

Q&A

22Q2: I live in Negros Island, Philippines. In the mountain, the white and weak stones which have a lot of dents in the surface, considered to be coral reefs, are rolling. Water supply uses spring water of mountain and is disinfected by chlorine. After I boil the water, then pour it into a bowl and cool it, white matters are settled in the bottom of the bowl. I asked the laboratory of water quality about white sediments. They said it was lime. I am considering using a lime removal equipment now. Could you tell me how to remove lime?

(N. K. Philippines)

A1 : Household measure

The water which Mr. N.K. uses, contains high concentration of calcium carbonate and/or magnesium carbonate, and it is called hard water. Boiling process of the hard water may generate the white precipitation of calcium carbonate. It is natural phenomenon for hard water, and not harmful for human's health. If you boil a bottled mineral water, you observe the same thing. High hardness disturbs foaming of soap, and generates scale (white colored precipitation), but it doesn't cause any health problem. Usual processes of removal of hardness are reverse osmosis and ion exchange in waterworks. Softening equipment is a commercial product for domestic use, which is application of ion exchange. The mechanism of hardness removal by ion exchange is that calcium ion and magnesium ion are replaced by sodium ion. That means usage of the softener can decrease the hardness but increase concentration of sodium. For this reason, use of softener is not recommended to a patient of hypertension, or disease caused by sodium intake. An ion exchange resin in softener should be regenerated regularly to work properly. Is it necessary for you to remove hardness? You can reduce the hardness by boiling for drinking purpose, after boil, wait until the precipitation could be settled.

(Answerer: Ms. KAMEGAI Yasuko, 2011)

From Questioner: If I take a shower with tap water about two weeks, I feel itchiness for the back, legs, hands, arms, etc., and worry about dry rough skin. Itchiness is eliminated if I wash the body with mineral water for drinking. (N.K.)

A2 : Dry rough skin

In the case that you have rough dry skin by hard water, the use of softener is recommended. There are many sufferers of dry skin by hard water.

(Answerer: Ms. KAMEGAI)

A3 : Softening of hardness water

Hard water contains both of temporary hardness and permanent hardness.

1) Temporary hardness consists of $\text{Ca}(\text{HCO}_3)_2$ and $\text{Mg}(\text{HCO}_3)_2$. By boiling the water, calcium carbonate (CaCO_3) and magnesium hydroxide ($\text{Mg}(\text{OH})_2$) is precipitated.

2) Permanent hardness consists of CaSO_4 and MgSO_4 (non-carbonate hardness). There is no precipitation by boiling the water.

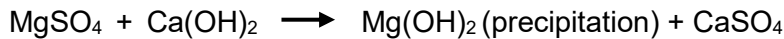
Water treatment method is as follows.

a) Ion exchange method

Softener is commonly-marketed for family use. Hardness including Ca, Mg -not only temporary hardness but also permanent hardness- is removed by ion exchange resin

b) Water softening process method by combination use of lime hydrate Ca(OH)_2 and sodium carbonate Na_2CO_3 .

This process can soften temporary hardness and permanent hardness.



However, Sodium ions remain in the water as evaporation residue. Depend on the utilization purpose, I suggest b) method that can considerably reduce total hardness. Moreover, treated water of this b) method contains micro-particle of the calcium carbonate. Therefore, filtration process and pH control (PH7-8) is needed after this treatment.

c) Treatment by lime hydrate Ca(OH)_2 . This method can remove only temporary hardness, but evaporation residue of the hardness is less. If total hardness of your water can be reduced to less than 100mg/L by removal of temporary hardness, I recommend this method. The following treatment processes are similar to b) method.
 $\text{Ca(HCO}_3)_2 + \text{Ca(OH)}_2 \longrightarrow 2\text{CaCO}_3 + 2\text{H}_2\text{O}$

(Answerer: Mr. TAKEBE Shigeru, 2011)

A4: An example of treatment by lime hydrate at the household level.

Batch process is better when you treat hard water by yourself at home. It is possible to improve situation by reducing the temporary hardness. Therefore, method of treatment by lime hydrate would be explained. It is relatively easy way. Both Mr. Takebe's suggestion and Mr. Sasayama's one are same. But they are slightly different. So, two cases are written below. They have recommended to experiment using actual water by both of the methods. (WaQuAC-Net Office)

Mr. Takebe's method

1) Decide injection volume of lime hydrate. Inject lime hydrate into 3 bottles which same source water is filled. And make lime hydrate solution of different concentration of 100mg/L, 150 mg/L, and 200mg/L. Then, take their supernatant water to 3 new bottles respectively and boil them. And compare the scales (white precipitation) in 3 new bottles. Select one bottle with the least amount of precipitation. It is optimal injection rate.

2) Stir for 10-15 minutes to end the reaction of softening if the water temperature is 15 to 20 degree centigrade. But if the water temperature is lower, it takes longer. Drain produced sludge. It is better to leave one fourth or one fifth of sludge in the tank in order for effective sedimentation in the next process.

3) After reaction of the softening, put to stand and leave it for solid-liquid separation. Take supernatant liquid out. And then control PH.

