

IESWTR or LT1ESWTR. Slow sand filtration is not typically used as a secondary filtration step following conventional treatment or other primary filtration processes of similar efficacy. However, EPA expects that slow sand filtration would achieve significant removal of *Cryptosporidium* in such a treatment train.

While there is a significant body of data demonstrating the effectiveness of slow sand filtration for *Cryptosporidium* removal as a primary filtration process, as described in section III.D, EPA has limited data on the effectiveness of slow sand filtration when used as a secondary filtration step. Hall *et al.* (1994) evaluated oocyst removal for a pilot scale slow sand filter following a primary filtration process identified as a rapid gravity filter. The combined treatment train of a primary filtration process followed by slow sand filtration achieved greater than 3 log *Cryptosporidium* removal in three of five experimental runs, while approximately 2.5 log reduction was observed in the other two runs. In comparison, Hall *et al.* (1994) reported slow sand filtration alone to achieve at least a 3 log removal of oocysts in each of four experimental runs when not preceded by a primary filtration process. The authors offered no explanation for these results, but measured oocyst removals may have been impacted by limitations with the analytical method.

Removal of microbial pathogens in slow sand filters is complex and is believed to occur through a combination of physical, chemical, and biological mechanisms, both on the surface (schmutzdecke) and in the interior of the filter bed. It is unknown if the higher quality of the water that would be influent to a slow sand filter when used as a secondary filtration step would impact the efficiency of the filter in removing *Cryptosporidium*. Based on the limited data on the performance of slow sand filtration as a secondary filtration step, and in consideration of the recommendation of the Advisory Committee, EPA is proposing only a 2.5 log additional *Cryptosporidium* treatment credit for this application.

c. Request for comment. The Agency requests comment on whether the available data are adequate to support awarding a 2.5 log *Cryptosporidium* removal credit for slow sand filtration applied as a secondary filtration step, along with any additional information related to this application.

11. Membrane Filtration

a. What is EPA proposing today? EPA is proposing criteria for awarding credit to membrane filtration processes for

removal of *Cryptosporidium*. To receive removal credit, the membrane filtration process must: (1) Meet the basic definition of a membrane filtration process, (2) have removal efficiency established through challenge testing and verified by direct integrity testing, and (3) undergo periodic direct integrity testing and continuous indirect integrity monitoring during use. The maximum removal credit that a membrane filtration process is eligible to receive is equal to the lower value of either:

- The removal efficiency demonstrated during challenge testing OR
- The maximum log removal value that can be verified through the direct integrity test (*i.e.*, integrity test sensitivity) used to monitor the membrane filtration process.

By the criteria in today's proposal, a membrane filtration process could potentially meet the Bin 4 *Cryptosporidium* treatment requirements of this proposal. These criteria are described in more detail below. EPA is developing a Membrane Filtration Guidance Manual that provides additional information and procedures for meeting these criteria (USEPA 2003e). A draft of this guidance is available in the docket for today's proposal (<http://www.epa.gov/edocket/>).

Definition of a Membrane Filtration Process

For the purpose of this proposed rule, membrane filtration is defined as a pressure or vacuum driven separation process in which particulate matter larger than 1 μm is rejected by a nonfibrous, engineered barrier, primarily through a size exclusion mechanism, and which has a measurable removal efficiency of a target organism that can be verified through the application of a direct integrity test. This definition is intended to include the common membrane technology classifications: microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO). MF and UF are low-pressure membrane filtration processes that are primarily used to remove particulate matter and microbial contaminants. NF and RO are membrane separation processes that are primarily used to remove dissolved contaminants through a variety of mechanisms, but which also remove particulate matter via a size exclusion mechanism.

In today's proposal, the critical distinction between membrane filtration processes and bag and cartridge filters, described in section IV.C.12, is that the integrity of membrane filtration processes can be directly tested. Based

on this distinction, EPA is proposing that membrane material configured into a cartridge filtration device that meets the definition of membrane filtration and that can be direct integrity tested according to the criteria specified in this section is eligible for the same removal credit as a membrane filtration process.

Membrane devices can be designed in a variety of configurations including hollow-fiber modules, hollow-fiber cassettes, spiral-wound elements, cartridge filter elements, plate and frame modules, and tubular modules among others. In today's proposal, the generic term module is used to refer to all of these various configurations and is defined as the smallest component of a membrane unit in which a specific membrane surface area is housed in a device with a filtrate outlet structure. A membrane unit is defined as a group of membrane modules that share common valving that allows the unit to be isolated from the rest of the system for the purpose of integrity testing or other maintenance.

Challenge Testing

A challenge test is defined as a study conducted to determine the removal efficiency (*i.e.*, log removal value) of the membrane filtration media. The removal efficiency demonstrated during challenge testing establishes the maximum removal credit that a membrane filtration process is eligible to receive, provided this value is less than or equal to the maximum log removal value that can be verified by the direct integrity test (as described in the following subsection). Challenge testing is a product specific rather than a site specific requirement. At the discretion of the State, data from challenge studies conducted prior to promulgation of this regulation may be considered in lieu of additional testing. However, the prior testing must have been conducted in a manner that demonstrates a removal efficiency for *Cryptosporidium* commensurate with the treatment credit awarded to the process. Guidance for conducting challenge testing to meet the requirements of the rule is provided in the Membrane Filtration Guidance Manual (USEPA 2003e). Challenge testing must be conducted according to the following criteria:

- Challenge testing must be conducted on a full-scale membrane module identical in material and construction to the membrane modules proposed for use in full-scale treatment facilities. Alternatively, challenge testing may be conducted on a smaller membrane module, identical in material and similar in construction to the full-