



Three Rivers Area Enterprise Park
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Testing of Pelican Shower Filters for the Reduction of Free Chlorine to NSF Standard 177-2004

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General

tc \12 "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 the removal of free chlorine from shower water. This protocol was established following the standards set by NSF International in NSF Standard 177-2004. Results of testing in laboratories outside of KDFFT may vary slightly due to differences in water chemistry and analytical techniques.

Equipment

tc \13 "Equipment/Instrumentation

HACH DR 2000 Direct Reading Spectrophotometer
HACH 2100P Turbidimeter
HACH EC20 pH/ISE meter
Temperature probe, NIST traceable
HACH Accuvac DPD free available chlorine reagent (HACH method 8021)
NIST traceable standards and buffers
FlexFlo A-100N metering pump
LMI metering pump model P021-151
50-gallon polyethylene storage vessel
35-gallon polyethylene storage vessel
12.5 % Sodium Hypochlorite Solution
Tannic Acid, 95%, granular
120 gallon mixing vessel
Commercial grade electric water heater
Grundfos Model MQ3-45 booster pump
Pressure regulator
One ASME Grade A pressure gauge
Two GPI Model A104GMN025NA1 Digital Flow Totalizers
One top loading balance
One 2-gallon container
Stopwatch, NIST traceable
One Tork Model 8601 timer
Two brass solenoids
½-inch OD acetal tube fittings (quick disconnect)
½-inch OD plastic tubing
Two identical shower filters (provided by client)

Test Apparatus

tc \13 "Step One: Installation of Filters onto Challenge Water Line

KDFFT has a dedicated system for the specific task of testing shower filters to NSF Standard 177 using equipment listed above. The source for the challenge water is a shallow well drilled into a glacial drift aquifer which is then softened before use. Chlorinated challenge water is created by injecting the softened well supply with dilute 12.5% sodium hypochlorite solution to an influent free chlorine concentration of 2.00 ± 0.20 mg/l. Preceding the chlorination stage is a 120-



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gallon mixing vessel allowing for a minimum 20-minute contact time. Since the source well only has a TOC concentration of 0.50 mg/l an additional 0.50 mg/l to 1.0 mg/l of TOC is injected into the test line using a tannic acid solution. This satisfies the TOC requirements of NSF Standard 177-2004. The water is then pressurized to 80-psi using a booster pump. After the booster pump the challenge water is fed to an on-demand electric water heater and heated to 41°C. This temperature ensures that a constant 40 ± 2 °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. The last stage in preparing the challenge water for use is to run it through a 20-micron paper filter to remove any calcium carbonate scale particles that periodically fall off the heater coils that could interfere with the function of the flow meters and solenoids.

Challenge water flow through each shower filter at the testing station is controlled by timer-activated solenoids attached to digital flow totalizers with flow rate capabilities. The timer is set for a fifteen minute on and fifteen minute off cycle. A maximum flow rate of 2.5-gpm is to be used. If this flow cannot be reached then the filter is to be tested at its maximum output not to be below 0.50-gpm. Controlling the entire system: the water heaters, timer, solenoids and injection pumps, is another timer set for a 16-hour run time per day. Additionally a ball valve, flow restrictor or showerhead will be used to set the required flow rate per the manufacturer’s instructions.

General Test Water Characteristics

pH	7.5 ± 0.5
Temperature	20 °C ± 3 °C
TDS	200-500 mg/l
Turbidity	<1 NTU
TOC	>1.00 mg/l

Calibration Procedures

Prior to the start of testing, the challenge water delivery system must be calibrated as to flow rate, pressure and temperature. The flow totalizers are calibrated using a mass versus time procedure using a 2-gallon container, a top loading balance and an NIST traceable stopwatch. Pressure for each line to a filter is measured directly before the filter using a NIST traceable ASME Class A gauge. Temperature is calibrated using an NIST traceable temperature probe. Once the system is calibrated it is checked at one-half the total challenge volume and at the end of testing.



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Testing Procedures

Prior to the start of testing, the challenge water delivery system must be calibrated as to flow rate, Testing Procedures

Two shower filters are attached to solenoid controlled flow meters and set at a proper angle at which it would be in normal use on the testing station. At the start of testing the well influent challenge line is opened and the chlorine metering pump turned on. Next, a separate non-testing shower filter port is opened then the heaters are turned on. After the temperature settles at 41 oC the booster pump is turned on. The temperature controller for the heaters is verified using an NIST Traceable temperature probe. The challenge water is then monitored until it reaches the target of 2.00 ± 0.2 mg/l free chlorine. Then the timer for the solenoids is set to a fifteen-minute on-off cycle and plugged in. The ball valve for the hot water challenge line to the filters is then opened and the flow rate verified on the totalizer.

At the initial startup, after 15-gallons of challenge, a 500-mL sample is grabbed from the influent and effluent streams and tested immediately for free chlorine. 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 and effluent free chlorine concentrations are immediately measured with a HACH DR 2000 spectrophotometer using HACH Method 8021 (SM 18th 4500-Cl G), DPD colorimetric method, approved by the USEPA. All glassware used is chlorine demand free and sample pH adjustments for high alkalinity are made per HACH instructions. The sampling interval thereafter is at every 10% of the expected total volume of challenge or until the efficiency of the filter drops to 50%.

Data / Results

Gallons	Filter #1	Flow Rate	%	Filter #2	Flow Rate	%	Influent
Start	0.00	2.52	100	0.00	2.56	100	1.81
2000	0.00	2.50	100	0.01	2.51	99	1.82
4000	0.01	2.51	99	0.03	2.50	98	1.79
6000	0.04	2.46	98	0.04	2.55	98	1.91
8,000	0.05	2.46	98	0.06	2.53	97	2.06
10,000	0.11	2.45	94	0.13	2.51	93	1.95
12,000	0.05	2.49	97	0.13	2.53	93	1.81
14,000	0.16	2.49	91	0.22	2.56	88	1.87
16,000	0.22	2.50	89	0.34	2.52	83	1.97
18,000	0.21	2.46	89	0.29	2.51	85	1.95
20,000	0.24	2.46	88	0.31	2.52	84	1.94
22,000	0.31	2.48	84	0.37	2.56	81	1.94
24,000	0.40	2.48	82	0.39	2.51	82	2.20
26,000	0.52	2.46	76	0.58	2.48	74	2.20
28,000	0.46	2.45	77	0.49	2.47	76	2.00
30,000	0.35	2.52	81	0.40	2.49	78	1.80
	mg/l	gpm	%	mg/l	gpm	%	mg/l



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References

NSF/ANSI 177-2004. NSF International Standard for Shower Filter Systems. NSF International: Ann Arbor, MI.

Standard Methods for the Examination of Water and Wastewater, 18th Edition. 1992. American Public Health Association (Joint APHA, AWWA and WEF publication). Washington D.C.

Water Analysis Handbook, 2nd Edition. 1992. HACH Company. Loveland, CO. 831 pages.

