

The Importance of Filtration in Wastewater Reclamation

by *George Tchobanoglous and Onder Calliskaner*

As the discharge requirements for treated secondary effluent become more restrictive, effluent filtration is becoming a more integral part of secondary treatment. Because a high quality effluent is produced after filtration, the potential for reusing treated effluent is being examined by a number of municipalities, especially those in the water-short areas of the southwestern United States. A new concept of filtration in reuse applications and an innovative filter technology is being used to help alleviate some of these problems.

Wastewater Reuse Requirements

Health effects are of primary concern in the disposal of municipal wastewater. Disinfection by chlorination and/or UV irradiation is common when treated wastewater is discharged to inland surface waters. While routine disinfection achieves essentially complete destruction of pathogenic bacteria and substantial deactivation of viruses, it does not provide complete virus destruction. Because viruses have been detected in disinfected secondary effluents, concern exists over protecting the health of individuals who may come in contact with the treated wastewater in reuse applications. As a result of this concern, the California DOHS (Department of Health Services) has established quality and treatment criteria for wastewater reuse in which human contact may occur. These criteria, along with criteria for other reuse applications, are set forth in Title 22, Division 4, Chapter 3 of the California Administrative Code.

Viral monitoring is not specified in Title 22, because, (1) viruses usu-

ally occur in low concentrations in treated wastewater, (2) their assay requires special expertise, (3) there is a long time delay in obtaining the results due to complex laboratory procedures, and (4) the analytical costs are high. Instead of imposing measurements of viral concentrations, a tertiary treatment system consisting of chemical coagulation, sedimentation, filtration, and disinfection is specified in the Title 22 criteria where the public may be exposed to the treated wastewater, such as in recreational impoundments. After final filtration, turbidity of the treated effluent cannot exceed an average operating value of two turbidity units and cannot exceed five turbidity units more than five percent of the time during any 24-hour period. Direct filtration with chemical addition has been allowed as an alternative to the complete treatment system specified in Title 22, where it has been demonstrated that the results of the two treatment systems are comparable and meet the appropriate criteria.

Disinfection of Filtered Effluent

In recent studies dealing with the disinfection of filtered effluent, it has been found that for a given chlorine or UV dose, the disinfection rates correlated well with the wastewater particle size distributions. Analysis of the data supports the conclusion that the ability to inactivate an individual wastewater particle containing bacteria is a function of the size of the particle. As a result, granular medium filtration is now almost universally required as part of the wastewater reclamation process.

In addition to improving the aesthetic quality of the reclaimed water

and removing chlorine-demanding substances, direct tertiary filtration alone does not enhance the rate of disinfection unless the particle size distribution of the settled wastewater is modified. If a tertiary filtration system can operate to remove larger size particles completely, it should be possible to safely reduce the long contact times and high chlorine dosages typically employed in wastewater reclamation processes. Similar effects have been observed in the application of UV irradiation for the disinfection of filtered effluent.

Existing Filtration Technologies

Over the past ten years, a variety of filtration technologies have been developed and applied to the filtration of secondary effluent. The principal types of technologies include (1) conventional mono-, dual-, and multi-medium downward flow filters, (2) deep-bed downward flow and/or upflow mono-medium filters, (3) pulsed-bed mono-medium downward flow filter, (4) shallow-depth single and dual-medium downward flow traveling bridge filters, and (5) continuous backwash upflow unstratified mono-medium deep bed filters. There is however, a new filter technology that has been developed recently.

