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Water Treatment for the Small Homes or Farms

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Illinois is rightfully classed as a hard water state and the large majority of water users fail to do anything about it other than to grin and take it. Fortunately, this is not necessary and no one is better situated to improve the comforts of the well water users than the man who provides the water. Water for most purposes should be something more than just wet—and altogether too often, water is used which is not only of inconvenient quality but is actually costly and even dangerous from the standpoint of disease, fire and explosion.

Let us list the undesirable ingredients so; often present in water. First, we all know that pollution and harmful bacteria may be present. Second, methane, the colorless, odorless, tasteless, but inflammable and explosive (Marsh) gas, may be present. Third, hydrogen sulfide may be in sufficient concentration to produce the nasty but harmless, rotten egg odor. Fourth, we may have iron in the water as it comes from the well and results in staining of laundry and porcelain and in clogging filters and pipes. Fifth, calcium and magnesium or hard water, the soap water, is almost always present. The average hardness of Illinois ground water is about 275 ppm. or 16 grains per gallon and waters of 500 ppm. hardness are not unusual. Sixth, salty or highly mineralized waters appear to be the only wet stuff available that is non-alcoholic. Until the last few years nothing could be done with salty water, but recent advances have provided a method for limited treatment of such water.

Any water treatment problem involves consideration of the purpose for which the water is to be used and the cost of the treatment. In the following discussion it is assumed that the water will be used for general household purposes and the treatments will be for the purpose of providing a pure, safe, clean, soft, palatable water.

The cost of treatment will depend on the quality of the raw water, on the quality desired and the quantity required. In general, the major cost is involved in the equipment, and the cost of chemicals, when required, is very nominal. Proper care of the equipment, although essential, is not difficult and the useful life of the equipment will depend on the quality of the original installation as well as on the maintenance.

Chlorination. The use of chlorine for disinfecting water to assure safety is an established procedure in water treatment. Chlorine, when present in water in proper concentration and if given sufficient time to act, will kill all germs which cause disease in human beings. If the water is underdosed or if it is consumed too soon after the chlorine is applied, all the disease germs may not be killed. If the water is over-dosed, disinfection will be accomplished and the water will not be harmful, but an objectionable chemical taste may result which most persons do not like. Therefore if chlorination of water is to be satisfactory, proper equipment to assure correct dosage is necessary, and at least some personal control of the treatment is essential. Municipal water supplies and other large water sources can afford the necessary equipment and have operating personnel available to give good operating control and maintenance. This may not always be possible for private water supplies. For this reason, private water supplies, wherever possible should be so located and constructed that safety of the water will be assured without resorting to chlorination.

In limestone areas, wells should be cased to a sufficient depth to exclude the contaminated water which is usually confined to the upper rock formations. If safe water can not be obtained by proper location and construction, and use of chemical disinfectant is the only alternative, some type of chlorine-feed machine should be installed. Practically, this means that some source of mechanical power must be available, preferably electric power. Electric-motor-driven chlorinators are available, and can be arranged to operate automatically whenever the main water-supply pump operates, thus assuring uniform dosage of the water as it is pumped. Water-powered chlorinators can be procured and these also will operate automatically, but some source of power must be available to place the water under pressure. Although it is indicated that these chlorinators operate automatically, they need personal attention at least every few days to check operation and to replenish the supply of chlorine.

With every chlorinator installation a small test kit should be provided to enable the owner to check the quantity of chlorine present in the treated water. These testing kits are not expensive and are simple to use, but they are absolutely essential to proper adjustment of any chlorinating machine and periodic cheeking of chlorine dosage.

At present we know of no satisfactory arrangement or equipment which will permit automatic chlorination of water pumped from a well equipped with a hand pump. In emergencies, water in a well can be disinfected manually, or water in a barrel or other container can likewise be dosed with chlorine to make.it safe, but such batch treatment should not be expected to be continued for any great length of time. Experience has shown that owners of private water supplies will not religiously continue such manual dosage for any prolonged period.

Methane Removal. Several serious gas explosions have occurred in Illinois at public water supplies, schools and private institutions.

