

Technical Way for Resolve Pollution Problem in Drinking Water Network of Al-Najaf Governorate

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الخلاصة:

أجريت هذه الدراسة في مدينتي النجف والكوفة والتابعتين لمحافظة النجف الاشراف بواسطة اختبار البعض من محددات مياه الشرب لمنظمة الصحة العالمية لغرض تنصيب طريقة جديدة بواسطة نظام حقن الكلور (حاقن الكلور) في شبكة المياه لمحافظة النجف الاشراف والتي تعمل على إعادة الكلورة لمياه الشرب وكذلك السيطرة على خلل أوتكسرات الشبكة، إن النتيجة النهائية هي طريقة مزج جيدة وممتازة للتنقية.

هذا المزج يتم بواسطة استخدام حاقن الكلور والمقتبس من استخدامه في نظام الكلورة المستمرة والمستخدم في العديد من الدول المتقدمة وتنصيبه في نقاط التلوث (بؤر التلوث) في شبكة المياه المعدة للشرب لطريقة التنقية الحالية، وان استخدام هذا المزج يعتبر طريقة جديدة وغير مستخدمة كما أوصت الدراسة.

إن تحديد مواقع التنصيب (بؤر التلوث) قد تم بواسطة اثنان من المحددات :-

1 - الفحوصات البكتيريولوجية (طريقة العد الأكثر احتمالاً).

2 - الفحوصات الكيماوية (فحص الكلور).

إن نظام حقن الكلور يجب أن ينصب موقعا في جميع الأحياء التي أعطت نتائج ايجابية للفحص البكتيريولوجي، إن هذه الدراسة أوجدت 25 حيا أعطت نتائج موجبة في الفحص البكتيريولوجي من خلال استخدام المقارنة بالمواصفات العراقية ومواصفات منظمة الصحة العالمية.

وجدت الدراسة خلل واضح في طريقة تنقية المياه الحالية وكذلك في نظام التوزيع

ومعامل ارتباط بيرسون حيث أعطيا فروق معنوية إحصائية، استخدم فحص T.

إن العلاقة بين فحص الكلور والفحص البكتيريولوجي بينت وجود فروق معنوية عالية. توصي الدراسة بتحسين شبكة مياه الشرب لمحافظة النجف الاشراف من خلال تنصيب تقنية نظام حاقن الكلور في جميع المواقع (الأحياء) التي اعطت نتيجة بكتيريولوجية ايجابية. تأسيس برنامج طوارئ للتعامل بسرعة مع التلوثات البكتيريولوجية حال تأكديها في اي جزء من نظام التوزيع العام.

Abstract:

The study was conducted in Al-Najaf and Al-Kufa City that follow to Al-Najaf Governorate and it carried out of a tested some of WHO drinking water parameter for installation of a new approach Chlorine injection system (CL2 injector) in the drinking water network of Al-NAJAF Governorate that working as re disinfecting drinking water and control the defect or leakage of the network, the finally resulted was a good and excellent mixing way for disinfection.

These mixing are doing by using CL2 injector that separating from continuous chlorination system that was used in many developed countries and installed on the pointed pollution (pollutant focus) of the drinking water network of present water treatment plant, this mixing way considered a new approach and never using like it.

The determination of the installation site (pollutant focus) was made by two parameter:

1 - Bacteriological examination (M.P.N).

2 - Chemical examination (CL2).

The CL₂ injection system must be installed locally in the all district that giving positive bacteriological results, the study was found a 25 district with positive results through comparison with Iraqi and WHO standard.

The study finding is indicating a clear defect in a present drinking water treatment plant and its distribution system .

T-test and Pearson correlation was applied and giving significant statistical differences that's confirming study aims .

The correlation between CL₂ and bacteriological examination was showed a highly significant difference ($p > 0.001$). The study recommended of Improvement of drinking water network of al-Najaf governorate by installation of Chlorine Injection System Technology (Cl₂ Injector) in all locations (neighborhoods) that gave positive bacteriological results. Establishing emergency program that deals quickly with the bacteriological drinking water contamination when confirmed in any part of community water system.

