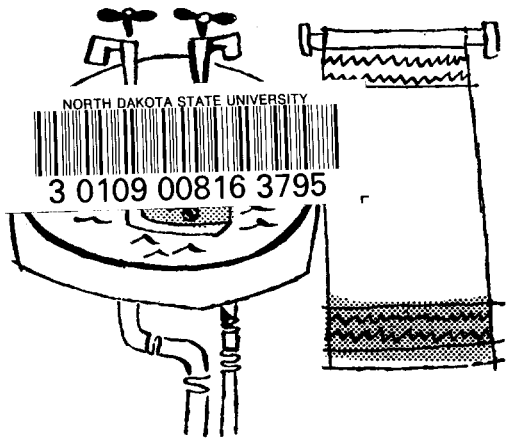



NORTH DAKOTA STATE UNIVERSITY
OF AGRICULTURE AND APPLIED SCIENCE

# WATER CONDITIONING

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CIRCULAR A-449 FEBRUARY 19

## I. HARDNESS

Hard water and soft water are relative terms. Hardness in water retards the cleaning action of soaps and detergents, causing an expense in the form of extra work and cleaning agents. When heated, hard water deposits a scale (as in a kettle, heating coils, or cooking utensils) and results in waste of fuel.

Hardness in water usually is expressed in grains per gallon of hardness. However, you may see hardness expressed in parts per million. (17.1 parts per million of hardness is the same as 1 grain per gallon of hardness.)

Softening is a process for removing hardness-causing minerals from the water.

There is no hard and fast rule that states how or when water should be softened. However, these guides may be helpful. Softening of hard water is desirable if:

1. Large quantities of soap are needed to produce a lather.
2. Hard scale is formed on cooking utensils or laundry basins.
3. Hard, chalklike formation coats the interior of piping or water tanks.
4. Heat transfer efficiency through the walls of the heating element or exchange unit of the water tank is reduced.

### Softening Water for the Laundry

Often, individual needs can be met by softening only the water used for laundry. In this case there is no need to install a commercial softener.

Water used for laundry purposes may be softened at the time of use by the addition of certain chemicals such as borax, washing soda, trisodium phosphate, ammonia, and the non-precipitating softeners such as Calgon and Spring Rain. Commercial softening compounds should not be used in water intended for drinking or cooking until the advice of the state or district health department is obtained regarding their safety.

If you plan to soften all or part of the water to be used in your water system, you will use the ion exchange method. The lime soda ash water softening process is not practical for a small water supply system.

### Ion Exchange Softeners

ATTENTION: ION EXCHANGE WATER SOFTENERS ADD SODIUM TO THE WATER. IF SOMEONE IN YOUR HOME IS ON A SALT-RESTRICTED DIET, CONSULT YOUR PHYSICIAN BEFORE INSTALLING A SOFTENER.

The chemical process of changing hard water to soft in the home water softener is based on the ion exchange principle. The ion exchange materials which may be used in softeners are glauconite (greensand); precipitated synthetic, organic (carbonaceous), and synthetic resins; or gel zeolites. The last two are the most commonly used for domestic systems.

When the hard water enters the softener, hardness-causing calcium and magnesium are attracted to the ion exchange material. As calcium and magnesium are united with the ion exchange material, sodium is released into the water, thus the ion exchange softener trades sodium for calcium and magnesium.

Every water softener has a definite capacity for trading sodium for calcium and magnesium. Different ion exchange materials have different capacities. The exchange capacity of commercially available softeners varies from about 5,000 grains to 32,000 grains per cubic foot of exchange material. When its capacity has been reached, the softener must be regenerated. Three steps are necessary in regeneration.

The series of diagrams shows the operation cycle of a water softener. Various manufacturers accomplish the same cycle with valving systems of their own design.

1. BACKWASH (Fig. 1) In the backwash operation water is run through the softener in the opposite direction from normal flow. This fluffs up the ion exchange material and removes any foreign material which the softener may have filtered out of the water.

