Military Technical College
Kobry Elkobbah, Cairo,
Egypt.

C.E.E. 2006

3rd International Conference
On
Chemical & Environmental
Engineering

IRON AND MANGANESE REMOVAL PLUS DISINFECTION OF GROUND WATER USING OZONE

"Case study "

Mohamed F. M. * and Eissa M. A. F. *

ABSTRACT

Next to hardness, the presence of iron is probably the most common water problem faced by consumers and water treatment processionals. The secondary (aesthetic) maximum contaminant levels (MCL) for iron and manganese are 0.3 (mg/l) and 0.05 mg/l, respectively .

Iron and Manganese are two of the most abundant elements found in earth's crust. The oxidized forms Fe^{+3} and $Mn^{+4}$are most prevalent, but reduced forms (rhodochrosite) [$FeCO_3$] and siderite [$MnCO_3$] that are present in water]. The existence of iron and manganese in drinking water generates certain unpleasant side effects, such as color, precipitates in water, stains on clothing and plumbing fixtures.

The objective of the present study is production of ozone by corona discharge (bench scale, which produce 0.3 mg ozone per minute that sufficient to reduce of ferrous and Manganous ions 2 ppm and 4 ppm respectively to permissible limits of WHO specifications as well as disinfecting of water from microorganisms like Escherichia - Coli, streptococcus -Faecalis and Staphylococcus-Aureus.

KEY WORDS

Ozone, iron, manganese oxidation, disinfection, and filtration

* Kaha Company for Chemical Industries.
.

1. INTRODUCTION

In The time that it takes you to read this sentence, three people will die because they do not have ready access to save and reliable supply of drinking water [1]

The total quantity of water on earth is estimated to be 1.4 trillion cubic meters. Of this, less than 1% water, present in rivers and ground resources is available to meet our requirement. These resources are being contaminated with toxic substances due to ever-increasing environmental pollution. To reduce this contamination, many countries have established standards for the discharge of municipal and industrial waste into water streams [2].

We use water for various purposes and for each purpose we require water of appropriate quality. Evaluating the physical, chemical, biological and radiological characteristics of water assesses the quality of water. Water for drinking and food preparation must be free from turbidity, color, Odour and objectionable tastes, as well as from disease-causing organisms and inorganic and organic substances, which may produce adverse physiological effects. Such water is referred to as potable water and is produced by treatment of raw water, involving various unit operations [3-6].

Ozone is considered the second most powerful oxidizing agent after fluorine [7]. Ozone is so effective disinfecting and oxidizing agent than other oxidants because of several reasons: (i) oxidation potential is higher than chlorine and hypochlorite and oxidation potential are (- 2.07V,-1.49V and –1.36V respectively, (ii) has no negative residuals such as trihalomethane production, (iii) aid in coagulation and flocculation, (iv)doesn’t alter the pH of water, (v)ozone is12.5 times more soluble in water than oxygen ,(vi) it is effective against Odour,taste and unsaturated compounds ,(vii) helps with the removal of iron and manganese [8-10] .

Ozone can disinfect roughly 3000 times faster than chlorine. Ozone can remove the following metals at percent 99.5% or above aluminum, arsenic, and cadmium. Chromium, iron, nickel, cobalt, lead, copper and change nitrite to nitrate [10].

Two hundred years have elapsed since Van Marum noted the pungent odor of ozone in 1781. It was not until 1867 that it was found to be composed of tri atomic oxygen, O_3. The first full-scale application of ozone in drinking water treatment was in 1893 at Oudshoorm (Netherlands)]. , For water sterilization in Holland. The first major treatment plant installation was in Nice, France, in 1906. Before 1970, there were only two drinking-water plants using ozone in The United States [11]. Today there are more than 2,000 plants using ozone, mostly for oxidation of impurities, not for final disinfection

Disinfection (elimination or inactivation of bacteria, viral particles and parasites) is one of major objectives of drinking water suppliers. Ozone is very effective against bacteria as compared with other water treatment disinfectant. Wuhrmann and meryrath (1955) studied the effect of very small concentration of dissolved ozone, i.e., and 0.6 μg/ l on E.coli. They showed that at 12˚C an E.coli strain added to pure water was reduced by 99.99 percent in less than one min with 9 μg/ l of dissolved ozone [14].