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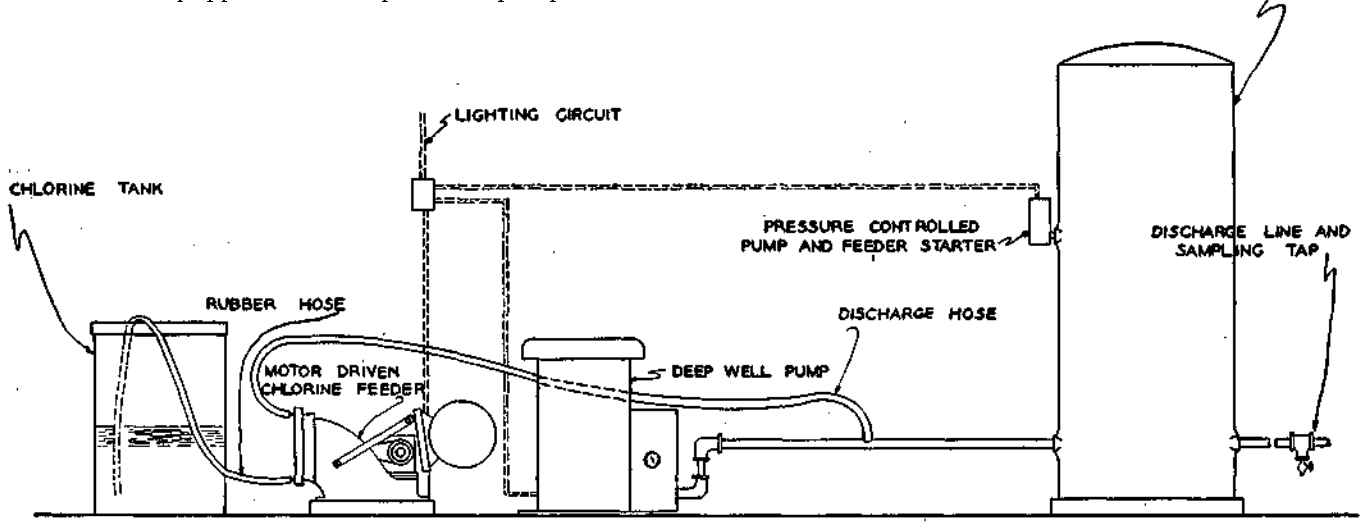
It has been known for many years that water wells in certain areas of Illinois produce a burnable gas known as methane. The gas is colorless, odorless and slightly lighter than air and when present in air between the limits of 5% and 15% the resulting mixture is highly explosive. Gas as it occurs in the underground formations is under pressure and, therefore, dissolved in the water. When the water is pumped to the surface some of the gas separates from the water, appearing often as small bubbles breaking at the water surface. Under certain conditions when the gas separates from the water it will mix with the air to form an explosive mixture and if a source of ignition such as a lighted match or spark from an electric switch occurs under these conditions an explosion will result.

Wells producing methane, but located out of doors and equipped with hand pumps do not present any special gas explosion hazard. However, any well producing methane and equipped with a pressure pump which places water directly from the well into a storage structure, may create an explosion hazard. Methane gas wells supplying water through ordinary water pressure installations utilizing enclosed steel pressure tanks create ideal conditions for explosion hazards. In these installations an "air" cushion is always employed above the water surface to maintain pressure. The so-called "air" cushion has been found to be almost 100% pure methane in some installations obtaining water from wells producing gas. It is frequently found that the cushion builds up to the point where there is insufficient space for water storage and common practice is to provide a vent on the top of the tank to discharge the excess accumulated "air." This discharge being largely methane, when made inside a building, can easily produce a 5 to 15% mixture with air that is within the explosive range. Water containing methane when used through constantly running drinking fountains, or showers and toilets in closed rooms may also present a serious hazard.

It is possible to remove methane gas from water by the installation of proper treatment equipment. Such equipment consists of a small screened aerator to which the water as it is pumped from the well is directly discharged. The aerator consists of three or four metal trays with perforated bottoms, the trays assembled one over another and spaced about one foot apart. Each tray is filled with pieces of coke having an average size of about 1½ inch and with a depth of about 8 or 10 inches in each tray. Water discharged from the well onto the top layer of coke is broken up into fine particles as it trickles on down through each succeeding tray and the dissolved methane is quickly evolved into the atmosphere. The aerator must be located in the open air so that the evolved methane may be dissipated to the atmosphere without creating an explosion hazard as would occur if the aerator should be equipped with a water-tight roof but the sides should be left open except for a covering of fine mesh screen (24 meshes per inch) in order to protect the water from contamination.

