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Diagnostic of Water Purity by Using Solar Distiller

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Abstract

In Present research ,the validity of a solar distiller which is made of two parts (a solar tank and a solar distiller) has been tested and distillered the water of one water- trench in Baghdad was treated using this equipment which produced pure water with an average of (1106 ml/m^2 .h) during the day and (222 ml/m^2 .h) at night .The total water produced is thus (1324 ml/m^2 . h) . The laboratorial tests of the samples water before distillation showed that the stream water contained T.P.C/ 1ml =2900 (Total Content Of Bacteria) , T.C/100ml >1600 T.C (Total coli form) , F.C /100 ml>1600 (Fecal Coli Formand) and E. coli /100ml>1600 . The total percentage of salt in water trench before distillation was T.D.S mg/l 1886 \ After water treatment and distillation , the Total Content of Bacteria (T.P.C) was decreased to T.P.C / 1ml = 210 , (Total coli form) T.C /100 ml = Zero , (Fecal Coli Formand) F.C/100ml= Zero and E.coli /100ml = Zero . In and, the total percentage of salt after distillation T.D.S was decreased to 105 mg/l . The results of this research show that water distillation using solar distiller is a successful and efficient process led to decreasing T.C.P 93.8% and killing all types of harmful T.C , F.C. and E. coli bacteria. (By analyzing the samples of sterile water using the solar distiller in the laboratories of the Ministry of Health and Environment- Central Environmental Laboratory as shown in Table (6)).

Keywords: solar distiller, Water Purity, Purification, temperature.

الخلاصة

تم في هذا البحث اختبار مقطر شمسي مصنوع من جزئين (سخان شمسي, مقطر شمسي) حيث تم تقطير ومعالجة مياه احد المبازل في مدينة بغداد بهذا الجهاز الذي انتج ماء مقطر بمعدل (1106)ml/m^2. h نهاراً و (222) ml/m^2. h ليلاً وتكون الانتاجية الكلية (1324) ml/m^2. h الفحوصات المختبرية التي اجريت على نماذج المياه قبل عملية التقطير بينت ان مياه المبزل كانت تحتوي على T.P.C (Total Content Of bacteria) 1ml/ = 2900 T.P.C و **(Total** T.C **coli form) 1600** T.C/100ml > و **(Fecal Coli Formand) F. C** 1600 < F.C / 100ml و > / 100ml **E.coli** 1600 ان نسبة الاملاح الكلية في مياه المبزل قبل الفحص فقد كانت 1886 T.D.S mg/l وبعد عملية التعقيم والمعالجة قل المحتوى الكلي للبكتريا T.P.C (Total Content Of bacteria) /1ml= 210 و T.P.C **(Total coli form)** T.C/100ml = Zero T.C و **(Fecal Coli Formand) F. C** F.C / 100ml = Zero وكذلك **E.coli** / 100ml = Zero اما نسبة الاملاح الكلية T.D.S mg/l قلت الى 105 وهذا يدل على ان عملية التعقيم باستخدام المقطر الشمسي عملية ناجحة وذات كفاءة جيدة ادت الى انخفاض T.C.P بمقدار 93.8 % وادت ايضا الى القضاء بشكل تام على البكتيريا المرضية نوع T.Cو F.C و E.COIL.

Introduction

With the shortage of water in different areas from the world , need of new techniques for treating unhealthy water and making it pure and can be used for drinking and other daily needs there became a An obvious improvement is seen in these techniques especially in terms of water distillation by means of solar energy and increasing the production of pure drinking water from different resources as sea water, water trench drainage systems and other sources [**1**].

The decrease of pure water and problems of drainage systems have bad effects on human health and are considered among the main risk factors which lead to various health problems. Thus, the solution of such problems lies in water purity, which means reduce the germs or bacteria that cause such problems [**2**].

One of the methods or techniques used in purification of water is distillation, which is

considered the best and cheapest method which depends on solar energy systems that can be locally made such as water distillers [**3**] .

Water distillation which is done by these techniques depends on two main principles : The first principle is heating (Pasteurization) in which germs and bacteria are killed in water when temperature water heated to reachs(60 Celsius) for 30 minutes (The subject of sterilization using heating, including pasteurization of ancient techniques used in all regions or in homes and in laboratories and factories has nothing to do with the seasons of the year) [**4**], or (70 Celsius) for 15 minutes , although some bacteria may remain alive but not affecting human health [**5**].The second principle of water distillation however depends on ultra-violet radiation naturally obtained from daily solar radiation with waves length all tapys of ranging from 100 – 400 / nm [**6**]. These waves attack the DNA of bacteria directly and destroy its genetic map in this DNA and consequently , the bacteria will lose its ability to grow and spread [**7**]. The total Ultra – Violet Dose that is required for water purification from all T.C (Total coli form) , F.C (Fecal Coli Formand) , E. Coli and T.P.C. (Total Content of bacteria) ranges between (0.5 – 10.4 mg/cm2) [**8**].

