IRON AND MANGANESE IN MISSISSIPPI WATER SUPPLIES

by

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INTRODUCTION

Water is one of the most important of all natural resources and is, indeed, absolutely essential for the existence of life. It has been estimated that by 1980 the total water requirements in the United States will be twice those of 1954 and by 2000 the requirements will be triple the requirements of 1954 (1). It is anticipated that by 2000, 888.4 billion gallons of water per day will be withdrawn from all sources for all purposes and of this almost 160 billion gallons per day will be consumed.

One of the reasons for this rapidly increasing demand on the Nation's water resources is the increased per capita consumption for domestic use. Increased living standards create increased demands and governmental assistance programs are making potable running water available to more and more families. In the mid 1930's the Water Facilities Act was passed which provided for development and irrigation of agricultural land mainly in the West and Mid-West. In 1954 the Act was broadened and extended to the eastern and southern parts of the country. This "Soil and Water Loan Program" act was amended in 1961 by the Farmers Home Administration Consolidation Act. This made it possible for rural communities to obtain loans under very liberal conditions for the purpose of constructing public water supplies for domestic use and livestock watering (2).

On November 7, 1962, the Farmers Home Administration approved a loan of $50,000 for the construction of a rural water system by the Abbeville Water Association, Inc., in Lafayette County. This was the first system built in the State of Mississippi under the program. Since that time more than 334 associations have been formed and applications made for these systems in the State. Of these about 150 projects have either been completed or are making certain progress toward that end. This number of systems is especially noteworthy when compared to the total number of about 250 water systems in incorporated communities in the State which have been financed by other means.

All but four of these public water supplies in Mississippi are ground water suppplies and many of these ground waters contain iron in excess of the maximum concentration of 0.3 mg/l as recommended in the Public Health Service Drinking Water Standards, 1962 (3). None of the ground water supplies in the State have been found to contain significant concentrations of manganese; however, the surface water supplies at Jackson and Meridian have, on occasion, had manganese concentrations greater than the 0.05 mg/l as recommended in the Drinking Water Standards. The surface water supplies at Vicksburg and Meridian have not been found to contain significant concentrations of manganese.

Some well supplies in the State have been abandoned because of difficulties encountered with iron removal. When iron or manganese cannot be sucessfully removed from a water, the water is quite often unsatisfactory for many uses. Iron, in concentrations even less than 0.3 mg/l, and manganese, in concentrations even less than 0.05 mg/l, can cause taste and turbidity problems; discolor pulp and paper in the paper industry; spot and discolor leather in the tanning process; discolor, cloud, and effect the taste of beverages; stain plumbing fixtures and laundered clothes; and iron can provide an energy source for iron bacteria in water mains.

DEVELOPMENT OF SUPPLIES

When a new source of water is sought, considerations as to quality as well as quantity must be made. If a surface water source is being considered, the probable water quality characteristics can be readily and fairly accurately determined; however, the quality of water from a proposed well can only be surmised from a study of quality characteristics of water from existing wells in the area under consideration.

Various surface waters in Mississippi would require treatment for the removal of turbidity, color, taste, hardness, iron, and/or manganese. The lake water supplies for Jackson and Meridian contain manganese which is satisfactorily removed by careful coagulation and pH adjustment. The Tombigbee River at Columbus, which is not used as a public water supply, contains manganese. In addition to correcting any existing objectionable physical or chemical properties of a surface water, all surface waters must be assumed to be polluted and continuous disinfection must be provided.

Some Mississippi ground waters contain concentrations of hardness, iron, hydrogen sulfide, methane, and/or carbon dioxide which must be removed in order to make a water satisfactory for most uses. Carbon dioxide must be removed for two reasons. Because carbon dioxide hydrolyzes to form carbonic acid which lowers the pH of the water, it makes the water corrosive and, further, this depressed pH quite often interfers with successful iron removal. Ground waters are frequently found to be free from bacterial contamination and, if wells are properly located and constructed, these waters can be safely used without disinfection. It is, however, absolutely necessary to constantly check these waters for quality deterioration.

If a new water supply is to be obtained from a surface source, removal of any iron or manganese present is usually a simple matter. The clarification facilities which are necessary for any water which carries suspended solids, and all Mississippi surface waters potentially have this capacity, can readily be designed to provide for iron and manganese removal.

The development of ground water supplies is more unpredictable and no absolute plans for treatment facilities can be made until a well is dug and placed in operation. Several steps should be followed in developing a ground water supply. They are as follows:

1. Study all available records of other wells in the area and determine the approximate depth to the aquifer with the most desirable characteristics. Careful planning can often provide an adequate source of water which will require little or no treatment.

2. If the well is to be located in an undeveloped area, drill one or more test wells in order to locate the best possible water source.

3. When wells or test wells are completed, pump the wells for a sufficient time to insure that the water being discharged truly represents the quality in the aquifer before taking any samples for analysis. Iron from the casing or carried into the aquifer during construction is, all too often, mistaken for iron from the aquifer. Iron removal plants have been built to remove iron which does not exist.

4. Even after consistent analyses are obtained, compare them with reports from other wells in the area in order to guard against unneeded treatment facilities.

5. It is to be noted that variations in the level of the water table or other undefined factors will occasionally cause changes in the quality of the water to such an extent that different treatment facilities must be provided. Such changes in treatment requirements can be held to an absolute minimum if steps 1 through 4 are carefully followed whenever a new well is to be constructed.