The objective of the present study is production of ozone by corona discharge (bench scale, which produces 0.6 mg ozone per minute that sufficient to reduce of ferrous and manganous ions 2 ppm and 4 ppm respectively to permissible limits of WHO specifications as well as disinfecting of water from microorganisms like Escherichia - Coli, streptococcus -Faecalis and Staphylococcus-Aureus.

2. MATERIALS AND METHODS OF ANALYSIS AND COUNT

2.1Experimental

The experimental design divided to two parts:

1st part: concern with removal of iron and manganese (2, 4) ppm respectively from ground water by action of ozone prepared by corona discharge and two parameter; contact time and ozone dose are studied as follow : contact time range (0-3) minutes, (0-10) minutes and ozone dose range (0.1- 1.8) mg, (0.6- 6) mg in iron and manganese cases respectively .

2nd part: concern with disinfection of water from microorganisms such as Escherichia-Coli, Streptococcus-Faecalis and Staphylococcus-Aureus. And two parameter: contact time and ozone doses are discussed as shown in table (1)

Table(1)

Property	Contact time	Ozone dose
Escherichia-Coli	(3-6-9) min.	(0.1-0.3-0.6) mg/l
Streptococcus -Faecalis	(3-6-9) min.	(0.1-0.3-0.6) mg/l
Staphylococcus-Aureus	(3-6-9) min.	(0.1-0.3-0.6) mg/l

2.2. Chemical and Biological analysis

In all samples before and after removal of iron and manganese the physicochemical parameters were determined according to APHA (1995) and in the case of disinfection the results confirmed by biological analysis.

3. RESULTS AND DISCUSSIONS

It divided two parts:

1st part: Concern with removal of iron and manganese from ground water by action of ozone prepared by corona discharge and two parameter; contact time and ozone doses are discussed and final results are recorded as shown in the Fig(1-2) and amount of ozone doses required for iron and manganese are (1.8 and 4.2)mg respectively .and contact times are (3and 7) minutes respectively as shown in Fig.(3-4)

2nd part: concern with disinfection of water from microorganisms such as Escherichia-Coli, Streptococcus-Faecalis and Staphylococcus-Aureus. And two parameter: contact time and ozone doses are discussed and optimum conditions are recorded as shown in following table(2).

4. Possible Reaction mechanisms of iron and manganese oxidation by ozone

Oxidation of ferrous and manganous ions can be oxidized by ozone as summarized as shown in table (4) [13,15-16] .

5. CONCLUSION

1- Ferrous ion only can be removed from ground water after contact time 3 minutes and rate flow of ozone 0.6mg /l /minute.
2- Manganous ion only can be removed from ground water after contact time 7 minutes and rate flow of ozone 0.6 mg /l /minute.
3- Escherichia - Coli can be removed with initial concentration$1X10^{10}$/ml after contact time 3 minutes.
4- Streptococcus -Faecalis can be removed with initial concentration$1X10^{8}$/ml after contact time 6 minutes.
5- Staphylococcus-Aureus can be removed with initial concentration $5X10^{10}$/ml after contact time 3 minutes.

