

waters with variable and seasonably high suspended solids concentrations. This study collected data on roughing filters in Peru, Colombia, Sudan, and Ghana. Table IV-17 summarizes data for three of the roughing filters. These filters were capable of reducing peak turbidities by 80 to 90 percent. Further, the Peruvian and Colombian filters

reduced fecal coliforms by 77 and 89 percent, respectively. The Sudanese filter may have removed around 90 percent of the fecal coliforms, but specific values were not given. Data collected from roughing filters in Ghana on algae removal indicate that the Merismopedia (0.5 µm) and Chlorophyta (2–10 µm), which are comparable in size

to *Cryptosporidium* oocysts, were completely removed from the water in mature filters, and that some removal of Chlorophyta, but not Merismopedia, occurred in filters after three days of operation. However, the removal of these organisms has not been correlated with *Cryptosporidium* oocyst removal.

TABLE IV-17.—ROUGHING FILTER DATA FROM WEGELIN, 1988

Location	Azpita, Peru	El Retiro, Colombia	Blue Nile Health Project, Sudan
Roughing Filter Type	Downflow	Upflow (multi-layer filter)	Horizontal-flow.
Filtration Rate	0.30 m/h (0.98 ft/hr)	0.74 m/h (2.43 f/hr)	0.3 m/h (0.98 ft/hr).
Design Capacity	35 m ³ /d	790 m ³ /d	5 m ³ /d.
Turbidity (NTU)			
Raw Water	50–200	10–150	40–500
Roughing Filter Effluent	15–40	5–15	5–50
Fecal Coliforms (/100 mL)			
Raw Water	700	16,000	>300
Roughing Filter Effluent	160	1,680	<25

oller (1993) details the mechanisms of particle removal that occur in roughing filters. The conclusions are similar to those drawn by Wegelin *et al.* (1987). Particle analysis reviewed by Boller indicates that after seven days of operation, the four stage pilot filter utilized by Wegelin *et al.* (1987) removed more than 98 percent of particles sized 1.1 µm, and greater than 99 percent of particles sized 3.6 µm. After 62 days, only 80 percent of particles sized 1.1 µm were removed, while 90 percent of particles sized 3.6 µm were removed. Boller did not give the solids loading on the tested filter, and particle removal was not correlated to *Cryptosporidium* oocyst removal.

Collins *et al.* (1994) investigated solids and algae removal with pilot scale vertical downflow roughing filters. Gravel media size, filter depth, and flow rate were varied to determine which design variables had the greatest effect on filter performance. Results indicated that the most influential design parameters for removing solids from water, in order of importance, were filter length, gravel size, and hydraulic flow rate. For algae removal, the most influential design parameters were hydraulic flow rate, filter length, and gravel size. Solids removal was better in filters that had been ripened with algae for 5–7 days. However, extrapolation of these results to *Cryptosporidium* removal could not be made.

c. *Request for comment.* The Agency requests comment on the information that has been presented about roughing

filters, and specifically the question of whether and under what conditions roughing filters should be awarded a 0.5 log credit for removal of *Cryptosporidium*. EPA also requests information on specific studies of *Cryptosporidium* oocyst removal by roughing filters, or from studies of the removal of surrogate parameters that have been shown to correlate with oocyst removal in roughing filters.

10. Slow Sand Filtration

a. *What is EPA proposing today?* Slow sand filtration is defined in 40 CFR 141.2 as a process involving passage of raw water through a bed of sand at low velocity (generally less than 0.4 m/h) resulting in substantial particulate removal by physical and biological mechanisms. Today's proposal allows systems using slow sand filtration as a secondary filtration step following a primary filtration process (e.g., conventional treatment) to receive an additional 2.5 log *Cryptosporidium* treatment credit. There must be no disinfectant residual in the influent water to the slow sand filtration process to be eligible for credit.

Note that this proposed credit differs from the credit proposed for slow sand filtration as a primary filtration process. EPA has concluded, based on treatment studies described in section III.D, that plants using well designed and well operated slow sand filtration as a primary filtration process can achieve an average *Cryptosporidium* removal of 3 log (Schuler and Ghosh, 1991, Timms

et al. 1995, Hall *et al.* 1994). Consequently, as described in section IV.A, EPA is proposing that plants using slow sand filtration as a primary filtration process receive a 3 log credit towards *Cryptosporidium* treatment requirements associated with Bins 2–4 under the LT2ESWTR (*i.e.*, credit equivalent to a conventional treatment plant).

The proposed 2.5 log credit for slow sand filtration as part of the microbial toolbox applies only when it is used as a secondary filtration step, following a primary filtration process like conventional treatment. While the removal mechanisms that make slow sand filtration effective as a primary filtration process would also be operative when used as a secondary filtration step, EPA has little data on this specific application. The Agency is proposing 2.5 log credit for slow sand filtration as a secondary filtration step, in comparison to 3 log credit as a primary filtration process, as a conservative measure reflecting greater uncertainty. In addition, the proposed 2.5 log credit for slow sand filtration as part of the microbial toolbox is consistent with the recommendation in the Stage 2 M-DBP Agreement in Principle.

b. *How was this proposal developed?* The Stage 2 M-DBP Agreement in Principle recommends that slow sand filtration receive 2.5 log or greater *Cryptosporidium* treatment credit when used in addition to existing treatment that achieves compliance with the