Most studies on water pollution emphasized that the bacteria causing most diseases include E. Coli , Vibrochloreq , Salmonella typhi and other types of Shigella bacteria which caused by unhealthy or improper activities of human beings [**9**] [**10**].

Practical Part

A solar distiller was made for water purification and desalination .It contained the following parts :

1- A water – heater made of a glass basin haveing and four sides , three of which are thermally insulated with dimensions (length 70 cm , width 50 cm and height 100 cm) in addition to a basel which its 5cm thickness. The water heater is surrounded by an anti – oxidation material and painted in black from the inner and outer surface except one side which is not heat resistant facing the south and its controlled by a moveable door containing a reflecting mirror . The mirror is used to increase the solar radiation falling on the heater , which is also considered as a basin for providing the wicking distiller with water .

2- Solar – wicking distiller (basin type) with a glass cover with a 33 degree angle that suits the geographical latitude of Baghdad . This distiller is insulated by cork of 5cm thickness from all sides with the dimensions (length = 70cm , width =60cm) except its glass part . Its base contains 140 cotton wickings (each wicking is of 5 ml diameter) . These wickings help the water to move or transform from the heater to the internal surface of the distiller . This distiller is placed on the surface of the solar heater (as if to be its cover) . The placement of the distiller must be done perfectly in order not to let any water or vapor get out of the system parts (the heater and the distiller).

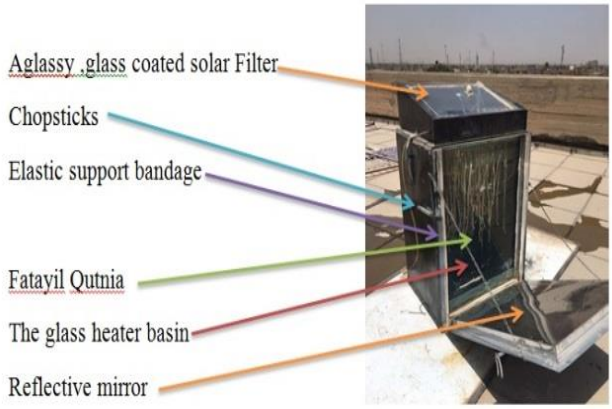

Figure 1: System of the tank and distiller

The distiller is operated by of filling the heater with trench water which brought from one of the streams in Baghdad , specifically from the stream in Sab'a Qusor to the north-east of Baghdad .

Figure 2: Unhealthy water – stream

The solar distiller increases the temperature of water and purifies it .Figure 2 shows the system while it is operating where drops of water are condensed on the internal surface of the glass of the distiller. Also, samples of 100 ml of water were taken before and after distillation process, these samples were analyzed in The Central Health Environment Unit.

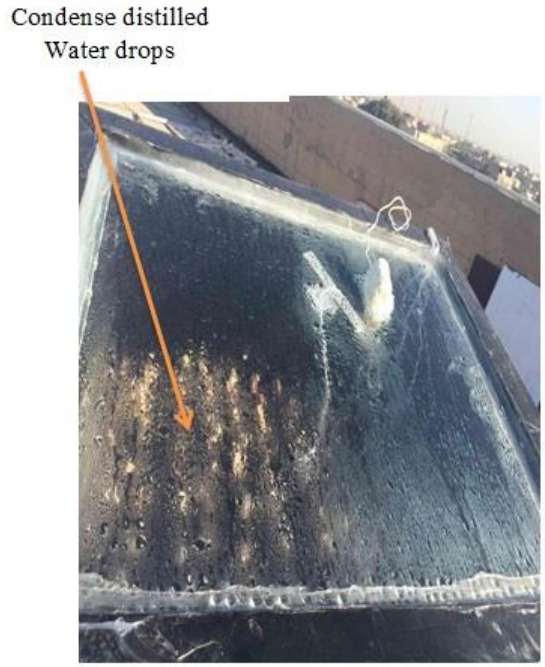

Figure 3 : Solar Distiller

Results and Discussion

The solar distiller produced distilled water with an average of (1106 ml/m^2. h) during the day and (222 ml/m^2 . h) at night . The total water produced every day is (1324 ml/m^2.h) and as presented below in Table 1.
Where the months of March and April are long sufficient to give good results for the pilot drip.