1.1 Introduction

Water has a significant role in satisfying physical, hygienical, sanitary and domestic need for human life, and comprises 63 – 65 % of human body. Water of 2.5 – 3 liter is needed for human a day. This water satisfying human needs must fully meet hygienically requirements⁽¹⁾. Drinking water must have no special taste, odor and be pure, constant at chemical compound and not contain pathogenic bacteria's, parasites and toxic substances⁽²⁾.

Every day, 25000 people are dieing because of the shortage of good quality water and one million people are suffering from the communicable and no communicable diseases related to water factors⁽³⁾. Water have important Role for transmitted many of microorganism that responsible for many diseases like dysentery, typhoid, cholera, poliomyelitis, hepatitis A, respiratory disease and other⁽⁴⁾.

Chlorine, the most common disinfectant in the world, is effective in killing most pathogenic bacteria and viruses. Municipal potable water supplies are usually chlorinated to provide a residual concentration of 0.5 to 2.0 ppm. Higher chlorine concentrations are needed to kill many bacteria, the need to above (2 ppm) to provide pseudomonas – free water⁽⁵⁾. Chlorination is a water treatment that destroys disease – causing bacteria, nuisance bacteria, parasites and other organisms⁽⁶⁾. Chlorination removes a large amounts iron of and manganese from water and many other mineral and change of mineral to anther from⁽⁷⁾. Two methods from chlorinating water are chock chlorination using by water treatment plant and continuous chlorination that used to treat recurring bacterial contamination problems.

Continuous chlorination is a necessity for drinking water; you can use Cl₂ injection system (Cl₂ injector) to inject chlorine in to your system⁽⁸⁾. Because effective organism kill is function of contact time, the chlorine solution or gases should be injected in to the water network as close to the source of pollution⁽⁹⁾. Continuous chlorination can be an effective method for disinfection of drinking water⁽¹⁰⁾. It also can be one step in the process of removing iron, manganese⁽¹¹⁾. Continuous chlorination can be mix with the other types of treatment like a preventive measures for disinfectant of pollution happened by leakage from swage water that contact with drinking water network⁽¹²⁾.

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1.2- Aims of the study

The study aimed to modify of present Al-Najaf and Al-Kufa drinking water system by addition of chlorine (Cl₂) injection system that used in continuous chlorination, which work as preventive measures through:

- 1-Determination the focuses of pollution in a drinking water network through a define parameters (physiochemical and bacteriological examination).
- 2-Installation of Cl₂ injection system at the pollution points that discovered to prevent the regrowth of microorganisms and used as immediate solving a pollution problem.

2. Materials and Methods

2.1-Study Design: A cross sectional study.

2.2-Period of the Study: The collection of the samples lasted from (1/7/2011 to the 31/12/2011).

2.3-Place of the Study

The study was conducted in Al-Najaf and Al-Kufa city that belongs to Al-Najaf governorate about 165Km to the south of Baghdad, and 60km to the south of Babylon governorate.

2.4- Apparatus and Materials

2.4.1 -Apparatus that used in the study.

Apparatus	Manufactured company
Digital chlorine meter	Hanna instrument company (Romania)
Pipettes	England

2.4.2- Chemical and Biological materials that used in the study.

Materials	Manufactured company
D.P.D (no 1) free chlorine reagent	Hanna instrument (Romania)
MocConky broth medium	Difco (United State)
Na ₂ SO ₂ O ₃	Germany

2.5-MocConkey broth medium: This medium was used in account of coliforms bacteria; it was preparing in two strength as recommended by WHO (17).

- A. Single strength medium:** it was prepared by dissolving of (35 gm) in (1 L) of distilled water, the PH was controlled to (7.2), it sterilized by autoclave in (121°C) for (15min.) after distributed in (10 ml) for each tube that contained each one of Durham tube (used to test gas formation).
- B. Double strength medium:** it was prepared at the same way of a single strength but the difference is only in quantity of medium that dissolved (70 gm) in distilled water.

