City of Rochester
Department of Environmental Services
7412 Rix Hill Road
Hemlock, New York 14466
www.cityofrochester.gov

Average % Reduction of Dissolved and Particulate Lead over the Life of a DuPont™ Traditional Water Filter Pitcher, Model WFPTC100

Brittany Vanno
City of Rochester
Water Quality Laboratory
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Abstract

The City of Rochester distributes water filter pitchers to City residents whose lead service lines have been disturbed by construction (service line replacement, water main cleaning and lining, etc.). The purpose of this study is to evaluate the efficacy of the supplied filter pitchers in the reduction and removal of dissolved and particulate lead from tap water to be used for drinking and cooking. Lead levels of samples from a corrosion testing apparatus that includes three lead loops, and two copper loops with 50/50 lead soldered joints, were analyzed both before and after filtration. This process was repeated after every 5 gallons of lead-containing water was passed through the filter, up to the manufacturer's recommended capacity of 40 gallons [1].

Background

The City of Rochester (City) Water Bureau has programs in place for both the rehabilitation of existing water mains, and the replacement of lead service lines (LSLs) within its distribution system. In 2017, the City began a study to determine the effects that disturbances to LSLs from these programs had on the lead levels in drinking water. The study concluded lead levels at the tap increased immediately after an LSL disturbance, and returned to baseline after 3 months. In accordance with industry best practices, and to ensure the safety of its customers, the City began distributing DuPont™ Traditional Filtered Water Pitchers with three months of replacement filters to customers who had LSLs disturbed by construction activities.

The DuPont™ Traditional Filtered Water Pitcher (model WFPT100) (filter pitcher) meets the standards of NSF/ANSI Standard 53 for Health Effects, as tested by the Water Quality Association[1]. NSF/ANSI Standard 53, requires a minimum 93 per cent reduction of lead with a maximum permissible water concentration of 0.010 parts per million (ppm), or 10 parts per billion (ppb) lead after filtration [1].

In August of 2019, filter pitchers distributed by Newark, New Jersey were tested by the United States Environmental Protection Agency (USEPA). Results from filters at two of the three homes that were tested showed that the filters may not perform to the NSF 53 standard [2]. Upon learning of this issue, Rochester Water Quality Laboratory Staff thought it best to test the efficacy of lead reduction of the DuPont™ filters.

The City has a corrosion control test rack consisting of two copper pipe loops with 50/50 lead soldered joints, and three lead pipe loops. All samples referred to for this study were collected from this test rack, numbered 1-5. Sample numbers 1, 3, and 5 were collected from the lead pipe loops, and samples 2 and 4 were collected from the copper pipe loops with 50/50 lead soldered joints. The test rack is programmed to simulate water use patterns in a typical household, including an 8 hour stagnation period.

Materials/Equipment

- DuPont™ Traditional Water Filter Pitcher (model WFPT100)
- Corrosion Test Rack (3 lead pipe loops, 2 copper pipe loops with 50/50 lead-soldered joints)
- Inductively Coupled Plasma - Mass Spectrometer (ICP-MS)
- 1L metals-free certified wide-mouth sample bottles
- 500mL wide-mouth sample bottles
- Concentrated stock HCl and HNO3
- Type 1 DI water
- Volumetric flasks
- Adjustable pipettes (100-1000uL, 1.0-10.0 mL) and accompanying tips

Procedure

Filter Installation

A new filter pitcher was used for this study. Filter cartridge installation steps were followed according to the manufacturer's instructions [3]. The pitcher and all pitcher parts were thoroughly washed and rinsed with soap and warm water. A new cartridge was opened and soaked in a tall glass of cold tap water for 15 minutes. This step ensures the activation of the carbon filter media within the cartridge. After the 15 minute soaking period, the cartridge was removed from the glass and held upright under a stream of cold tap water for a flushing time of 15 seconds. Excess water was allowed to drain completely from the cartridge by holding it in the upright position. The filter cartridge was inserted into its seat in the pitcher reservoir, ensuring a proper, tight seal. Two reservoir volumes of cold tap water were then filtered and discarded in order to season the filter cartridge.

Sample Collection/Preparation

Samples were collected from the corrosion test rack after a minimum six hour stagnation period in accordance with USEPA's instructions for collection of samples for lead analysis [4]. One-liter (1L), certified metals-free, wide mouth sample bottles were used to collect each sample.

500 milliliter (mL) aliquots of each 1L sample (1-5) were passed through the pitcher filter. Each aliquot, both filtered and unfiltered, were then acidified to contain 2% HNO3 (v/v) and 0.5% HCl (v/v). Samples were acidified after filtration because the performance of the filter pitcher is pH dependent, and is best between pH 6.5 and 8.5 Su [1]. Samples were allowed to sit for at least 24 hours after acidification, and the pH was measured to ensure the pH stayed below 2 Su.

In between testing intervals, 5 gallons of water from the pipe loop with the highest concentration of lead were collected in a single event and passed through the filter pitcher. After each 5 gallon interval, new samples were collected from the test rack, passed through the filter pitcher and prepared for analysis as described previously. This process was repeated in 5 gallon intervals until the manufacturer's recommended capacity of 40 gallons [1]. The average lead concentration of each 5 gallon aliquot passed through the filter was 12 ppb.