Table (1): The average of day, night and total production of water distiller under experiment.

Days	Water produced in the Distiller during the day(ml/m2 . h)	Water produced in the Distiller at night (ml/m2 . h)	Total water produced Per day (ml/m2 . h)
8th /March/2017	964	193	1157
9th / March/2017	1060	212	1272
14th / March/2017	992	198	1190
15th / March/2017	1059	212	1271
20th / March/2017	997	199	1196
21st / March/2017	1063	213	1276
22nd / March/2017	974	195	1169
27th / March/2017	1117	223	1340
3rd / April/2017	959	199	1194
4th / April/2017	1044	209	1253
5th / April/2017	1091	221	1212
6th / April/2017	1228	246	1474

9th / April/2017	1072	214	1286
10th / April/2017	907	181	1088
16th / April/2017	1203	241	1444
17th / April/2017	1286	258	1544
19th / April/2017	1167	233	1400
20th / April/2017	1354	271	1625
25th / April/2017	1309	262	1571
26th / April/2017	1269	293	1518
	Average = 1106	Average = 222	Average = 1324

The readings of the experimental distiller were taken for 20 random days of March and April in the year 2017. These tests started every day from 8:00 A.M. until 8:00 A.M. the next day according to Baghdad timing. The reading was taken each hour from 8:00 A.M. to 4:00 P.M. and readings stop from 4:00 P.M. to the next morning.

Table (2): The average temperature of water during the operation of the distiller

Time	T1 Celsius	T2 Celsius	T3 Celsius	T4 Celsius	T5 Celsius	T6 Celsius	T7 Celsius	T8 Celsius	T9 Celsius
8:00	28	30	28	33	28	27	26	19	31
9:00	33	38	39	41	29	28	26	19	41
10:00	37	42	44	46	30	29	27	21	48
11:00	40	46	54	52	30	31	28	22	54
12:00	44	49	59	55	31	31	29	24	58
13:00	45	50	60	55	31	32	30	25	59
14:00	44	49	60	54	30	30	31	27	58
15:00	40	46	59	53	28	29	32	27	57
16:00	38	44	57	51	27	27	32	27	56
Average							29 C	23.4 C	51.3 C

T1 is the temperature of the outer glass surface of the distiller
T2 is the temperature of the inner glass surface of the distiller
T3 is the temperature of the inner surface of the distiller
T4 is the temperature of the air-vapor mixture of the distiller
T5 is the temperature of the surface of heater outer glass
T6 is the temperature of the surface of heater inner glass
T7 is the heater water- temperature
T8 is the temperature of the tank water
T9 is the temperature of the wicking.

From Table 2, we notice that the average water temperature in the heater reached 29 Celsius, which is the first stage of heating water for purification. It is also observed that the average of water temperature increased 6 degrees when compared with normal water temperature in the water tank (234 Celsius). In the second stage of distillation, the water temperature reached (51.3 Celsius), which is the temperature of the wicking.

The third stage represents water purification by of ultra-violet radiation. As seen from Table (3) below, the average of ultra-violet radiation falling on the distiller reached (15.7 mg/ cm^2), which is a sufficient amount radiation needed for water purification as seen in Table 4.

Table 3: Ultra – violet Radiation

Days	Highest Ultra – violet Dose	Average of Ultra – violet Dose
8th /March/2017	1.24	0.7
9th / March/2017	1.11	0.7
14th / March/2017	1.33	0.8
15th / March/2017	1.11	0.7
20th / March/2017	1.33	0.8

21st / March/2017	1.24	0.7
22nd / March/2017	0.86	0.6
27th / March/2017	1.33	0.7
3rd / April/2017	1.54	0.8
4th / April/2017	1.59	0.9
5th / April/2017	1.76	1
6th / April/2017	1.46	0.8
9th / April/2017	1.33	0.6
10th / April/2017	1.16	0.7
16th / April/2017	1.89	1.1
17th / April/2017	1.84	1.1
19th / April/2017	1.63	1.1
20th / April/2017	1.89	1.1
25th / April/2017	1.59	1
26th / April/2017	1.71	0.9

Table 4: Ultra – violet disinfection dose requirements for inactivation (mj/cm^2)