2.6 -Sampling Design and Collections

A Simple random sample technique was the method that chosen in this study from neighborhoods of Al-Najaf and Al-Kufa city by:

- Numbering of a drinking water main pipelines of each neighborhoods and then put the numbers in a bag, then we select only one number.
- Physiochemical test was taken to the same pipeline that chosen randomly from each neighborhoods.

2.6.1- types of tests were used:-

- a) **Field Tests:** samples were tested for physiochemical parameter in the field by using portable digitized devices on each location tested for ((Cl₂ residual free)).
- b) **Laboratory Tests:** at the same time another samples were collected for bacteriological tests by used of a 100 ml completely sterilized containers, (0.1 ml) of sodium thiosulphate solution was added to neutralize the effect of chlorine residual that present in the water sample, the samples was stored at a temperature below 4 °C at a dark place directly after collection.

2-7 Bacteriological Tests:

2.7.1-Total Coliform bacteria (T.C.):-

The Bacteriological examination started after arrival of water samples to the laboratory of Al-Kufa technical institute to detect indicator bacteria. The most probable number (M.P.N/100ml of water) was used for detection of total coliforms bacteria in this study. 3 groups of tubes were inoculated that contain mocConky broth; each group consisted of 5 tubes.

The 1st group contained doubled strength maconky broth. While the 2nd and 3rd groups; contained (10ml) of single strength maconky broth medium, inverted Durham tube was added to all tube of the 3 groups to explore for gas formation. The 3 groups of tubes were inoculated subsequently by (10ml), (1ml), (0.1ml) of water sample then incubated at 37°C for 24 hr. The formation of acid with the gas means a positive result, while the negative tubes for each group were re incubated for another 24 hr. Probable number of coliforms were calculated from a special statistically table, (table 3.1) (21).

2.7.2- Thermotolerant ((fecal)) Coliforms Bacteria:

This test was done to confirm the thermotolerant (fecal) coliforms as a confirmed test as recommended by WHO (22).

3 groups of tubes that contain a single strength of mocConky broth were inoculate by a loop full through making subcultures from tubes that formed of acid and gas, these tubes were incubated at (44C° for 24 hr.) (Only tubes that were formation acid

and gas showed a positive result). Special table was used to obtain the probable number for thermotolerant (fecal) coliforms in 100ml of water.

2.8-Free Chlorine Residual Tests

Portable digital chlorine meter was used to measurement of Cl_2 concentration in drinking water samples in all collection sites.

2.9 -Statistical methods

Descriptive and analytical statistics were carried out by utilizing the statistical package for social science (S.P.S.S) version 17.

t-Test was applied to obtain any significant statistical differences in comparison at level of (0.01) . In addition the (Pearson correlation) was applied between Cl_2 and bacteriological tests.

3. Results

Table (3.1):- Cl_2 and bacteriological values of studied districts

Samples Locations	Free Residual Chlorine (ppm)	Thermotolerant (Fecal) Coliform (at 44°C)
1-Al-Makrama	0.2	52
2-Al-Wafaa	0.5	18
3-Al-Askary 3000	1.5	N.D
4-Al- Melad	0	27
5-Al-Nassir	0.6	14
6-Al- Mohandisen	0.5	N.D
7-Al- Faw althany	0	40
8-Al- Salam	0.7	N.D
9-Al Judaida 4	1.5	N.D
10-Al- Judaida 1	1.2	N.D
11-Al- Judaida 2	1.3	N.D
12-Al- Judaida 3	1.2	N.D
13-Al –Thwora	0	44
14-Al -Shorta	0.7	N.D
15-Al –Mothanna	0.2	241
16-Al-Ishteraky	0.5	254
17-Al-Saad	0.6	183
18-Al- Ansar	0.8	N.D
19-Al- Madina street	0.8	N.D
20-Al- Buraq	0.8	15
21-Al- Rasol street	1	N.D
22-Al- Furat	2	N.D
23-Al- shuhadaa	1	N.D
24-Al -gahder	1.8	N.D
25-Al- iskan	1	N.D
26-Al -ameer	0.21	94