6. REERENCES

[1] Michael, price .Introducing Groundwater Chapman and Hall, 1992.
[2] Fanklin W. Schwatraz Hubaozhang, “Fundamental of ground water,”2003.
[3] American Water Works Association, “Water Treatment Plant Design”, Third Edition, 1995.
[4] American Water Works Association, “Water Quality Treatment,”. Forth Edition 1998.
[5] American Water Works Association Water Quality and Treatment. Fifth Edition 2000.
[6] Water Treatment handbook. Fifth Edition. Degrëmont 1979.
[7] DEL industries, Ozone questions and answers, web page 1997.
[8] Coate, Robert, the Co-Deca- Tech- water/waste water systems, web page, 1997.
[9] Towles, jon, Ozone uses in odor control, web page, 1997a.
[10] Towles, jon, the technology of ozone in the oxidation of organic compounds, web, page, 1997,b.
[11] B.Langlais, D.Reckhow and D.Brink, “ ozone in water treatment application and engineering,” Lewis publishers 1991.
[12] World health organization “Guideline for drinking water quality,” Geneva, 2003.
[13] Pouvereau, P “Elimination specific iron and manganese,”1984.
[14] Wuhrmann, K and meryrath, J “Bacterial action of ozone solution,”1955.
[15] Stoebner, R.A& Rollag, 1981. “Ozonazation of municipal ground water supply to reduce iron, manganese and trihalomethane formation,” 1981.
[16] Knocke, W R. Et al, “ using alternative oxidant to remove dissolved Manganese from water,” 1987.

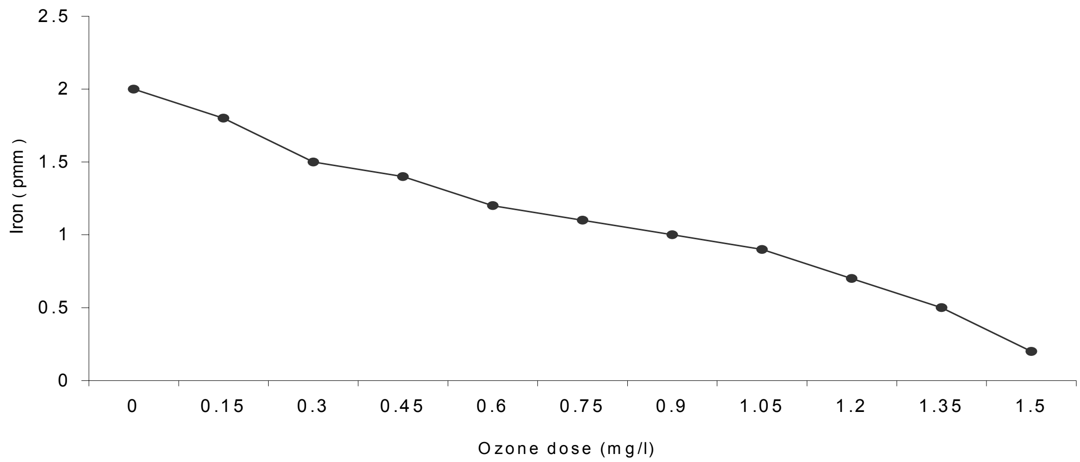
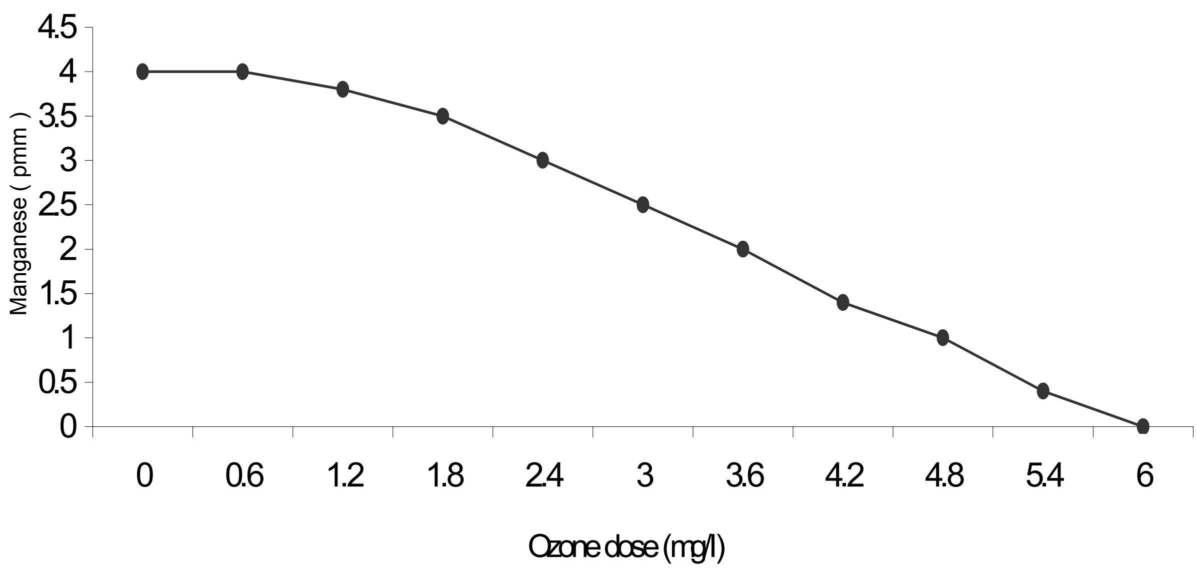


