Matters of Perspective (Part 3 – Size Does Matter)

Tim Loftus

Contrary to popular belief, size does matter – at least as it relates to analytical equipment used in the environmental field. Take, for example, filter papers. Many types of filter papers may visually seem to be equal, but most are not. The pore size, those small and invisible openings (to our eyes anyway), varies greatly in size depending on filter type. Using the wrong filter for a particular analytical method will affect the resulting measurements.

A few of the most common analytical procedures in the wastewater field that require filtration are Total Suspended Solids (TSS) and Total Dissolved Solids (TDS), orthophosphate, and the indicator organisms we use to determine by membrane filtration the effectiveness of disinfection (the coliform group – total, fecal, *E. coli*; and the enterococcus group).

Total Suspended Solids is a test-defined analysis. Unlike copper, where copper is there or it isn't, TSS is what remains after a sample is passed through a filter with a specific pore size. In *Standard Methods*, TSS is defined as anything that is retained on a filter with a pore size of equal to, or less than 2.0-um (um is shorthand for micrometer). Particles that pass through this filter are considered "dissolved solids." The most common filters for TSS are glass fiber filters with a nominal pore size of 1.5 um. Note that in old texts these two types of solids are often referred to as "filterable" and "nonfilterable" solids.

How small is 1.5 um? The average width of human hair is a little less than 100 um. The cut-off between TSS and dissolved solids is about 65 times smaller than the width of a strand of hair. If you could line up side-by-side the particles of TSS the size of 1.4 um each, 71 of them would equal the width of a piece of hair. Of course, some "dissolved" solids are much smaller than this, even down to the molecular level.

Larger than 1.5 um, and the particles are considered suspended solids.

Filters for coliform bacteria analyses by the membrane filtration method have a pore size of 0.45 um. While some bacteria are half that size and will easily pass through one of these filters, the coliform group of bacteria is easily retained. The coliform bacteria, to which *E. coli* belongs, are rod-shaped and generally 1 um (or less) in diameter and are 1 to 6 um long, depending on the specie.

Viruses are even smaller. For comparison, the poliovirus is about 0.025 um in diameter. Line up 4000 of them side-by-side and it will equal the width of a human hair.

The difference between dissolved phosphorus and suspended phosphorus is simply the form that passes through a filter with a pore size of 0.45 um. If it passes through the filter, it is considered dissolved. The form retained on the filter is considered suspended. In the water and wastewater field, most of the dissolved phosphorus is considered orthophosphate and is easily taken up in biological processes.

As you can see, size does matter in environmental analyses. In the case of filter papers, it is extremely important to use the correct type/pore size that you will find outlined in the test procedures. Use no substitutions. Not only will you meet the testing requirements for your NPDES permit, but you will also produce much more consistent results for in-house process control.

The information in this article is very general. As usual, check your federal, state, and local regulations. You may have additional regulations or requirements that you must meet.

References:

Standard Methods for the Examination of Water and Wastewater 23rd edition 2017, part 2540 Solids A. Introduction, 1. Terminology.

Standard Methods for the Examination of Water and Wastewater 23rd edition 2017, part 9222 B, 9222B, 9222 D, and 9230 A.

40 CFR 136 Table 11 Required Containers, Preservation Techniques, and Holding Times. Footnote 24 (for orthophosphate).

https://www.capitolscientific.com/Whatman-1827-047-Grade-934-AH-Glass-Fiber-Filter-Paper-without-Binder-Diameter-4-7cm-Pore-Size

June 20, 2024