Pathogen	1-Log (90%)	2-Log (99%)	3-Log (99.9%)	4-Log (99.99%)
Cryptosporidium parvum	1.3	2.5	4.3	5.7
Giardia lamblia cysts	3	.7	1.3	1.7
Vibrio cholerae	8	1.4	2.2	2.9
Shigella dysenteriae	5	1.2	2	3
Escherichia coli	1.5	2.8	4.1	5.6
Salmonella typhi	1.8 - 2.7	4.1 - 4.8	5.5 – 6.4	7.1 – 8.2
Shigella sonnei	3.2	4.9	6.5	8.2
Salmonella enteritidis	5	7	9	10
Hepatitis A virus	4.1 – 5.5	8.2 - 14	12.3 - 22	16.4–29.6
Polio type 1	4.1 - 6	8.7 - 14	14.2 - 23	21.5 - 30
Coxsackie B5 virus	6.9	13.7	20.6	30
Rotavirus 5 A 11	7.1 – 9.1	14.8 - 19	23 - 25	36

It can be observed that the highest Uv dose during the days of experimentation was 1.89 mj/cm^2 , and this dose is relatively similar to the Uv dose of **Escherichia coli , Total coil form , Fecal coil Formand, and Total Content of Bacteria** which ranges from (0.5 – 10.4 mj/ cm^2) for water purification .

Conclusions and Findings

Both of trench water and distilled water were analyzed in The Central Environmental laboratory. The findings of these tests are presented below in Tables 5 and 6 which respectively show the rate of bacterial content in water before and after purification.

Table 5: Total contents of bacteria before purification.

Test	Method	No.1
T.P.C / 1 ml	Pour Plate	2900
M.P.N of T.C / 100 ml	M.T.F	> 1600
M . P. N of F.C / 100 ml	M.T.F	> 1600
M . P. N of E.Coli / 100 ml	M.T.F	> 1600

Table 6: Total content of bacteria after purification.

Test	Method	No.1 Vapor Water
T.P.C / 1 ml	Pour Plate	210
M.P.N of T.C / 100 ml	M.T.F	ZERO
M . P. N of F.C / 100 ml	M.T.F	ZERO
M . P. N of E.Coli / 100 ml	M.T.F	ZERO

From Table 5, it can be seen that T.P.C/1 ml before purification = 2900 , T.C / 100 ml > 1600 , F.C / 100 ml > 1600 and E.Coli / 100 ml > 1600 , while in Table 6, we find that the T.P.C / 1 ml is decreased to 210. In addition, T.C, F.C and E.Coli had ZERO percent, which means that these types of bacteria were completely killed during water purification.
Tables 7 and 8 respectively show the features of water before and after purification in addition to physical and chemical characteristics.

Table 7: Physical and chemical characteristics of water before Purification.

Parameters PH	Methods	Samples
PH Value	PH meter	8.16
E. (C) us	Conductivity meter	3350
T.D.S mg/l	Gravimetric	1886
T.H. as Ca Co_3 mg/l	Titration	1519
Ca mg/l	Titration	239
Mg mg/l	Calculated	225
CL mg/l	Titration	315
So_4 mg/l	Turbidity metric	760
Po_4 mg/l	Colour metric	2.5
No_3 mg/l	Colour metric	8.8
Na mg/l	Flame photometric	250
K mg/l	Flame photometric	6.5

Table 7 above shows that the percentage of salt (T.D.S mg/l) before purification was very high and is increased to reach 1886, while this percentage is decreased after purification to reach 105 mg/l as seen below in Table 8 .

Table 8: Physical and chemical characteristics of water after Purification

Parameters PH	Methods	Samples
PH Value	PH meter	7.5
E. (C) us	Conductivity meter	310
T.D.S mg/l	Gravimetric	105
T.H. as Ca co_3 mg/l	Titration	16
Ca mg/l	Titration	6
Mg mg/l	Calculated	12
CL mg/l	Titration	18.2
So4 mg/l	Turbidity metric	1.2
Po4 mg/l	Colour metric	0.2
No3 mg/l	Colour metric	4.3
Na mg/l	Flame photometric	12
K mg/l	Flame photometric	0.7

The percent tage of total soluble salts ranged between (1886 mg/l – 105 mg/l) making the value of the variable examaned less than the maximum allowable according to the specification of the world Health organization (1000 – 500 mg/l) shown in the Table 9.

Table 9: Iraqi standards for drinking water and international standards [11]

property	Iraqi standards	WHO specifications
PH Value	6.5 - 8.5	<8
TDS mg/l	-	500-1000
E. (C) us	1500	1530
No_3 mg/l	20	50
Hco_3 mg/l	-	125-350
So_4 mg/l	200	250
CL mg/l	200	250
Ca mg/l	200	75
Mg mg/l	50-150	125
Na mg/l	-	200
K mg/l	-	12

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