4) If the injection volume of lime hydrate increase, PH also rise. Although it depends on source water, I think it is possible to treat under the condition of PH 9. However, you

need to verify it. It is necessary to neutralize by acid to pH 7 to 8. It would be good to use litmus paper for checking pH value.

5) The produced sludge has good dewatering ability. It is easy to handle once sludge is dried to a powdery state. Since the ingredient is calcium carbonate, there is no problem even if to mix soil. But, please consider the environment. It is said that sludge may harden depending on how to handle it. So please be careful.

6) It might be possible to stir it by hands if water volume in one process is 100L to 150L

7) It is possible to use caustic soda instead of lime hydrate. However, sodium remains in water.

(Answerer: Mr. TAKEBE)

Mr. Sasayama's method

Controlling pH is important to soften water with lime. You have to control pH of treated water as not so high because higher pH is harmful to human. You can control injection amount of lime by monitoring pH but not so easy. It is better that the operator get training of handling lime and monitoring pH. You have to choose good filtering material. For the case of using sand, you have to wash sand well with clean water. Bacteria or worms can grow easily in the sand if washing is not enough. The best way is sterilizing sand before use. If fiber or leaf of palm is available as filter material, frequent exchanging material is better for sanitary use. I show a model of softening facility with using lime. It is just a model to design an actual one. (see the diagram below)

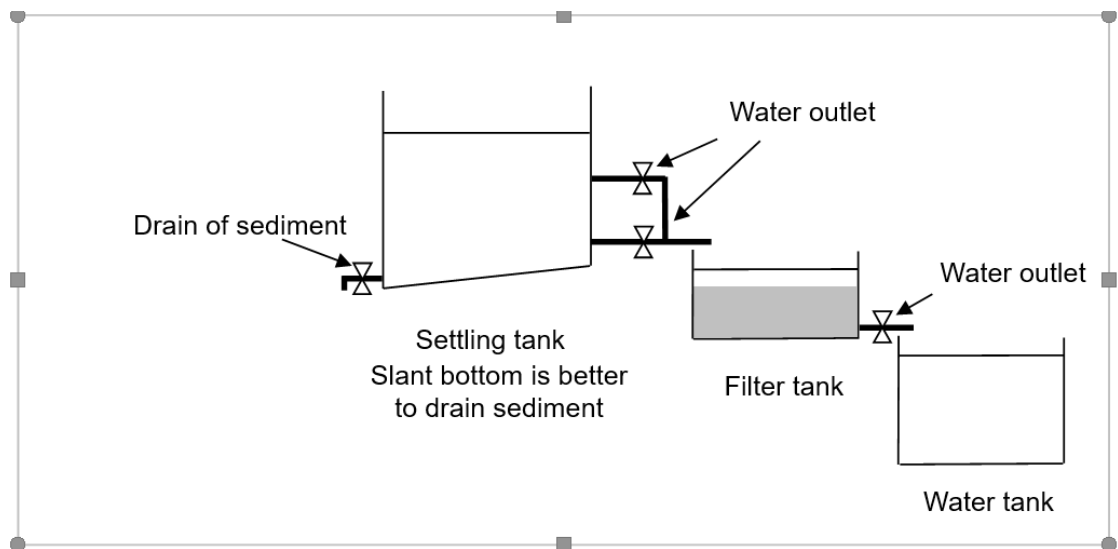


Diagram of softening facility under batch operation

1) Material

- A tank or large bucket for preparation of lime slurry
- Settling tank for reaction between lime and source water
- Filter tank to remove small particle of calcium carbonate
- Water tank to store filtered water

2) Treatment procedure

- a. Source water is stored in the settling tank.
- b. Lime slurry is prepared with powder lime and water in lime slurry tank.
- c. Lime slurry is poured into settling tank little by little, with mixing the water.

- d. Step c. is repeated till pH is coming to 8
- e. Slurry is no more added when pH reach to 8
- f. Produced calcium carbonate is settled for about 1 hour.
- g. Supernatant of settling tank slowly flow into the filter tank and filtered water is stored in the water tank.
- h. Sediment in the settling tank is drained.

3. Note

- a. Be careful not to exceed pH 8 in the settling tank.
- b. Necessary amount of lime will be known after several trials. Then prepare lime slurry as just necessary amount.
- c. Sediment is calcium carbonate. Please consider the place for wasting.
- d. Treated water may lose disinfection effect even the source water is well disinfected.
- e. Try popular material as filter. Material should be washed well before use.
- f. Replace the filter material to new one when filter is clogged
- g. The valves for outlet water should be able to adjust water flow.
- h. Diameter of pipe for sediment drain is larger than 20mm to drain easily.

<Comment to Mr. Takebe's method>

Hydrochloric acid is rather safe to use to decrease pH. It is easier to use diluted acid for adjustment of pH because diluted acid can change pH value fewer with same amount of dosing comparing with concentrated acid. I recommend trying experiment of controlling pH with plastic buckets before building facility.

(Answerer: Mr. SASAYAMA Hiroshi, Yokohama Waterworks Bureau, 2011)