Plants, Animals and Humans with Iron Free Water

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ABSTRACT: Water is the greatest gift of nature and necessity of living organisms. Water is regarded as an universal solvent because more things can be dissolved in water than in any other liquid. Plants require iron at the source from the soil in the form of ferric salts to perform their functions for the synthesis of chlorophyll and formation of carotenoids. Animals especially humans obtain iron at the source of human diet. Though iron in traces is too important means of our life but at some places excessive iron is found in water causing serious problems.

The method of removal of iron from water consists in oxidation of Fe$^{2+}$ to Fe$^{3+}$ metal and its precipitation as Fe(OH)$_3$. If iron is present in water as hydrocarbonate, it can be removed by aeration. Iron can be removed from water by a mixed coagulant consisting of sodium aluminate and ferric chloride (Molar ration, NaAlO$_2$ to FeCl$_3$ is 1:1). Another method to remove iron is to pass water through a bed of highly dispersed suspension of chalk and aluminium hydroxide. Ferric iron can be removed from water by cation exchange method. The removal of iron from subsoil sources of filtration is combined with one of the preliminary methods of purification of water, such as simplified aeration, adding oxidants with or without aeration.


INTRODUCTION

Water is the greatest gift of nature and necessity of living organisms. Hydrosphere, the component of environment, covers more than 75 percent of the earth’s surface either as oceans (salt water) or as fresh water. Water is regarded as an universal solvent because more things can be dissolved in water than in any other liquid. The inorganic compounds are mostly soluble in water and also dissociate to form electrically charged particles, called ions. It is probable that all natural elements are soluble in water at least in trace amounts, and they are all found in natural water at some place or the other on the earth’s surface.

Importance of iron to living organism

Plants require 10-1500 ppm of iron at the source from the soil in the form of ferric salts to perform their functions for the synthesis of chlorophyll and formation of carotenoids, as a constituent of cytochromes activating a number of enzymes. Iron deficiency in plants shows symptoms of interveinal chlorosis, localized or generalized chlorosis etc. [4]. Animals specially humans obtain iron at the source of human diet like liver meat, green vegetables, eggs, whole grains, legumes, nuts etc. meant for major functions as an inactive site of many redox enzymes and electron carriers; haemoglobin; myoglobin etc. Iron deficiency in human diet leads to deficiency of haemoglobin because iron is necessary for the production of haemoglobin; this disease is called microcytic anaemia.

Pregnant and lactating mothers need additional dose of iron for the foetus and the infants. Women of child bearing age also require extra dose of iron because of loss of blood at each menstrual discharge [3].

Excessive Iron in Water.

Though iron in traces is too important means of our life but at same places excessive iron is found in water causing serious problems like

i. Yellowing of teeth, clothes, cooking pots, toilets and bathroom floors etc,

ii. Loss of appetite,

iii. Stomach disorders,

iv. Excessive weakness human males in comparison to females etc,

v. Damage of liver causing jaundice,

vi. Ulcer of intestine.
**EXPERIMENTAL**

With the purpose to remove iron from water- oxidation, precipita
tion, aeration, coagulation, filtration and autocatalytic process etc. being applied separately as well as steps in 
combination.

**Removal of Iron from Water**

The method of removal of iron from water consists in oxidation of Fe$^{2+}$ to Fe$^{3+}$ metal and its precipitation as 
Fe(OH)$_3$.

If iron is present in water as hydrocarbonate, it can be 
removed by aeration. This salt is hydrolysed in the 
following way.

$$Fe(HCO_3)_2 + 2H_2O \rightarrow Fe(OH)_2 + 2H_2CO_3$$

$H_2CO_3 \leftrightarrow H_2 + CO_2$

CO$_2$ is removed from water by aeration and, therefore, 
hydrolysis can be completed to the end. Ferrous 
hydroxide is oxidized by atmospheric oxygen to Fe(OH)$_3$.

$$4Fe(OH)_2 + 2H_2O + O_2 \rightarrow 4Fe(OH)_3$$

This method can be used to reduce the iron content up
to 0.1 to 0.3 mg/litre. Humans interfere with the 
precipitation of iron, because they act as protective 
 colloids with respect to Fe(OH)$_2$. In such cases, water is 
treated with chlorine, which oxidizes Fe$^{2+}$ iron to Fe$^{3+}$ 
iron and destroys humans.