27-Al -qadissia	0.7	14
28-Al zahraa	0.5	16
29-Al -gary	0.8	30
30-Al ulamaa	0.8	N.D
31-Al mualmeen	0.7	15
32-Al hindia	0.7	N.D
33-Al-askary 4000	1.2	N.D
34-Al-askary 5000	1	55
35-Miesain	0.2	35
36-Kinda	0.4	N.D
37-Al- seka	0.8	N.D
38-Al -hussain	0.8	35
39-Al -seha	0.8	N.D
40-Kahn almkhadar	0.8	45
41-Al- melad	0.5	N.D
42-Hanoon	0.21	34
43-Al- mutanabi	0.5	N.D
44-Al -karama	0.8	N.D
45-Al- shurta	0.7	N.D
46-Al- saray	0.3	14
47-Al -mualmen kufa	0.4	N.D
48-Al -gazera	0.5	55
49-Al -kuffa dis.	0.7	N.D
50-Al askary – Kufa	0.4	N.D

*Not Detected <1.8

Table (3.2): The mean value of free chlorine in all drinking water location

All Samples Locations (N=50)	Free Chlorine Mean
	0.716±0.432

samples.

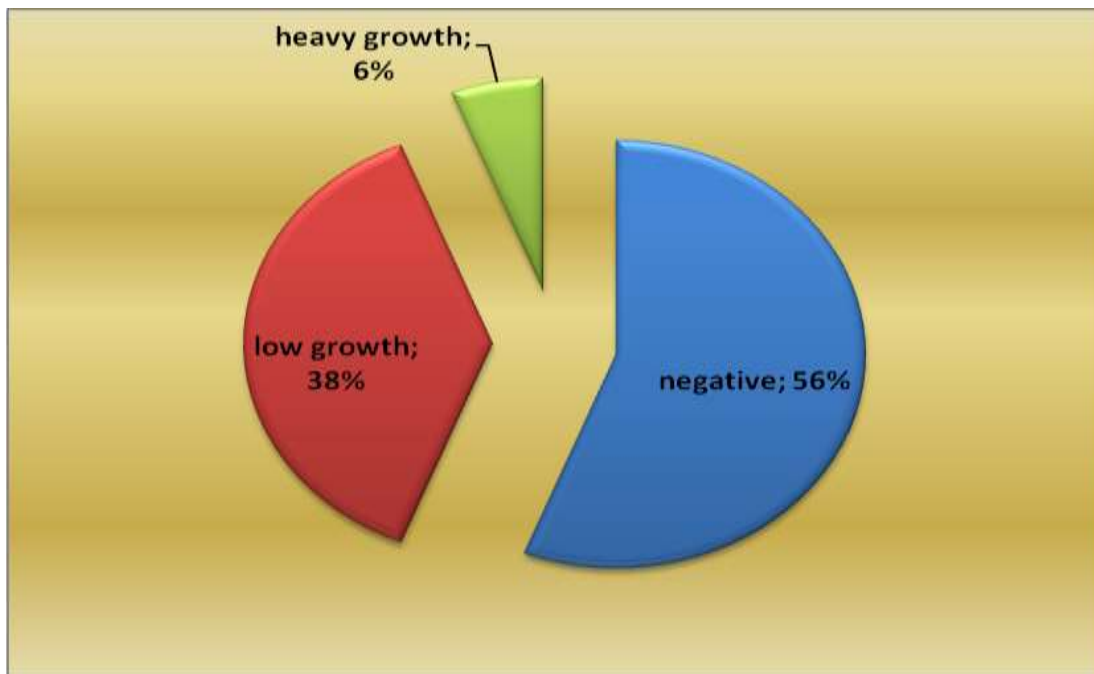
Table (3.3): The mean value of Cl₂ in location samples that showed positive and negative thermotolerant (fecal) coliform (Bacteriological) results.

Free Chlorine Mean	
Positive Bacteriological results (n=22)	Negative Bacteriological results (n=28)
0.478±0.307	0.904±0.428
T = 3.927 P value = 0.001*	

* = (H.S)

Table (3.4): The correlation value between Thermotolerant (fecal) coliform and Free Residual Chlorine in all location samples.

