By L.P. Raman

Filtration

In Water and Wastewater Analysis

Filtration is widely accepted as a way of producing quality water. As simple as it looks, the filtration media and how it works is more complex that what meets the eye. In general, filtration media is classified as depth filters or screen filters. Depth filters retain particles in the matrix of the filter media and along the direction of fluid flow. In contrast, screen filters (also known as membrane filters) retain particles on the surface of the filters.

While depth filters are rated based on the size of the particles they retain, membrane filters are usually rated by pore sizes. Table 1 below compares and contrasts depth and membrane filters.

Filtration Media Construction Materials

Filtration media is made from natural materials such as cotton and wood pulp or from synthetic polymers such as polypropylene. In-organic materials such as glass micro fiber, quartz, aluminum oxide and silver are also used as filter media. Table 2 shows materials of construction and types of filters these are made into.

Water Analysis Lab Filters

Filters used in water analysis labs generally are used for removing particulates, capturing and quantifying specified impurities or for analyzing microorganisms. Generally, laboratories use filter media in circular formats in sheet forms such as filter papers or membranes or as encapsulated devices such as syringe filters and capsules.

Filter Papers

Cellulose and glass micro fiber media are used for basic qualitative and quantitative measurements. The basic procedure is to take a filter paper, measure its base line weight, then filter a specified quantity of liquid through it, dry the filter paper and measure the weight again. Total suspended solids analysis is done through a similar method.

Total Suspended Solids – Waste Water. Total suspended solids refers to matter suspended in wastewater and is the residue left behind on a filter paper (with a retention of 2 µm or less) after filtration and drying. The procedure is specified in Method 2540D of American Public Health Association's (APHA) – Standard Methods of Analysis of Water and Waste Water. Depending on the volume required to be filtered, a 934-AH Glass Micro Fiber (GMF) Filter in diameter of 2.4, 4.7 or 9.0 cm is widely used for this application. With a particle retention of 1.5 µm and made of binder free borosilicate glass, 934-AH has a unique GMF formulation that has high flow rates, high loading capacity and can withstand high temperatures. The product is designed to have no brittleness, increased strength, less fiber shedding and pin holing.

Membranes

Membranes are screen filters that remove particles generally in the sub-micron range. These are used for both filtration and enumeration of particles and microorganisms. Membranes used in laboratory analysis are cast membranes (mixed ester of cellulose used commonly for coliform colony counting) or sieve–like track-etch membranes. In water analysis membranes are used for capturing and analyzing microorganisms on the surface of the filter.

Rapid Enumeration of Microorganisms. Epifluorescent membrane assay that can be used in the field, on-line or in the laboratory using the unique surface capture effect of Black Polycarbonate Track-Etch Membrane. Black Polycarbonate Track-Etch Membranes exhibit extremely low auto fluorescence and there fore permit high visibility of microorganisms captured on the membrane surfaces. Since, essentially, all types of microorganisms, including viable, nonviable, autotrophs and anaerobes are detected by this method, it consistently yields higher counts than the traditional pour-plate, or similar culturing methods. Figure 1 shows generalized work flow of this method.

TABLE 1 COMPARISON OF DEPTH AND MEMBRANE FILTERS

Depth Filter	Membrane Filter
• Retain larger particles (1-100µm)	• Retain sub-micron particles (~ < 1 µm)
• Used as pre-filters	• Used as final filters
• Have fibrous surface	• Have relatively flat smooth surface
• Have higher particle loading capacity	• Low particle holding capacity
• Specified based on particle retention	• Specified based on pore size

TABLE 2 FILTRATION MEDIA MATERIALS

Type of Filter	Materials of construction
Depth Filter	• Cellulose (Filter Papers) • Glass Micro fiber • Quartz Fiber
Membrane	• Cellulose Nitrate • Cellulose
Acetate	• Mixed Esters • PVDF • PTFE • PES/PS • Nylon • Polycarbonate • Polyester • Polypropylene • Ceramics • Metals • Stainless steel

Figure 1 Work Flow for Epifluroscence Microscopy

Step 1
- Filter Sample.
- Use standard filtration technique.
- Collect microorganism on track-etch membrane.
- Black Polycarbonate membrane surface.

Step 2
- Stain Sample.
- Stain/label sample.
- Air dry.
- Mount on slide.

Step 3
- View Sample.
- View sample under Epifluorescence Microscope.
- UV excitation results in fluorescence emission.
- Enumerate Microorganisms.

Figure 2 below shows Epifluorescence micrograph of bacteria in water. These can be rapidly counted using standard microscopy counting techniques.