Fig.(1)Effect of ozone dose on iron removal



Fig(2) Effect of ozone dose in manganese removal

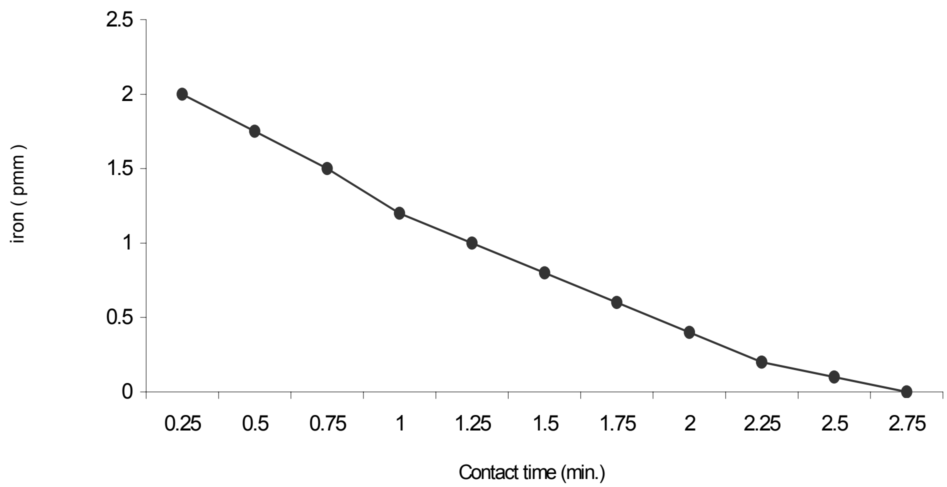


Fig.(3)Effect of ozone contact time on iron removal

Table (2) : Effects of contact time and ozone dose in some microorganisms removal

Property	Initial concentration	After ozone	Contact time	Ozone dose
Escherichia-Coli	$1X10^{10}$/ml	nil	(3) min.	(0.9) g/l
Streptococcus - Faecalis	$1X10^{8}$/ml	nil	(6) min.	(1.8) g/l
Staphylococcus-Aureus	$5X10^{10}$/ml	nil	(3) min.	(0.9) g/l

Table (3): Possible Reaction mechanisms of iron and manganese oxidation by ozone

Metal	Oxidant	Reactions	Stoichiometry
Fe^{2+}	O_3 aq	$Fe^{2+} + O_3 + 5H_2O \rightarrow 2\,Fe(OH)_3\,(S) + 4\,H^+ + O_2$ aq	0.43mg O_3 /mg Fe
Mn^{2+}	O_3 aq	$Mn^{2+} + O_{3\,(aq)} + H_2O \rightarrow 2\,MnO_2\,(S) + 2\,H^+ + O_2$ aq	0.88mg O_3/mg Mn