Aerated water from the bottom of the aerator may be collected on a water-tight tray and flow by gravity to a storage tank. A small pressure pump may then pick the water up from the storage tank and place it under pressure in the usual water pressure storage tank from which it is discharged for use. Water so treated will be reasonably free of methane and should eliminate the possibility of methane gas explosions where employed.

The accompanying sketch shows such a methane removal treatment process employing aeration for the ordinary small water pressure installation, applicable for schools and institutions. This may be somewhat larger than required for private homes. For good design the total tray area should be about 5 square feet per 10 gallons per minute.



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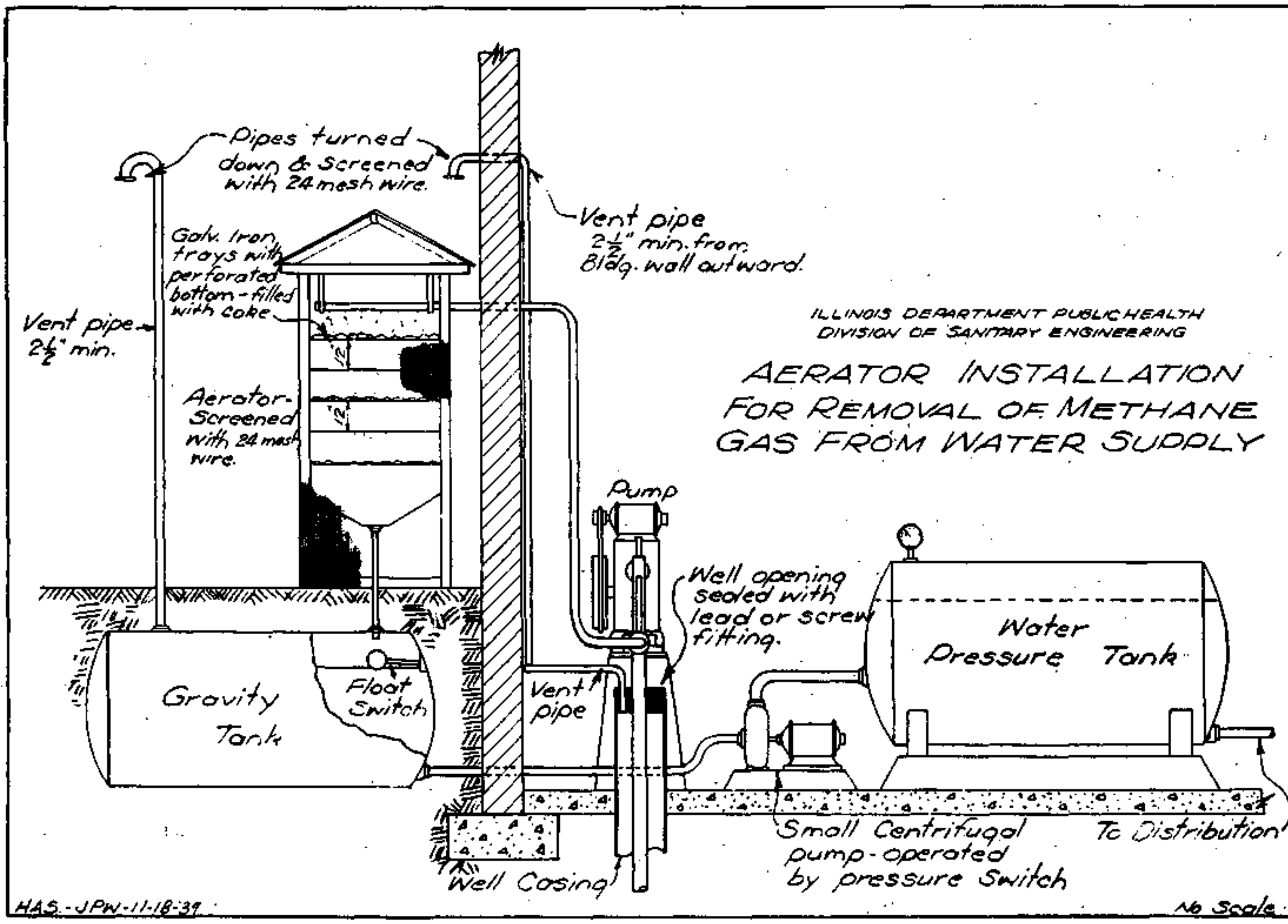
Pressure aerators are also used but great care must be taken to provide sufficient air to prevent the possibility of forming an explosive air-methane mixture in the tank. In general, about 1 cubic foot of air should accompany each gallon of water. An air compressor is necessary for such an installation and the controls should be such that the pump cannot be operated without first starting the air compressor. Any installation using a volume less than this should be carefully checked before considered safe.