Thermotolerant (fecal) coliform (at 44 C)	Free Residual Chlorine (ppm)
R= - 0.493	



Graph (1):-The Percentage for bacteriological results of Thermotolerant (fecal) coliform in all Location Samples of Al-Najaf and Al-Kufa City.

4. Discussion

When we see thermotolerant (fecal) coliform bacteria in drinking water meaning of presence of pathogenic bacteria as well as presence of virus & different parasites have important role of causing different human diseases⁽¹⁶⁾.

The chlorine (Cl₂) injection system that installed in pollution focuses of the public drinking water treatment plant responsible of determination of the time and quantity of chlorine which were needed for excellent water disinfection, and keeping an acceptable of chlorine residual level at the end point of pipelines in face of changing of pH and temperatures (3).

chemical and bacteriological parameter were used for detection of the pollutant point in the drinking water network of the 50 district in Al-Najaf governorate as recommended by WHO⁽¹²⁾.

In the present study, there was irregularity of free chlorine residual value in different locations; this defect might be due to the low of knowledge especially in target quantity of chlorine that must be added. There was an increase of free chlorine more than (1 ppm); this might be due to the pumping of the chlorinated water in a random way as directly to the distribution network pipelines without using appropriate contact time.

The data of thermotolerant (fecal) coliforms in al-Najaf and Al-Kufa drinking water locations samples represent bacteriological pollution in spite of the precedence of residual chlorine, there was found of many pollution foci of thermotolerant (fecal) coliforms in many locations; this result might be due to the presence of resistant bacteria to the chlorine or treated water was needed of a new standard and technique for chlorine quantity that must to be add. This result was agreement with A.Tavakoli in Iran (12), of the study in 2005, who found that the WHO standards of total chlorine was not enough for killing of all microorganisms in drinking water. The present of coliform indicator bacteria in network system are indicate of there was a leakage present in the network distribution system .(13)

In many locations of samples locations there was presence of thermotolerant coliforms at a highly positive results, this might be due to the effect of sewage system pipelines in some locations or/and a septic tank. The presence of thermotolerant coliforms confirms human related pollution, and there was a source of pollution at these locations.

There was a highly inverse correlated between effects of free chlorine residual on the bacteriological test result, that explain the decreasing of bacteriological test result in increasing of free chlorine residual.

These results were explained by Palamuleni in Delhi, India (10), who showed that there was a relation between increasing addition of chlorine in inhibition of fecal coliform bacteria in drinking water network.

5. Conclusions and Recommendations

5.1- Conclusions:

- 1- The study shows 22 location samples from all samples that giving bacteriological positive results some of them consider a highly positive results that increasing the incidence of communicable and infectious diseases.
- 2- There is a variation in the CL2 levels in all studied locations that gave a clear defect in the performance of the present drinking water treatment plant.
- 3- In most district especially the highly positive needs increasing of CL2 levels more than 1ppm.
- 4- Shortage of professional human resources, equipment of laboratories, reagent supply and methodology and structural imbalance of local laboratories are the negative factors that affect the process of examination and control for drinking water quality.
- 5- There was a highly statistical significant difference between positive and negative of thermotolerant coliform in increasing of free chlorine residual, as well as strongly inverse correlated between Cl_2 and bacteriological tests.

5.2- Recommendations

- 1- Improvement of drinking water network of al-Najaf governorate by installation of Chlorine Injection System Technology (Cl₂ Injector) in all locations (neighborhoods) that gave positive bacteriological results, as a modification and new technique to the present public water system, by another special study in this field with the ultimate aim. This technique injects Cl₂ to the water supply system by jet action. The amount of chlorine can be adjusted electronically and control to the flow of treated water.
- 2- availability of new materials and digitized devices in all laboratories that follow of al-Najaf governorate water office especially laboratories in water treatment plant.
- 3- Establishing emergency program that deals quickly with the bacteriological drinking water contamination when confirmed in any part of community water system.
- 4- Increasing of the efficiency of disinfectant, to reaching from the international limits.

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