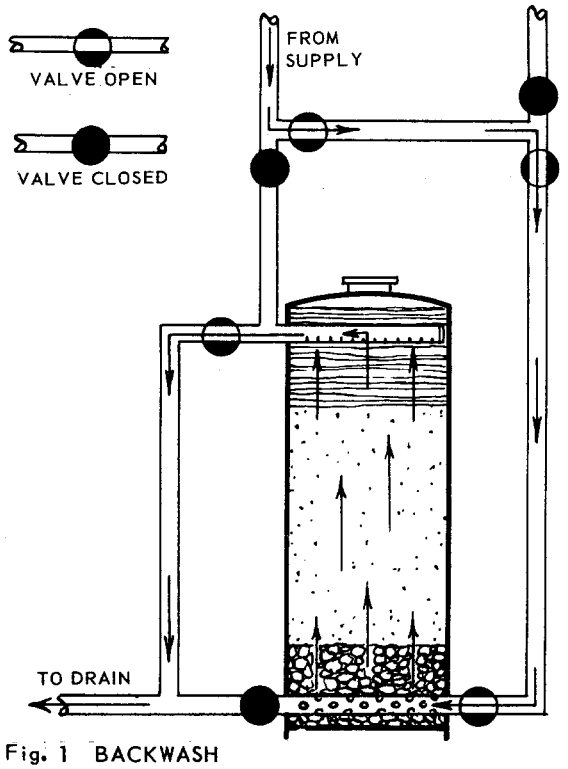

Fig. 1 BACKWASH

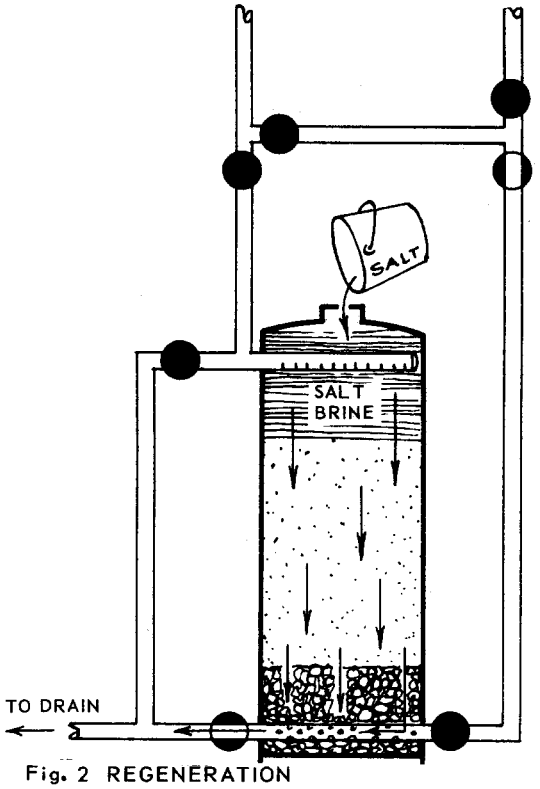

Fig. 2 REGENERATION

2. BRINING (Fig. 2) The brine operation is the chemical process of recharging the softener. The brine is left in contact with the ion exchange material for 30 minutes in order that the sodium (Na) in the salt (NaCl) will combine with the ion exchange material. The chemical reaction leaves free calcium chloride ($CaCl_2$).

3. RINSING (Fig. 3) The ion exchange material is rinsed and the calcium chloride ($CaCl_2$) and any unused salt go down the drain. After rinsing, the softener is ready for operation. (Fig. 4)

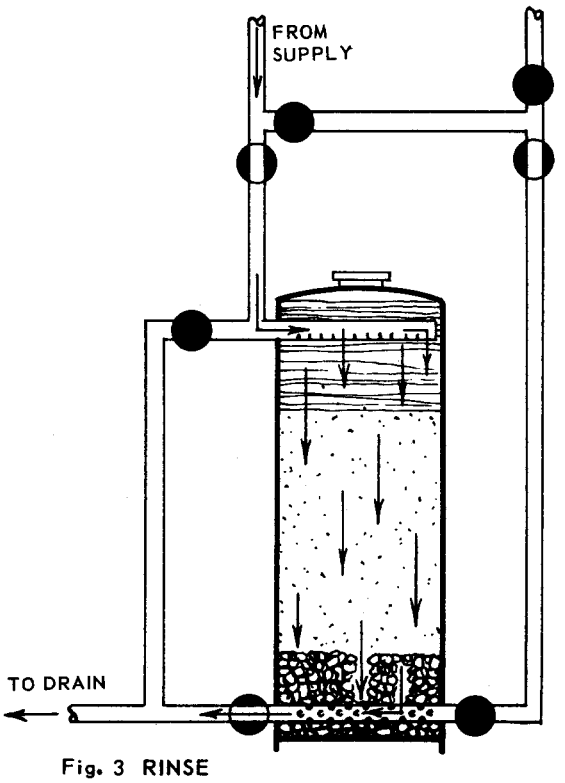

Fig. 3 RINSE

**Selecting a Water Softener**

Step One

Determine the degree of hardness in your water. This service is available from your local water softener dealer, or from the State Laboratories Department in Bismarck. The hardness will be expressed in grains per gallon.

Step Two

Determine the amount of water you are going to soften.

