Removal of Iron and Manganese from Ground Water

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***Abstract*—Drinking water supplies are based on groundwater resources all over the world. At some localities problem with higher concentrations of iron and manganese found in ground water. These higher concentration of these metals result in metallic taste of water, effect color and flavor of food and cause staining of different products like paper, cloths and plastics. Therefore WORLD HEALTH ORGANISATION has proved the treatment of water if concentrations of iron and manganese are higher than 0.3mg/L and 0.1mg/L. several techniques have been applied to remove iron and manganese from ground water.**

I. INTRODUCTION

Some regions in india suffer from the contamination of ground water with high concentration of iron and manganese, which threat human health and leading to chronic diseases. Groundwater pollution can occur in various ways, in addition to natural or geochemical contamination, by leaks in pipelines, from landfill leachates, etc. It can be divided into three main contamination categories, by organic compounds, by microorganisms, and inorganic pollutants. The contamination of groundwater with metals of inorganic pollution comprises a danger environmental problem due to the fact that metals are not biodegradable and can cause severe adverse effects on human health .The presence of iron and manganese compounds in groundwater, and eventually in drinking water, is a serious environmental problem. When iron and manganese compounds are present in both surface and groundwater, even at low concentrations, they can be linked to various water quality problems and their removal is essential. The Safe Drinking Water Act (SDWA) secondary standards for iron in drinking water is 0.3 parts per million (ppm) and for manganese it is 0.05 ppm. Iron and manganese are both known to stain the water supply. They can make water appearance red or yellow, create brown or black stains, and give off an easily detectable metallic taste. Several years ago, it was believed that incumbent soil layers, acting as natural filters and protected ground waters, but actually it was found that soil ores of iron and manganese can be easily dissolved into ground water particularly at highly acidic medium.

Iron in water supplies causes aesthetic and operational problems, such as bad taste and color, staining and deposition in the water distribution system leading to high turbidity. Manganese is a very common compound that can be found everywhere on earth and it is one of the most abundant metals in soils, where it occurs as oxides and hydroxides, and cycles through its various oxidation states. Manganese is one out of three toxic essential trace elements, which means that it is not only necessary for humans to survive, but it is also toxic when too high concentrations are present in a human body. Manganese is one of the most abundant metals in soils, where it occurs as oxides and hydroxides, and it cycles through its various oxidation states. Manganese occurs principally as pyrolusite (MnO2), and to a lesser extent as rhodochrosite (MnCO3). Manganese, in the form of potassium permanganate, may be used in drinking water treatment to oxidize and remove iron, manganese, and other contaminants .Manganese in ground water is difficult to remove by using normal methods, where it required a high potential to overcome its high activation energy required for manganese oxide formation, where MnO2 is formed by highly oxidizing and high pH conditions.

In recent years, various treatment technologies have been employed to enhance water quality by removing inorganic and organic contaminants. Both photo and electro-chemical oxidation technologies recently have become more popular for water treatment.

Doan and Saidi used combined electrochemical and photochemical oxidation for the removal of inorganic contaminants like Zn and Ni, and organic contaminants like alkylbenzene sulfonate. They found that the results of combined system are at comparable levels to those obtained in the sole electrochemical system. Peralta-Hernández et al designed an annular tube reactor of combined photo-electrochemical system for the generation of H2O2 and Fenton reagent in situ, the rate of oxidation was increases substantially when the semiconductor anode was illuminated as compared to the same processes carried out in the dark. These processes are considered as attractive options in solving the issues concerning iron and manganese removal from water particularly, if other compounds such as ammonia, total dissolved solids or natural organic matter (NOM) are found . To solve this problem, Fe+2 or Fe+3 can be introduced into the system, constructing an electro-Fenton's reagent as one of a special class of oxidation techniques defined as advanced oxidation processes (AOPs) . These processes are characterized by the capability of exploiting the high reactivity of free hydroxyl radicals. Free hydroxyl radical (OH•) is a non selective and very powerful oxidant agent able to oxidize organic and inorganic pollutants in water and is generated from chemical, electro and photochemical (by using light irradiation) processes. Electro-Fenton process can be enhanced in presence of UV radiation Stephen and Charlotte were used electrolytic cell containing aluminum and iron electrodes of high surface area relative to the volume of electrolyte for the generation of fine flocs of Al(OH)3 acting as colloids and adsorption centers for contaminants dispersed in waste.

