Protocol for the Testing of a Canpro Shower Filter for the Reduction of Free Chlorine

23 August 2000

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Introduction

This protocol details the steps used by the Research and Development Laboratory of KDF Fluid Treatment (KDFFT) in testing the efficiency of shower filters for dechlorination of water (reductive dehalogenation). It must be noted that this protocol was established to only test the ability of KDF Process Media for the reduction of free available chlorine. While KDF Process Media theoretically have the ability to reduce other halogens and halogenated compounds there is insufficient data available at the present time to determine the exact parameters required.

The Research and Development Laboratory of KDFFT is not certified by any State or Federal regulatory agency and no standardized written protocol for the testing of shower filter units exists. However, this protocol does follow the methods currently used throughout the water treatment industry in particular ANSI/NSF 42-2000, Standard Methods for the Examination of Water and Wastewater (AWWA / APHA /WEF) and the American Society for Testing Materials (ASTM). Results of testing in laboratories outside of KDFFT may vary slightly due to differences in water chemistry and analytical techniques.

Methodology

KDFFT has a dedicated system for the specific task of testing various water filtration systems for dechlorination. The source for the challenge water is a shallow well drilled into a glacial drift aquifer (analysis Appendix I). The well feeds a 1½-inch main water line through a 30-gallon bladder tank that maintains an influent line pressure of 50 psi. Challenge water for testing is generated by chlorinating the well supply with dilute 12.5% sodium hypochlorite solution to an influent free chlorine concentration of approximately 2.00 mg/l. Preceding the chlorination stage is a 120-gallon mixing vessel followed by a mixed bed filter to remove suspended iron particles precipitated by the chlorine.

This challenge water is then fed to a set of on-demand electric water heaters through a ¾-inch diameter PVC line and heated to 41 °C. This temperature ensures that a constant 40 °C is maintained at the shower filter testing station located approximately 10 feet from the heater units. These heaters are flow controlled and automatically come on as flow exceeds 0.50 gpm and is "instantaneously" (within 30 seconds) heated to the set temperature. A one-micron paper filter in a 9 ¾ - inch cartridge housing is placed in-line directly in front of the shower filter test station to remove calcium carbonate scale particles that periodically fall off of the heater coils that can foul the KDF shower filters.

Water flow through each shower filter at the testing station is controlled by a solenoid attached to a flow meter. The solenoid in turn is wired into a timer set for a fifteen minute on and fifteen minute off cycle. Additionally, each filter has a ball valve on its flow meter to set the correct flow through the filter. From the solenoid, ½-inch outer diameter plastic tubing is used to connect the filter both to the influent and effluent ports. Flow rates used in testing typically range between 2.5 and 2.0 gpm. If this flow cannot be reached, then the filter is to be tested at its maximum output. Appendix II contains a simple schematic of the shower filter test station developed by KDFFT.

Equipment/Instrumentation

HACH DR 2000 Direct Reading Spectrophotometer
HACH CL-17 Chlorine Analyzer
DPD free available chlorine reagent (HACH method 8021)
Free chlorine buffer and indicator solution for CL-17
LMI metering pump model P021-151
50-gallon polyethylene storage vessel
12.5 % Sodium Hypochlorite Solution
120 gallon mixing vessel
Alamo Water Refiners model N5240-10 multimedia sediment filter
Keltech model C183 electric water heater
One 10 Micron filter and housing
Four Blue-White ® model F-4450LH-S flowmeters
Two, two cycle 20-amp timers
Four Imperial nylon solenoids
Eight ½-inch OD acetal tube fittings (quick disconnect)
½-inch OD plastic tubing
Shower filters (provided by client)
Showerheads (must meet or exceed ANSI A112.18.1M standards)

Installation of Filters onto Challenge Water Line

Acetal tube fittings, quick disconnects, and ½-inch OD plastic tubing are used at the solenoid, the filter in and out ports and at the discharge port of the test station. This allows for quick exchange of filters on the test station. A minimum of two filters supplied by the manufacturer must be tested. Each shower filter is attached to a solenoid controlled flow meter and set at a proper angle, that at which it would be in normal use, on the testing station. KDFFT does not normally attach showerheads to units for the purpose of testing for dechlorination. Aeration of the effluent sample by the head will occur leading to lowered free chlorine concentrations from degassing giving misleading results. If at the request of the client or regulatory agency a showerhead is to be used, it must then be supplied with the units and comply with ANSI A112.18.1M standards.