Sample Analysis

Samples were analyzed per EPA Method 200.8, Revision 5.4: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry [5]. Samples were diluted with a stock 2% HNO3 (v/v), 0.5% HCl (v/v) solution when necessary (measured value >50 ppb Pb).

The City of Rochester Water Quality Laboratory (ELAP ID# 10239) is approved as an Environmental Laboratory in conformance with the National Environmental Laboratory Accreditation Conformance Standards (2003) for the category Environmental Analysis Potable Water.

Results/Data

After 5 gal Filtered		
Unfiltered (ppb Pb)	**Filtered (ppb Pb)**	**% Reduction**
1. 170.462	<1	99.41
2. 63.034	<1	98.41
3. 189.382	<1	99.47
4. 47.606	<1	97.90
5. 119.191	<1	99.16
Average % Reduction:		**98.87**

After 10 gal Filtered		
Unfiltered (ppb Pb)	**Filtered (ppb Pb)**	**% Reduction**
1. 179.964	14.006**	92.22
2. 31.99	<1	96.87
3. 148.477	1.552	98.95
4. 37.191	<1	97.31
5. 171.055	2.024	98.82
Average % Reduction:		**97.90**

**** removed as outlier**

After 15 gal Filtered		
Unfiltered (ppb Pb)	**Filtered (ppb Pb)**	**% Reduction**
1. 135.98	<1	99.26
2. 36.424	<1	97.25
3. 156.499	1.744	98.89
4. 37.836	<1	97.36
5. 106.847	1.342	98.74
Average % Reduction:		**98.30**

After 20 gal Filtered		
Unfiltered (ppb Pb)	**Filtered (ppb Pb)**	**% Reduction**
1. 8.57	1.224	88.33
2. 52.363	<1	98.09
3. 135.848	<1	99.26
4. 39.212	<1	97.45
5. 117.031	<1	99.15
Average % Reduction:		**96.46**

After 25 gal Filtered		
Unfiltered (ppb Pb)	**Filtered (ppb Pb)**	**% Reduction**
1. 140.601	<1	99.29
2. 32.734	<1	96.95
3. 142.398	1.231	99.14
4. 36.195	<1	97.24
5. 106.08	<1	99.06
Average % Reduction:		**98.09**

After 30 gal Filtered		
Unfiltered (ppb Pb)	**Filtered (ppb Pb)**	**% Reduction**
1. 9.458	1.346	85.77
2. 43.991	<1	97.73
3. 167.477	<1	99.40
4. 39.513	<1	97.47
5. 110.709	<1	99.10
Average % Reduction:		**95.89**

After 35 gal Filtered		
Unfiltered (ppb Pb)	**Filtered (ppb Pb)**	**% Reduction**
1. 129.61	<1	99.2284546
2. 32.625	<1	96.9348659
3. 144.833	1.222	99.1562696
4. 38.747	<1	97.419155
5. 128.364	<1	99.2209654
Average % Reduction:		**98.182814**

After 40 gal Filtered		
Unfiltered (ppb Pb)	**Filtered (ppb Pb)**	**% Reduction**
1. 144.375	1.105	99.23463203
2. 34.42	<1	97.09471238
3. 209.719	1.483	99.29286331
4. 41.935	<1	97.6153571
5. 123.064	<1	99.18741468
Average % Reduction:		**98.29758687**

Discussion

Samples with a "Filtered" result of <1 ppb were calculated as 1 ppb. The minimum detection limit (MDL) of EPA Method 200.8 for metals analysis of Pb is 1 ppb, so any value less than 1 ppb could not be reported or calculated as such. This slightly decreased the % Reduction of each sample with a filtered Pb concentration that was calculated using 1 ppb.

The concentration of lead in the samples used for analysis is far higher than typical household lead levels. Depending on the composition of service material and internal plumbing, household lead levels can range from <1 ppb - ~20 ppb. The test rack samples ranged from 8 ppb – 210 ppb Pb, which further demonstrates the efficacy of lead reduction of the filter pitchers. Samples were taken from the test rack rather than preparing a solution spiked with a lead standard in order to include both dissolved and particulate lead (as would be seen in samples taken from a typical home) in analysis.

After 10 gallons of water filtered, the result of Sample 1 was omitted and marked as an outlier. The result of 14.006 ppb Pb was due to improper seating of the filter cartridge in the pitcher's reservoir.

After 30 gallons of water passed through the filter pitcher, the rate of filtration slowed considerably. It took more than a full hour for one liter of sample to pass through the filter. The average consumer might decide to replace their filter cartridge before reaching the manufacturer's recommended replacement after 40 gallons of use.

Including each 500 mL sample, a total of 45.3 gallons of water was passed through the filter pitcher. The average consumer might not replace their filter cartridge according to manufacturer's specifications. The data demonstrates that the filter maintains its efficacy of reducing lead beyond the manufacturer's recommended volume of 40 gallons.

Conclusion

It can be concluded that the DuPont™ Traditional Filtered Water Pitcher (model WFPT100) meets or exceeds the minimum 93% lead reduction requirement of NSF/ANSI Standard 53 for Health Effects. After 40 gallons of water passing through the filter, the average % reduction of lead was still greater than 98%. It can be assumed that the actual % reduction of lead is even greater than this value, due to having to use a value of 1 ppb Pb in three of the five calculations in the last round of sample analysis.

References

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