New Filtration Technology

A new filter involving the use of a synthetic fiber filter medium is now being tested for Title 22 reclamation applications at the University of California at Davis. The filter is unusual in a number of ways: (1) the filtering medium is highly porous, (2) the porosity (void ratio) of the medium can be modified, (3) to backwash

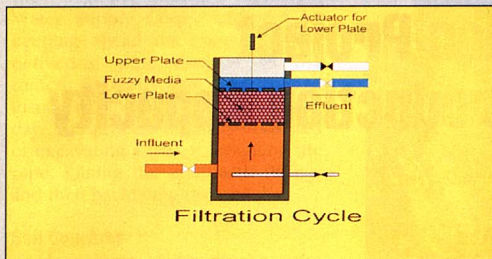


Fig 1

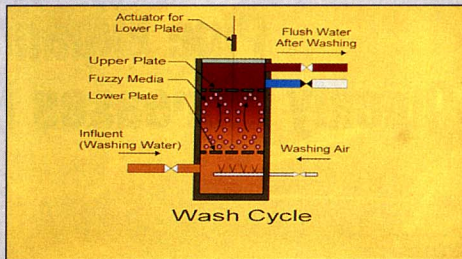


Fig 2

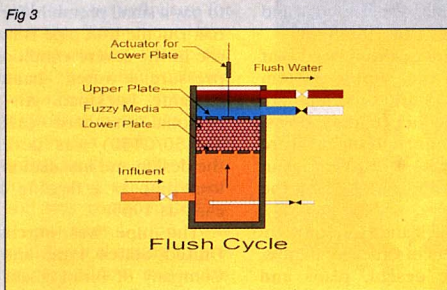


Fig 3

the filter, the porosity (size) of the filter bed is increased mechanically, and (4) the filter operates at very high filtration rates [e.g., 10 to as high as 40 gal/ft²•min (400 to 1600 L/m²•min)].

The synthetic filter medium is approximately 1.25 in. in diameter. Because of the fuzzy appearance of the filter medium, the filter has been designated the Fuzzy Filter by Schreiber Corporation, manufacturer of the patented filtration process. Based on displacement tests, the porosity of the uncompacted quasi-sphere filter medium itself is estimated to be about 88 to 90 percent, and the porosity of the filter bed made up of the filter medium is approximately 94 percent. Because of its low density, the filter medium is retained between two perforated plates (Fig 1). Also, because the filter medium is compressible, the porosity of the filter bed can be altered according to the characteristics of the influent. The filter medium also represents a departure from conventional filter mediums in that the fluid to be filtered flows through

the medium as opposed to flowing around the filtering medium, as in sand and anthracite filters.

In the filtering mode, secondary effluent is introduced in the bottom of the filter. Equal distribution is assured because the filter bottom serves as a plenum. The influent wastewater flows upward through the filter medium, retained by two porous plates, and is discharged from the top of the filter. To backwash the filter, the lower perforated plate is lowered mechanically. While flow to the filter continues, air is introduced sequentially from the left and right sides of the filter below the lower perforated plate, causing the filter medium to move in a rolling motion (Fig 2). The filter medium is cleaned by the shearing forces as the wastewater moves past the filter and by abrasion as the filter medium rubs against itself. Wastewater containing the solids removed from the filter are diverted for subsequent processing. To put the filter back into operation after the backwash cycle has been completed, the lowered perforated plate is returned to its original

position. Once the lower plate is in position the filter is flushed for a short period to remove any residual backwash solids (Fig 3). After a short flushing cycle, the filtered effluent valve is opened, and filtered effluent is discharged.

The high porosity of the filter medium and the unusual design of the filter make it possible to achieve very high rates of filtration. The clear water headloss through 24 in. of filter medium at filtration rates of five and 40 gal/ft²•min (200 and 1600 L/m²•min) is equal to 1.57 in. and 11.2 in., respectively. To control the particle size of the filtered effluent, the porosity of the filter bed can be modified.

Objectives Of Filtration Studies

The principal objective of the filtration studies that are currently underway is to evaluate the characteristics of the new system in wastewater filtration applications. Subobjectives include: (1) the quantification of the operating characteristics of the filter with specific reference to Title 22 wastewater reclamation applications, (2) evaluation of filter reliability and performance as affected by variations in effluent quality, (3) evaluation of the backwash operation and frequency, and (4) the assessment of the filter for the filtration of primary effluent. ■

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