II. MATERIALS AND METHODOLOGY

The methodology includes the process sequentially which carried out, this project includes the process of experiment for the characterization of both treated and un treated water by treatment plant.

A. Iron

Soluble iron and iron-loving bacteria can cause blockages in pipes, drippers and sprinklers and can damage equipment such as pressure gauges. If water with high soluble iron is applied by spray, it can discolour leaves and reduce the efficiency of transpiration and photosynthesis.

High levels of soluble iron are usually associated with deep bores and dams where oxygen supply is limited. Iron is soluble in water where there is little or no oxygen. Aeration oxidises the iron, forming solid particles that can then settle out of solution. Dissolved iron can promote the growth of iron bacteria in groundwater. The presence of bacteria worsens the impacts of soluble iron, as they extract the iron out of solution and convert it into sludge. Oxidised iron, even in low concentrations of 0.2 mg/l, stimulates some aerobic slime deposits. These slimes are sticky and can attach themselves to irrigation pipes causing blockages. Heavy iron deposits can make pasture unpalatable to stock. If eaten, the iron deposits may cause dairy cattle to scour and milk production to drop. Iron deposits on vegetables, fruit and ornamental plants make them difficult to sell because of their stained appearance.

As a general guide, iron bacteria will develop in water where the concentration range of iron is 0.3 to 1.5 mg/L (0.3 to 1.5 parts per million, ppm). Concentrations above 1.5 mg/L (1.5 ppm) tend to favour the development of iron deposits. Irrigation systems used for fertigation (liquid feeding of nutrients) should not use water high in iron. Injecting unchelated phosphates or calcium salts into the water will accelerate the precipitation of iron, and should be avoided.

In domestic water supplies, iron and manganese will turn the water yellow-brown to black and will stain plumbing fixtures and laundry. Iron can also dramatically reduce the efficiency of water-softening units.

B. Treatment

Iron is soluble in water where there is little or no oxygen. Oxidising the iron makes it form solid particles that can then settle out of solution or be caught in a filter.

The recommended treatment to remove iron is oxidation, sedimentation and then filtration. Procedures used include aeration and settling (Figure 1), chlorination and use of potassium permanganate.

C. Effect of iron and manganese

Iron and manganese are two similar elements that can be a nuisance in a drinking water supply. Iron is more common than manganese, but they often occur together. They are not hazardous to health. Problems of iron and manganese cause Iron and manganese can give water an unpleasant taste, odor and color. Iron causes reddish-brown stains on laundry, porcelain, dishes, utensils, glassware, sinks, fixtures and concrete. Manganese causes brownish-black stains on the same materials. Detergents do not remove these stains. Chlorine bleach and alkaline builders (such as sodium and carbonate) may even intensify the stains. Iron and manganese deposits build up in pipelines, pressure tanks, water heaters and water softening equipment. These deposits restrict the flow of water and reduce water pressure. More energy is required to pump water through clogged pipes and to heat water if heating rods are coated with mineral deposits. This raises energy and water costs. Water contaminated with iron and manganese often contains iron or manganese bacteria. These bacteria feed on the minerals in the water. They do not cause health problems, but do form a reddishbrown (iron) or brownish-black (manganese) slime in toilet tanks and can clog water systems.

Eliminate iron and manganese from ground water

Figure 1. Treatment unit

If the test shows that your water does contain undesirable levels of iron and/or manganese you have two options: 1) obtain a different water supply; or 2) treat the water to remove the impurities. You might be able to drill a new well in a different location, or complete the existing well in a different water-bearing formation. Ask your well driller for advice on these options. If you decide to treat the water, there are several effective methods to choose from. These are summarized in Table 1. The most appropriate method depends on factors such as the concentration of iron and manganese in the water, whether bacteria are present, and the amount of water you need to treat.

D. Phosphate Treatment

Low levels of dissolved iron and manganese (combined concentrations up to 3 mg/L) can be remedied by injecting phosphate compounds into the water system. Phosphate prevents the minerals from oxidizing and thus keeps them in solution. The phosphate compounds must be introduced into the water at a point where the iron is still dissolved in order to keep the water clear and prevent staining. Injection should occur before the pressure tank and as close to the well discharge point as possible. Phosphate compound treatment is relatively inexpensive, but there can be disadvantages to this method.