Some pumps are designed to bleed air into the water as it is pumped to the pressure tank. Although this may be good practice for some purposes, it is a very dangerous practice if methane gas is present; Such pumps are not designed to bleed the required one cubic foot of air per gallon of water.

Hydrogen Sulfide Removal. This is the gas that stinks. It is generally found in waters from the Devonian, the Silurian or the Galena-Platteyille formations and occasionally in drift or Pennsylvanian sandstones. It is perfectly harmless to drink and with a good strong stomach one can get used to it. In fact, some people are so well fixed that they pay good money for the privilege of drinking the stuff. The worse it smells the better it is supposed to be for curing anything from fallen arches to indigestion.

This gas when released from the water may give eye trouble when in low concentrations (.005% in air) and in a concentration of 0.1% in air it will cause death in 30 seconds. This toxicity is comparable to that of hydrogen cyanide. Fortunately, in this respect it is detectable by odor in air in a concentration of .00001% or 0.1 ppm. A concentration of 0.2 ppm. in water is generally sufficient to cause a noticeable odor.

Simple aeration is usually sufficient to remove this gas. The open air aerator described for methane removal is generally satisfactory. For high concentrations of hydrogen sulfide a greater total tray area may be necessary. It is rather surprising to find many small private supplies containing a small amount of hydrogen sulfide used with no treatment. A very simple treatment for such water would be chlorination. The quantity of chlorine would not be excessive and if followed by an activated carbon filter even the extra chlorine can be removed.



It has been reported that a few manufacturers use an activated carbon filter alone for removal of hydrogen sulfide. Only three installations have been tested and in each ease the hydrogen sulfide content of the untreated water was very low. For the present it is believed that such filters would have a short life if the hydrogen sulfide content of the water is high.

Iron Removal. Approximately two out of every three well waters in Illinois contain sufficient iron to be troublesome. If a water contains more than 0.3 ppm. iron, staining will occur and 1.0 ppm. is much more than most users like to have.

Iron as it exists in natural ground water is in the soluble (ferrous) state, and gives the water a faint green tinge. On exposure to air it is converted to the insoluble (ferric) state and separates from the water to form very finely divided reddish brown particles. This constitutes "red water." If allowed to stand long enough these particles gather together and will settle to the bottom of the container. However, this usually takes more time than we like and generally all of the iron does not completely settle out.

Common practice for iron removal consists of aeration to convert the iron to the insoluble form and filtering out the insoluble particles. If this iron content is high it is also desirable to provide a reaction and sedimentation basin just before filtration. Aeration with the aerator design suggested for methane removal has proven satisfactory when followed by settling and filtration through sand.

Combined pressure aerators and sand filters are also available. These units provide for pumping air under pressure through the upper half of the tank and spraying the water through the air. The lower half of the tank is filled with sand for the purpose of filtering the iron out of the water. Although these units appear to meet all requirements for iron removal and also serve as a pressure tank, they have not always proven to be satisfactory. The probable reason for this lies in the fact that the water becomes supersaturated with three or four times as much air as it will hold when drawn from a tap, and milky water is produced. Furthermore, such an excessive amount of air leads to severe corrosion not only in the service lines but also in the tank itself and iron may be put right back into the water.

Another closed unit for iron removal consists of filtering the water through a material composed of sand which has been coated with manganese dioxide. This procedure has proven satisfactory in several installations that we have seen, but we have not observed a sufficient number to judge them properly. Although not specified, it would appear to be desirable to bleed a very small amount of air into the water before filtering through this material. This can easily be provided at the pump and would have the advantage of requiring less frequent regeneration with permanganate.

Iron can also be removed with the zeolite softeners but from the best available information this is done at the expense of the life of the zeolite. The useful life of the zeolite is shortened considerably or to a small extent depending on whether the iron is in the insoluble or soluble state when it reaches the zeolite.

