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Chapter 1

Introduction

Precoat filtration is a US Environmental Protection Agency (USEPA) accepted filtration technique for potable water treatment. When the Surface Water Treatment Rule (SWTR) went into effect in 1989, it provoked a renewed interest in this filtration process as well as other accepted filtration methods. This manual provides general guidelines for the use of precoat filtration, commonly called diatomaceous earth (DE or diatomite) filtration, in potable water treatment. It includes an evaluation of appropriate applications for precoat filtration, discusses the design of economical filtration units, and presents an overview of operating practices.

HISTORY

During World War II, the US Army needed a portable, efficient filter to remove Entamoeba histolytica, a protozoan parasite prevalent in the Pacific war zone, from drinking water. The army developed precoat filtration, which successfully removed the cysts. Since 1949, precoat filtration has been used in the filtration of sugar syrups, fruit juices, wine, beer, and water. More than 170 potable water treatment plants using precoat filtration have been constructed. New precoat filtration plants are anticipated as a result of the SWTR, including a 300-mgd plant for the treatment of New York City’s Croton Reservoir supply.

DESCRIPTION

In precoat filtration, unclarified water containing foreign particles is forced, under pressure or by vacuum, through a uniform layer of filtering material (media) that has been deposited (precoated) on a septum. The septum is a permeable support for the media and is sustained by the rigid structure of the filter element. As the water passes through the filter media and septum, suspended particles about 2 µm and larger are captured and removed. Figure 1-1 presents a size spectrum of waterborne contaminants and various filter pores used in water treatment. The average pore sizes for DE are much smaller than the pore sizes of conventional filter media, such as sand.
The basic function performed by all water filters is to remove particulate matter from the water. Precoat filters accomplish this by physically straining the solids out of the water. Normally, there is no chemical reaction unless a soluble contaminant must be precipitated prior to filtration. The thickness of the initial layer of precoat filter media is normally 1/8–1/4 in., and the water passageways through this layer are so small and numerous that even very fine particles are trapped. The majority of particles removed by the filter are trapped at the surface of the filter media layer, although some are retained within the filter layer. As water continues flowing through the filter, additional filter media, called body-feed, is regularly added to the incoming water flow in proportion to the particles being removed. The suspended particles intermingle with the body-feed particles to maintain flow through the filter. This mixture allows water to continue to flow through the filter as the accumulation of particles gradually grows thicker. The
body-feed retards the head loss that might occur if foreign particles clogged the filter. Because the permeability of the filter cake (the mixture of precoat filter media, particles, and body-feed) is maintained, the length of the filter cycle is extended. However, as the filter grows thicker, a gradually increasing pressure drop through the filter system makes filtration impractical. When this stage is reached, the processes stopped, and the filter media and collected particulate are washed off the septum. A new precoat of filter media is then applied, and filtration resumes. A typical flow schematic for a pressure filter is shown in Figure 1-2, and Figure 1-3 shows a flow schematic for vacuum filters.

For small installations, the precoat tank functions for both slurry makeup and precoat recycle. Figure 1-2 illustrates the following procedure to precoat the septa:

1. Begin with a clean filter. Fill the associated piping between the precoat tank and the filter, as well as the precoat tank, with clean, filtered water.
2. Start the mixer on the precoat tank to create movement in the water. Add a batch of filter media that is sufficient to cover the septa in the filters, and mix to make the slurry.

Figure 1-2  Schematic of a precoat pressure filter system
3. Turn on the precoat pump to bring the slurry to the filter and to recycle the slurry and carrier water from the filter to the tank and back to the filter.

4. When all the filter media is on the filters, change the valving to bring raw water and body-feed to the filter. The filter septa have been covered with all the filter media when the turbidity of the carrier water is as low as the normal, clean filtered water. The filter is then ready for use.

There are five or six commonly used grades of filter media (sometimes called filter aid) available. Various grades of filter media perform differently in the way they remove particles and in flow characteristics. With an appropriate selection from among these grades, a large number of particles as small as 1 µm can be removed by the filter cake. This includes most surface water impurities. However, where small to mid-size particles (10^{-4} to 10^{-6} m) are present, filtration alone may not be adequate to reduce turbidity (particles suspended in the water) below the 1 ntu required by current regulations.

Generally speaking, precoat filtration is most effective when source water turbidity is moderate to low (10 ntu or less). However, higher turbidity levels may be
Economic Benefits

Where the source water and other conditions are suitable, precoat filtration offers a number of economic benefits to the user, including the following:

- Capital cost savings may be possible because of smaller land and building requirements and lower installed costs (see Figure 1-4).
- Treatment costs may be slightly less than for conventional coagulation, sedimentation, and granular media filtration when filterable solids are low.
- The use of chemicals associated with granular media filtration, such as aluminum sulfate, iron salts, and polymers, is not necessary. The process is entirely physical and does not require operator expertise in water chemistry relating to coagulation.
- The volume of filtered water used for cleaning the filter is less than the volume used to clean granular media filters. Normally, less than 1 percent of the total filtered water is required.
- Diatomaceous earth filter residuals are easily dewatered, and in some cases, the media may be reclaimed for other uses, including soil conditioning and land reclamation. Research is under way to determine the feasibility of reusing filter media as body-feed.