility must show that it can achieve 99.9% inactivation of giardia cysts. To demonstrate this, according to the 1987 draft guidance manual, a utility can use particle counting devices to show that a certain log reduction of giardia sized particles is accomplished through its filters.

Bacteria are generally .1-.12 microns, viruses smaller than that, and algae can range anywhere from .5-100 microns. The human eye can begin to see particles of about 70 micron size. Giardia cysts are about 7 to 12 microns in size and cryptosporidium, 3 to 5 microns.

A well operated granular media filter usually removes particles 10 microns and greater, and a flocculated particle will range in size from 1 micron up to 100 microns. A floc of about 15-30 micron size is considered to be optimal for settling. The laser particle counter used in the research has a detection range of 1 to 100 microns.

PARTICLE COUNTING TECHNIQUE

A number of methods have been used to count and size particles in water — each method uses a different technology, since there is no standardized method for performing particle size analysis for drinking water, and each has its own limitations. The methods used are:

*Microscopic Evaluation — Transmission and electron' microscopes have been used to visually quantify particulates. It is a time consuming method, and except for counting biological contaminants, it is not a useful method for drinking water analysis.

*Light Blockage - In these instruments (HIAC) the particles in a flowing sample actually block part of a light beam, and a pulse, proportional to the projected area of the particle, is generated on a photodiode.

*Electrical Zone Sensing - This procedure involves diluting the sample in an electrolyte solution, and passing it between 2 electrodes. A constant voltage is passed between the electrodes, and the particles passing through the sensing field produce a change in electrical resistance which is proportional to the particle volume. This volume measurement is then converted to particle size and concentration values. (Coulter Counter, Particle Data).

*Laser Light Scattering - (Spectrex, HIAC, Brinkman) The sample is placed in a beaker, which a rotating laser strikes, producing forward light scatter. The diameter of the conical section striking a photodetector is related to particle size.

The work in this report was done using a Spectrex laser light scattering instrument. Two types of information are obtained with this instrument. The total number of particles in a one milliliter of the liquid is counted and recorded. and the number of particles in the different size channels is determined. Two different lenses permit the operator to determine the size and number of particles in the 1 through 16 micron range and the 16 to 100 micron range.

CONCLUSIONS

The purpose of this paper was to demonstrate the possible utility of particle count and sizing technology for the evaluation of filtration performance. Pilot plant data were evaluated to determine if particle count correlation with turbidity and to determine if particle counts and distribution can be used to optimize treatment.

It was found that for this particular source and finished water that only a general correlation could be found between particle counts and turbidity. In the finished water, turbidity range less than 0.2 ntn, little correlation between TPC and turbidity existed. For a given tubidity, particle counts could vary by a factor of 10. It was possible to adjust treatment to produce a finished water that contained less total particles. It would also be possible to monitor filter breakthroughs based on TPC, however, no criteria are available or suggested for a maximum TPC.

With more stringent regulation proposed for water treatment, more information than turbidity may be necessary for choosing and optimizing filtration. Particle counting is a more sensitive measure than turbidity and can be a useful monitoring and research tool.