6. If the capacity of a well is inadequate, several methods can be used to increase the yield from the aquifer. If none of the legitimate methods prove sufficient, new wells must be constructed to provide the additional capacity. Never double screen a well! If two screens are placed in the same well, water from the two depths will quite probably be of different qualities. Variations in drawdown at the two levels and variations in pumping rates will make it impossible to predict the percentage of water which is being withdrawn from each level and, thus, the water quality will be variable and unpredictable. With such erratic variations in the water quality, treatment will be difficult if not impossible. One municipal well in Mississippi is known to be double screened in two entirely different aquifers. The upper aquifer provides high quality water under flowing artesian conditions while the

lower aquifer has an objectionable iron content. Water from the lower level is withdrawn in variable percentages when the pump is operating to provide the design discharge from the well. If, instead of double screening this well, additional wells had been dug to the upper aquifer, an adequate supply could have been obtained which would have required neither treatment nor pumping.

IRON AND MANGANESE REMOVAL FROM WELL WATER

If after careful planning and location of a well, iron and/or manganese problems still exist,treatment must be provided. Salbach (4) in 1868 first used aeration and filtration for iron removal and the first plant was constructed in Charlottenburg, Germany in 1874. In more recent years the number of iron removal plants has increased rapidly and with this increase came also an increasing number of problems associated with the successful treatment of certain waters. In order to solve these problems, modifications of the conventional treatment of aeration, sedimentation, and filtration were tried, as were entirely different methods of treatment. The more common methods of iron and manganese removal include:

1. Aeration followed by filtration.
2. Aeration, sedimentation, and filtration.
3. Aeration, addition of lime to raise the pH, sedimentation, and filtration.
4. Same as three but with the addition of special coagulants in addition to lime.
5. Aeration and filtration through manganese zeolite.
6. Substitution of chemical oxidants for aeration in any of the above processes.
7. Filtration through a sodium zeolite without prior aeration.
8. Iron has been successfully removed from some well waters in the State by simply allowing the water to flow through coke-tray aerators.

The type of treatment which will best do the job in any particular instance must be left to the discretion of the design engineer. Most of the iron-bearing waters in Mississippi respond readily to the more conventional methods of treatment; however, some systems have proved difficult. One method which has been used satisfactorily for problem waters in this State has been described by Alling (5). The method consists of adding potassium permanganate to a ground water and then filtering it through a manganese zeolite. It is preferable to aerate the water before adding the potassium permanganate in order to lower the dissolved gas concentration in the water and to lower the amount of permanganate required to complete the oxidation of iron to the ferric state. The potassium permanganate serves the purposes of oxidizing any iron which might prove resistant to simple aeration, of retarding any biological slime growth on the filter surface, and of recharging the zeolite continuously during operation. The manganese zeolite oxidizes and traps any iron which might get that far still in the ferrous state.

OCCURRENCE OF IRON AND MANGANESE

Although manganese in more than trace amounts has not been found in ground waters in Mississippi, it does occur in ground water in the surrounding states. Manganese creates a definite removal problem in the supply for Selma, Alabama. Because manganese is present in the surrounding areas, it is quite possible that it may appear in any one of the new supplies being developed in the State and must be considered should it appear.

Iron occurs frequently in Mississippi ground waters and must be considered whenever a ground water supply is to be developed. An indication of the prevalence of iron can be obtained by observing the following table. It is to be noted that many of the communities listed in the table have more than one well and only wells which produce iron-bearing waters are considered.

IRON IN MISSISSIPPI GROUND WATER SUPPLIES

Community	Concentration mg/l
Amory	12 - 15
Boonville	1.5
Canton	0.75 - 1.0
Carrollton	1.8
Charleston	1.4
Clarksdale	0.1 - 1.0
Columbia	2 - 3
Crosby	0.8 - 9.6
Decatur	1.0
D'Lo	0.5
Durant	0.8
Ethel	1.0
Eupora	0.7 - 5.0
Fayette	2 - 3
Fulton	7.5 - 12.5
Forest	1.0 - 2.0
Hattiesburg	0.1 - 1.5
Hazelhurst	0.1 - 3.5
Kilmichael	3.5 - 4.5
Kosciusko	0.75 - 1.2
Lake	3.0
Liberty	0.7
Louisville	2.0 - 7.5
Marks	1.0
McComb	0.3 - 0.5
Meridian	2.0
Morton	0.1 - 0.5
Mt. Olive	3.5
Natchez	0.6 - 1.5
New Hebron	1.0
Newton	0.5
North Carrolton	1.0
Noxapater	7.5
Oakland	5.5
Palahatchie	1.0 - 1.7
Philadelphia	11.0
Roxie	1.7
Union	2.0 - 4.0
Utica	0.5
Vaiden	0.8
West	4.4
Wiona	3.0 - 4.0
Woodville	0.8

FHA Systems	
Bogue Chitto	0.7
Cascilla	1.7
East Lowndes County	3 - 4
East Oxford	1.0
Hamilton	4.0
Hatley	7.5
Hilldale	1.0 - 1.5
Kentawaka	4.0
Kings	1.0 - 1.5
Lorman	3.0
Mantachie	4.0
Nanih Wayia	7.5
North District One	2 - 5
Palmer's Crossing	1.5
Rose Hill	1.5
Southeast Winston County	4.0

SUMMARY

With the rapidly increasing per capita water consumption and with the great number of new water systems being constructed with the support of financing by the Farmers Home Administration, new sources of water supply are being developed at a rapid rate. Because of the plentiful supply of water in Mississippi, obtaining a sufficient quantity of water is no great problem. By careful location and/or control of the source of supply, treatment problems and costs can be held to a minimum. To this end, the following suggestions have been made:

1. If a surface supply is to be used, design clarification equipment so that it will also have the capability to remove iron and manganese.

2. Locate wells carefully using all available information concerning characteristics of the ground water in the area.

3. Obtain representative samples from the well or test well before designing treatment facilities.

4. Iron and manganese, which are commonly in water supplies in Mississippi, can be successfully removed with properly designed and operated treatment facilities.

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