Method's Advantages.
- Better enumeration of microorganisms: Culture techniques underestimate the total number of microorganisms present in a sample due to the selective nature of the media which they employ.
- Results in less than 30 minutes: Culture techniques require incubation times of 48-72 hours before the results become available.

Figure 2 Bacteria in Stained with DAPI on Black-Track-Etch Membrane

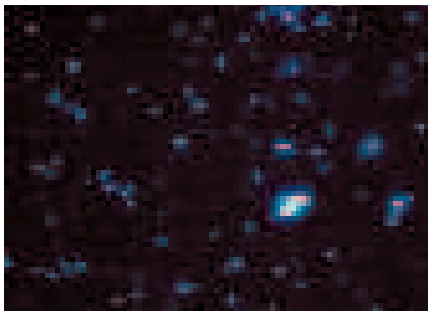
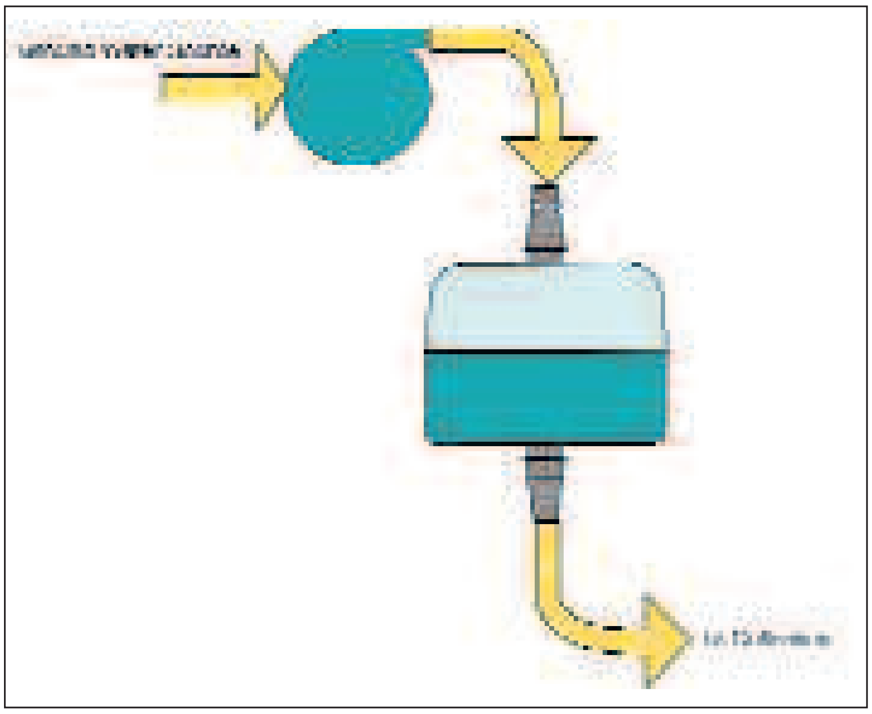


Figure 3 Schematic of Ground Water Capsule and Sample Collection



- Detect both non-viable and viable microorganisms.
- Can detect microorganisms present in clumps or micro-colonies.
- Time-averaged samples may be taken. Samples for microbial analysis may be collected during an entire production run. This adds an additional in-process control to the overall process quality control program.

Encapsulated Devices

Filtration media are often encapsulated in a ready-to-use plastic device. Examples of encapsulated filtration devices are syringe filters, capsule filters and filter cups. Encapsulated filtration devices are widely used in the medical and pharmaceutical industry and more and find more and more applications in laboratory water filtration. These devices are easier to use and minimize cross-contamination of samples. Capsule filtration devices are widely used when collecting ground water samples.

Ground Water Sampling. U.S. EPA and State Departments for Environmental Protection (DEP) protocols for groundwater specify filtering the sample when analyzing for inorganic constituents. Ground water monitoring wells are not under daily use and hence sample water contains silt and sand. Presence of particles can adversely affect the results, as the protocols often require instant acidification; samples are instantly acidified to prevent oxidation of ferrous salts to insoluble ferric salts upon exposure to atmospheric oxygen. Presence of sand particles in the acidification process can result in erroneous results. Figure 3 above shows a schematic of how Polycap GW ground water capsule is used.

Some of the advantage of using capsule filtration for ground water collection include:

- Minimization of cross contamination of samples.
- Savings in time for sample collection as no disassembling and reassembling of filter is required.

Conclusion

Filtration methods are widely used in water analysis labs. Filter papers are used in the basic quantitative methods such as those involved in total suspended solids analysis. Membranes are used as matrices for collecting and enumerating microorganism. Encapsulated filtration devices offer the convenience and ease of use for sample preparation before analysis. WQP

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