1. If you are going to soften all your water, plan on from 75 to 100 gallons per day per person.

2. If you plan to soften only the hot water, consult table 1.

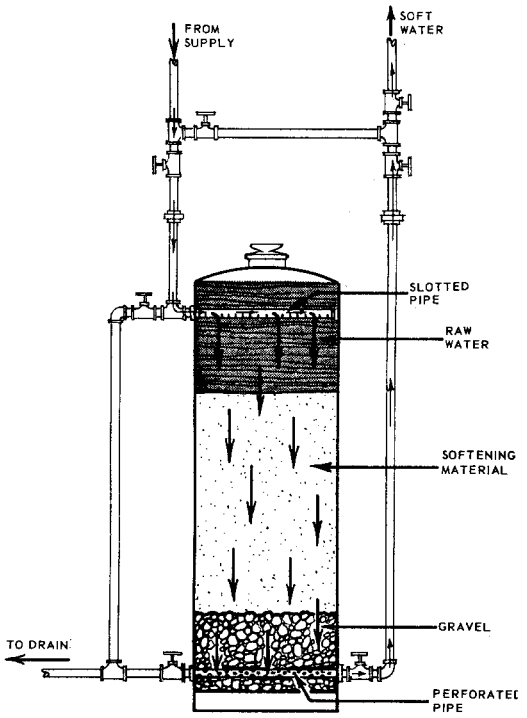

Fig. 4 SERVICE

TABLE 1

| | Gallons/day of hot water |
|---|---|
| Per person | 12 |
| Per infant in diapers | 24 |
| Per automatic washing machine | 12 |

Step Three

Determine the amount of hardness that must be removed from your water every day. To do this, multiply the grains per gallon of hardness of the water by the gallons per day you will be softening. This gives you the grains of hardness to be removed per day.

Example: 25 grains per gallon water
1,000 gallons used per day
1,000 gallons per day x 25 grains per gallon = 25,000 grains per day to be removed.

Step Four

Consider the types of softeners.

1. The manually operated softener requires addition of salt and manual valve manipulation at each regeneration. It is the lowest in initial cost and requires the most labor of any of the softeners.

2. The partially automatic softener requires occasional salt addition to a brine tank and manual starting of the regeneration sequence. A timing device completes the regeneration.

3. The automatic softener requires occasional salt addition to the brine tank. The regeneration process takes place automatically. It is the highest in initial cost and requires less labor than the other softeners.

## II. IRON

Well water is usually clear when it is drawn. When water containing colorless, dissolved iron is allowed to stand in a cooking container or comes into contact with a sink or bathtub, the iron combines with oxygen from the air to form a reddish-brown precipitate commonly called rust.

The rust particles affect the taste of the water and of any food prepared with the water. Iron particles form rusty stains on plumbing fixtures, fabrics, dishes and utensils. Soap and detergents will not remove these stains and bleaches will make the stains worse. Often times the iron deposits can build up in pressure tanks, water heaters and pipelines, reducing the available quantity and pressure of the water supply.

Iron can be removed from water by more than one method. Oxidization or chlorination and filtration, and ion exchange methods can be used to remove insoluble iron. Chlorination and filtration will remove iron caused by bacteria. The bacteria-caused iron can be recognized by its slimy appearance.

Before any iron removal equipment is installed, be sure the water has been analyzed and that proper equipment is installed. Some factors to help you with your decision are listed here:

Chlorination and filtration will remove iron in any concentration likely to be encountered. The chlorination oxidizes the iron and changes it to red rust. The fine filter removes the rust particles from the water. The chlorination and filtration method will also control iron bacteria and disease bacteria. If the water is to be softened, it must be filtered before it reaches the softener.

Oxidizing filters will remove iron when properly operated, but they have definite limitations. They require a large amount of water for the backwash cycle, more than is available in most farm systems. Most of the iron precipitates out in the bottom half of the filter and the top half isn't properly used. This system may be almost ready for backwash, when a surge of use, such as an automatic washer, will cause a "slug" of the iron to leave the filter and enter the system. This system will not kill iron bacteria.

Ion exchange (water softening unit) iron removal may be considered where iron concentrations in the water are not more than 2 parts per million, and iron bacteria are not present. Do not install ion exchange (water softening) equipment for iron removal unless you have excluded all the air from the pressure system ahead of the unit. If air contacts the water, the iron will oxidize and the insoluble iron

will cause fouling of the mineral bed and the valving of the unit. This means the elimination of the conventional air volume control on your pressure tank, and the installation of a float device in the pressure tank that will eliminate any air-water contact. If you use the ion exchange method bear three things in mind:

1. The proper iron removing ion-exchange material must be used.
2. All air must be kept from the water before it enters the softener.
3. The ion-exchange material will become saturated and will require occasional replacement.

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Extension Service, North Dakota State University of Agriculture and Applied Science, and U. S. Department of Agriculture cooperating. A. H. Schulz, Director, Fargo, North Dakota. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914.