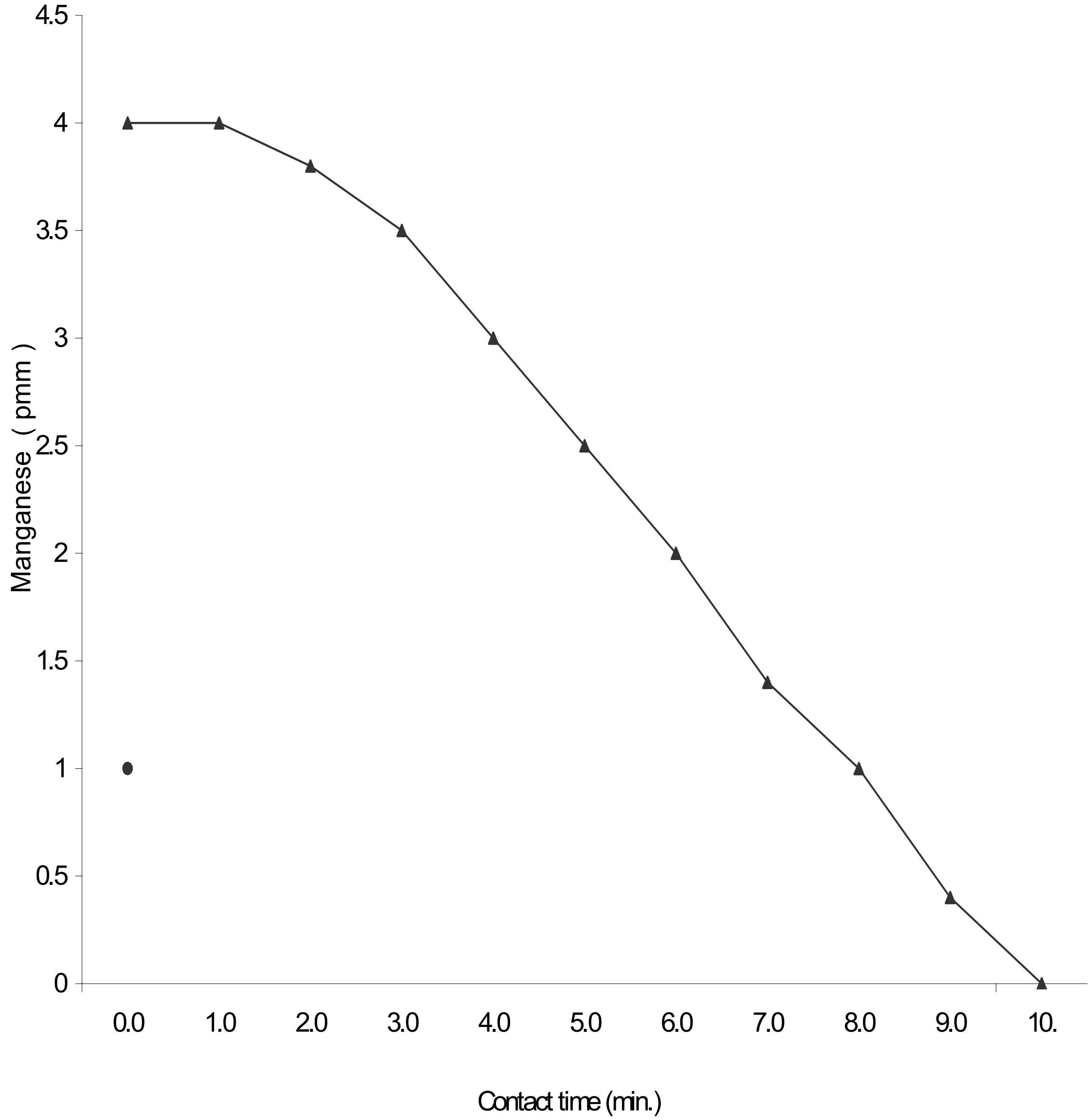


Fig.(4)Effect of ozone contact time on manganese removal