If the water contains iron which is in the soluble form, that is, if the water does not appear to be rusty but turns red or leaves **a** rust deposit after standing, it may be treated with one of the polyphosphates. The action of these compounds is to tie up or to sequester the soluble iron so that it is not converted into the insoluble rust form.

This may be done by installing a feeder directly on the pipe line leading from the well. This feeder must be installed to inject the polyphosphate into the line before air or chlorine comes in contact with the water. If the water from the well is rusty in appearance or if air or chlorine comes in contact with the water first, such treatment is worthless. The installation costs less than $20.00 and the cost of chemicals is about one cent per 100 gallons. This treatment is also effective in preventing scale formation in household hot water heaters and water lines although it does not soften the water.

Hardness Removal. Here we have a subject that has been very well publicized and with the present scarcity and cost of soap is receiving more and more attention. Everyone is acquainted with zeolite softeners and the soft water obtained from this treatment. There are many types of such softeners both with respect to the exchange mineral used and the equipment design. All must be periodically regenerated with salt.

We have mentioned before that the presence of calcium and magnesium in water makes it hard. Zeolite softening is based on the principle that these two ingredients are removed from the water on filtering through the zeolite and replaced with sodium, which does not make water hard. After a certain amount of hardness has been removed or a certain number of gallons of water has been passed through the zeolite, it is necessary to soak the zeolite in a brine or strong salt solution in order that the calcium and magnesium now stuck on the zeolite be released and replaced with sodium. After washing out the excess brine the unit is ready to go back to work. These units provide the most convenient method for softening water for household purposes. The size and original cost will depend on the hardness of the raw water and the number of times per month that the owner wishes to regenerate.

It should perhaps be worthwhile to mention that hard water can be partially softened in batches for laundry purposes by treatment with lime (that is, quick lime or hydrated lime). Ordinary lye (caustic soda) may also be used. The dosage will depend on analysis of the water but in Illinois it is usually three to five ounces per hundred gallons. The lime is added to the water, mixed completely, and the sludge permitted to settle out over night.

Salt Removal. Salt water has always been a difficult thing for well drillers to sell a customer. The U. S. Public Health Service Drinking Water Standards for Interstate Carriers states that waters should not contain more than 500 ppm. total mineral content but if such water is not available 1,000 ppm. may be permitted. A mineralization of 1,000 ppm. can be tasted faintly. Several municipalities use water of 1,500 and 2,000 ppm. mineral content. Waters of 3;000 and 4,000 ppm. can hardly be called palatable and at 5,000 or 6,000 ppm. even livestock do not do very well, although they can get used to it and live. At about 12,000 ppm. or 1.2 per cent the water is toxic and will cause death if used continuously.

Equipment is now available which can be used to demineralize even sea water which has about 34,000 ppm. mineral content. These units are costly when compared to zeolite softeners and the cost of regeneration does not permit too extensive use. However, for small quantities of water for drinking and cooking purposes, there is a good field for application. The cost of the original installation will depend on the quality of the raw water and. the quantity of the demineralized water required. The cost of regenerating chemicals is from $1.00 to $2.00 per 1,000 gallons per each 1,000 ppm. of mineral content. For example, to demineralize 100 gallons of 2,000 ppm. water the cost of chemicals would be $0.20 and to demineralize 100 gallons of 5,000 ppm. water the cost of chemicals would be $1.00. This would be pretty costly water for sprinkling the lawn but a bath in 10 gallons of such water would cost ten cents and the water for 16 cups of coffee would cost one cent. Compare this with 25 cents for a bottle of beer.

In conclusion it is no secret that almost every well water in Illinois can be improved in quality by proper treatment. Almost all are hard waters, more than half contain iron and many others contain methane, or hydrogen sulfide or salt.

Treatment can be devised to do almost anything with water except to make it dry. The treatment is not always cheap but the cost is also not prohibitive for limited use.

Two distinct warnings are in order. First, any treatment procedure must be so designed that pure, safe well water cannot possibly be contaminated by faulty equipment. Such equipment must be fool proof. Second, any treatment equipment and procedure requires care and attention. No automobile salesman has yet had the nerve to sell a car on the basis that it will run without gas or on the basis that the upholstery will never need cleaning.