E. ION Exchange Water Softener

Phosphate compounds do not actually remove iron, so treated water retains a metallic taste. Adding too much phosphate can make the water feel slippery. Phosphate compounds are not stable at high temperatures, which means that if treated water is heated (in a water heater or when cooking) the iron and manganese will be released, react with oxygen and precipitate. Finally, the use of phosphate products is banned in some areas because of environmental concerns.

Low to moderate levels of iron and manganese (a combined concentration of up to 5 mg/L) usually can be removed by an ion exchange water softener. Before you buy one, be sure the concentration of iron in your water does not exceed the maximum iron removal level of the equipment. Not all water softeners can remove iron from water, so check the manufacturer's specifications carefully. Excessive amounts of dissolved iron can plug a softener. An ion exchange softener works by exchanging the iron in the untreated water with sodium on the ion exchange medium. Backwashing flushes iron from the softener medium, forcing sodium-rich water back through the device. This process adds sodium to the resin medium while the iron is carried away in the waste water. Because iron reduces the unit's capacity to soften water, it will have to be recharged more often. Follow the manufacturer's recommendations concerning the appropriate material to use for a particular concentration of iron. Some manufacturers suggest adding a "bed cleaning" chemical with each backwashing to prevent clogging. Water softeners add sodium to water, which can cause health problems for people on sodium restricted diets. In such cases, install a reverse osmosis unit to provide un softened water for cooking and drinking, or use a potassium salt water softener.

F. Oxidizing Filter

Moderate levels of iron and manganese (a combined concentration of up to 15 mg/L) can be treated with an oxidizing filter. The filter is usually natural manganese greensand or manufactured zeolite coated with manganese oxide. These substances adsorb dissolved iron and manganese. Synthetic zeolite requires less backwash water and softens water as it removes impurities. The amount of dissolved oxygen in your water (which can be determined by field test kits, water treatment companies or water testing laboratories) determines the correct oxidizing filter to use.

III. TEST RESULTS AND DISCUSSION IRON BEFORE AND AFTER TREATMENT

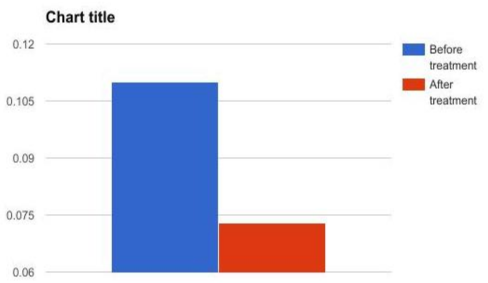

Figure 2. Before and after treatment (Removal of Iron)

A. Manganese Before And After Treatment

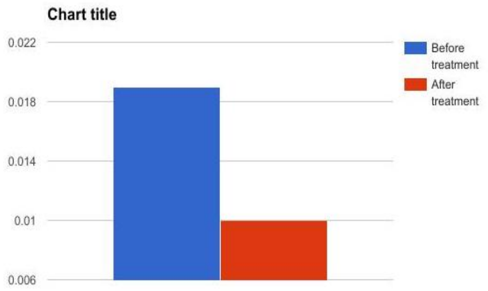

Figure 3. Before and after treatment (Removal of manganese)

IV. SUMMARY AND CONCLUSION

In this work the removal of Fe2+ and Mn2+ in groundwater by oxidation and filtration using filtering process was fabricated and investigated. The result showed that Fe was almost removed by oxidation and filtration, while Mn concentration still remained higher than water quality standard (0.05 mg L-1). In the test, an increase of pH and NaOCl dosage results in more formation of MnO particles. Thus, pH higher than 7.0 2and NaOCl dosage more than 3.0 mg L-1 are required to reach more than 90% Mn removal efficiency. In the test, the Mn2+ concentration of permeate that was beyond acceptable level during the initial operation time was gradually decreased from 0.1 to0.01 mg L-1. The accumulated sludge on membrane plated an important role for Mn removal, where the main composition of sludge was Fe-Mn oxide. This study confirmed that Micro Filteration process can be applied properly for improving water quality. The MF process can be directly utilized as water treatment process to establish a new water treatment plant, as well as to be used as stepped-up equipment at the backend of rapid sand filter to comply more stringent water quality standards.

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