Testing Shower Filters for Free Chlorine Reduction

At the start of testing, the timer for the solenoids is set to a fifteen-minute on-off cycle and plugged in. Next the ball valve for the hot water challenge line is opened and the controller for the heaters checked to ensure that the water is at the proper temperature. This temperature is verified using a standard glass thermometer. After an initial 10 unit volumes of challenge water have passed through each filter and, at 1000-gallon intervals thereafter up to 10,000 gallons, 250-mL samples are grabbed from each effluent stream and tested. Care is taken at the time of sample collection to ensure that degassing of chlorine through agitation of the sample is held to a minimum.

Influent free chlorine concentrations are measured using a HACH CL-17 in-line free chlorine analyzer with a sampling port directly in front of the first shower filter port. Effluent concentrations are measured with a HACH DR 2000 spectrophotometer. Determination of free chlorine concentrations by both instruments is HACH Method 8021 (SM 18th 4500-Cl G), DPD colorometric method, approved by the USEPA. The CL-17 is calibrated using a direct comparison method with the DR 2000 which in-turn is calibrated using a standard additions method on a weekly basis. Percent reduction of free chlorine is determined using the equation:

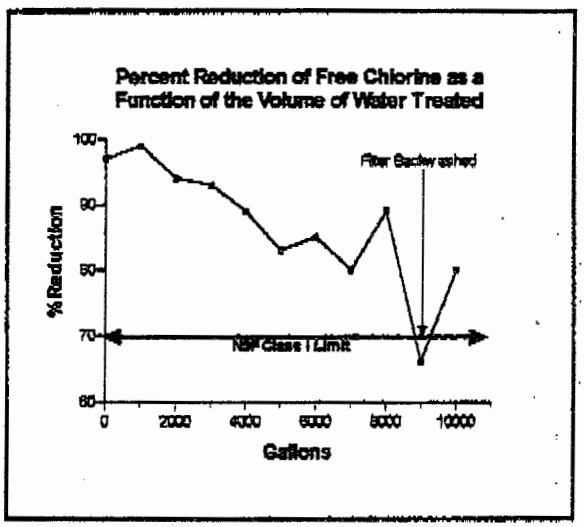
% Reduction = [(Influent Free Chlorine - Effluent free chlorine) / Influent free chlorine] x 100

Fluctuations in the influent free chlorine concentration do occur and the 2.00 mg/l concentration referred to in this protocol is the optimal target concentration. These fluctuations have been recorded in the range of 1.50 to 2.50 mg/l but the results reported are an average over the life of the test and normally are close to the target of 2.00 mg/l.

Data/Results

Canpro Shower Filter			
Influent		Effluent	
Gallons	Free Chlorine	Free Chlorine	% Reduction
0	2.70	0.09	97
1000	2.48	0.03	99
2000	2.05	0.12	94
3000	2.10	0.14	93
4000	2.22	0.24	89
5000	2.01	0.34	83
6000	2.30	0.35	85
7000	2.06	0.42	80
8000	2.10	0.23	89
9000	2.36	0.80	66
10,000	2.46	0.50	80

Discussion of Results



Under the provisions of ANSI/NSF 42-2000 filters for dechlorination are grouped into 3 classes dependent upon the level of chlorine reduction. Class I greater than 75%, Class II 50%-74% and Class III 25%-49%. From the data, presented in the graph on the right, the Canpro filter met the Class I standard for approximately 9000-gallons. At that time the filter was backwashed and a considerable amount of precipitated iron was blown out of the filter. After backwashing there was over a 10% increase in the filters efficiency back within the Class I rating. Typically KDF Fluid Treatment prefers its media to be 90% efficient or greater for the life of the filter. In this instance 4000-gallons. However there was considerable iron fouling of the medium which lowered the filters performance. It is felt that with periodic backwashing of the filter it would remain 90% efficient for well over 8000-gallons.

Appendix I

Raw Challenge Water Analysis

Parameter	June 2000
pH	7.14
Conductivity	656 µS
TDS	316 mg/l
Total Alkalinity as $CaCO_3$	266 mg/l
Total Hardness as $CaCO_3$	321 mg/l
Cation and Anion Concentrations are Reported in the Ionic Form	
Fe_{Total} (total iron)	0.13 mg/l
Ca^{2+} (calcium)	92 mg/l
Mg^{2+} (magnesium)	22 mg/l
K^+ (potassium)	0.87 mg/l
Na^+ (sodium)	13 mg/l
HCO_3^- (bicarbonate)	325 mg/l
Cl^- (chloride)	45 mg/l
NO_3-N (nitrate as nitrogen)	Non-Detect
SO_4^{2-} (sulfate)	47 mg/l
PO_4^{3-} (phosphate)	0.11 mg/l
SiO_2 (silica)	13 mg/l

Appendix II

Schematic of Laboratory Shower Filter Test Station