

Removal of Residual Chlorine from Drinking-Water By Solar Radiation (UV) and Activated Carbon Filtration

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ABSTRACT

The objective of this study is to investigate easy and effective household methods for the removal of residual chlorine generating unpleasant odor and taste in tap water, in order to encourage utility customer to use tap water as drinking-water.

Three experiments on the removal of residual chlorine in tap water were carried out in this study as follows:

- 1) Chlorine removal by solar radiation (UV)
- 2) Chlorine removal by activated carbon filtration
- 3) Chlorine removal by aeration at various temperatures.

Free chlorine concentrations greatly decreased from 1.59 to 0.09 mg/L for sample #1 (L1) and from 1.74 to 0.09 mg/L for sample #2 (L2) by the range of UV radiation of 2.85 to 866.87 $\mu\text{W}/\text{cm}^2$ for 2 days, showing the chlorine species change of OCl^- or HOCl to Cl^- . Bottle materials (HDPE and PETE) did not show any special effect on the degree of chlorine decrease by solar radiation (UV), and UV could penetrate effectively both HDPE and PETE bottles. The same concentrations between free chlorine and total chlorine were shown, which indicates the absence of combined chlorine (chloramines) in the tap water samples. The pH of the sample (L1) in open bottle (HDPE) slightly increased from 8.00 to 8.10, which is a very small increase and suggests that pH does not change in the reaction of chlorine decomposition by UV radiation. The electrical conductivity of the sample (L1) in open bottle (HDPE) also slightly increased from 330 to 340 $\mu\text{S}/\text{cm}$ by the photosynthesis of chlorine with sunlight (UV) exposure for 2 days.

In the case of treating only 2 gallons of water per day (L1) by an activated carbon filter, the removal efficiency of free chlorine ranged 96% to 100% for a total of 44 gallons of water (average: 99%). In the filtered water, no chlorine odor was detected and its taste was as good as bottled water. In the other case of treating more than 2 gallons of water per day (L1), the removal efficiency of free chlorine ranged 80% to 99% for a total of 120 gallons of water (average: 93%). Chlorine (OCl^-), existing as an anion in natural water, can be removed by exchanging it with negatively charged ions such as OH^- on carbon surfaces. The pH and electrical conductivity (EC) of the water decreased by the filtration (pH: 8.08 \rightarrow 6.33, EC: 345 \rightarrow 248 $\mu\text{S}/\text{cm}$ at the filtration of 20th gallon).

Chlorine removal by aeration at various temperatures was not effective. Free chlorine concentrations in sample #3 (L3) slightly decreased from 1.66 to 1.41 mg/L in open bottle on a dark shelf (26°C) and from 1.67 to 1.43 mg/L in open bottle in a refrigerator (5°C) for 3 days. Also, for chlorine removal in water by freezing (-20°C) and melting (5°C), free chlorine concentration slightly decreased from 1.68 to 1.56 mg/L in open bottle for 3 days. In an additional comment we can say that after 1 month almost the same concentration of free chlorine as that shown on the third day was detected (1.35 mg/L in open bottle on a dark shelf), which indicates the long residual effect of chlorine.

The results suggest that solar radiation (UV) and activated carbon filtration treatments are very effective for the removal of residual chlorine in water. Moreover, tap water with enough residual chlorine can be kept for a long time without any concern of bacteria re-growth by storing it in clean and sealed bottles in dark places with no sunlight.