FeSO$_4$ is removed from water by treating it with lime.

$$FeSO_4 + Ca(OH)_2 \rightarrow Fe(OH)_2 + CaSO_4$$

$$4Fe(OH)_2 + 2H_2O + O_2 \rightarrow 4Fe(OH)_3$$

Iron can be removed from water by a mixed coagulant 
consisting of sodium aluminate and ferric chloride 
(Molar ration, NaAlO$_2$ to FeCl$_3$ is 1:1). The 
concentration of residual iron does not exceed 0.3 
mg/litre. Iron present in organic and inorganic 
compounds can be removed by this method.

Another method to remove iron is to pass water through 
a bed of highly dispersed suspension of chalk and 
aluminium hydroxide. The iron salts are converted into 
ferrous carbonate by chalk.

$$FeSO_4 + CaCO_3 \rightarrow FeCO_3 + CaSO_4$$

FeCO$_3$ is hydrolysed into ferrous hydroxide.

$$FeCO_3 + 2H_2O \rightarrow Fe(OH)_2 + H_2CO_3$$

The Fe$^{2+}$ iron is then oxidized to Fe$^{3+}$ iron.

$$4Fe(OH)_2 + 2H_2O + O_2 \rightarrow 4Fe(OH)_3$$

The overall reaction can be represented as,

$$4CaCO_3 + 4FeSO_4 + 6H_2O + O_2 \rightarrow 4Fe(OH)_3 + 4CaSO_4 + 4CO_2$$

Ferric hydroxide is retained in the suspended filter 
which contains 16 parts by weight of Al(OH)$_3$ per 100 
parts of CaCO$_3$. About 95% of iron present in water can 
be removed by this method.

Ferric iron can be removed from water by the cation 
exchange method. For example, when water passes 
through calcium form of cation exchanger, the 
following reaction occurs.

$$3CaR + Fe_2(SO_4)_3 \rightarrow Fe_2R_3 + 3CaSO_4$$

The iron content can be decreased by this method 
upto 0.05 mg/litre and even lower.

It has also been observed that ferrous iron is 
converted into ferric iron when passed through a 
granular filter (without preliminary oxidation of iron).

The process is accompanied by the formation of a ferric 
xide film on the grains of the filter, which acts like a 
catalyst. Hence water is purified from iron by filtration 
and is an autocatalytic process.

There is, however, no universal method to remove 
iron from sub soil water, and the selection of a 
particular method depends on the analysis of water 
taken from the source.

The removal of iron from sub-soil sources by 
filtration is combined with one of the preliminary 
methods of purification of water, such as simplified 
aeration, adding oxidants with or without aeration.

The simplified aeration consists in that water falls on 
the filter from a height of 0.5 to 0.6 m. The method is 
convenient for water containing upto 10 mg/litre of total iron, of which the ferrous iron content should not 
be less than 70%, because no film is formed on the 
grains in its absence. [Ref.6]

The investigations have shown that only the presence 
of ferrous iron in water delivered on the filter provides 
the conditions under which the film is formed to ensure 
the high iron-removal effect.

**DISCUSSION AND CONCLUSION**

WHO International Standard recommended a 
permissible limit of 0.3 mg/L and an excessive limit of 
1.0 mg/L iron in drinking water. Iron tends to 
precipitate as hydroxides and stain laundry and 
porcelain fixture. Iron oxides form adherent coatings 
and lead to tube failures. Heavy metal like iron in water 
acts as cumulative poisons and accumulates in the 
body of living organisms causing chronic diseases. 
Iron causes skin and stomach diseases in man. Intestine 
is unable to absorb suspended iron of water as it is 
found in the form of ferrous ions. Thus removal of iron 
from water is necessary for easy consumption and 
assimilation.
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