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A Comparative Study of Pressure Cooker, Ultra-Violet and RO Methods of Water Purification

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Abstract: In this work, the performances of the pressure cooker method, the ultra-violet method and RO method of water purification is studied. The performance of any method studied here relates to the production of potable water which meets the World Health Organization (WHO) standards. This comparative study is based on underground water obtained from a depth greater than 300 feet. The results showed that all these three methods yield same level of purity.

Key words: Water purification, pressure cooker method, reverse osmosis method, ultra-violet method, potable water.

Introduction

Water-borne diseases take a heavy toll on the health of people living in non- industrialized countries. Diseases such as typhoid, diarrhoea, hepatitis and cholera are quite common in these countries. These diseases arise from bacteria in their drinking water. One can define drinking water or potable water as the water safe enough to be consumed by humans (Sharan, 2014; Drinking water or potable water; Portable water purification).

There are drinking water quality standards which are followed worldwide (Canadian Drinking Water Guidelines; WHO, 1996-2004; De Zuane, 1997; Health Canada). In the under-developed countries, many people live in places where there is no electricity. Due to the lack of electricity, people do not reap the benefits of research and developments in the water purification area. At the same time, these very people, which include many communities even in countries like Canada, do not get a supply of potable water from their municipalities.

As for those who are being supplied water, they may need to re-evaluate their situation based on their health conditions including cholesterol levels or heart problems. If their supply has chlorine which is very common in many municipal water supplies, it (chlorine) may be harmful for their health (World Health Organization, 1996–2004).

In these countries, individual families process drinking water either by boiling it or by using some water purifying machines which are available in the market. However, these machines require electricity which may not be available in rural areas. Based on the above, one can easily distinguish between two categories of people—those who have access to electricity to purify water for drinking and those that do not.

For those who do not have electricity, these water purifying machines are not an option. On the other hand, those who have electricity can use such machines for doing so.

Sharan (2014) carried out a research to establish the feasibility of a method where one can purify water for drinking. However, on a quantitative basis, further research was needed to compare the method discussed

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in Sharan (2014) to yield similar result as those obtained by water purifying machines which are in use presently.

In other words, the present paper primarily addresses the needs of those groups of people who do not have electricity or cannot afford to purchase machines even if electricity is available—to have an alternative option to machines. Before proceeding further, it would be desirable to review briefly a few methods used for water purification including the one mentioned in Sharan (2014).

The method uses a pressure cooker to boil water until one hears the first whistle; then the water is allowed to cool naturally without opening the cover (cooling under pressure) until it reaches room temperature. So, in this method, there are two steps—heating and cooling. While heating, thermal energy is supplied which has associated cost where fuel is consumed whereas the cooling step is free of cost. In this process, one speeds up the process of boiling water due to the use of pressure cooker and consequently, the energy consumption is a fraction of conventional boiling of water. In the cooling process, the energy taken up in converting water to steam in step 1, is recovered because here, the steam is not allowed to escape. Thirdly, by slowing down cooling, the temperature of water which rises to 121 °C in step 1 remains higher than 60 °C, the pasteurization temperature, for longer time than ordinary boiling and cooling of water.

Here, one can use any type of fuel such as natural gas, kerosene, coal, wood, dried leaves etc., i.e. whatever is available in rural areas. In any case, no electricity is needed here.

The paper then compares the results of the bacterial level obtained by this method and those resulting from the use of reverse osmosis (RO) or ultra-violet ray machines (Water Treatment; How Do Reverse Osmosis Filter Systems Work & What Do They Do?).

The idea of comparison of water purity at the same level as those obtained by using machines is to enable poor people who constitute the majority in India and many other countries to enjoy same kind of facility as by others.

RO and Ultra-violet Methods of Water Purification

Water purification with ultraviolet (UV) light is one of the most efficient sanitary methods for eliminating viruses and bacteria from drinking water. The purification includes deactivation of all pathogenic water-borne bacteria and viruses, and also cryptosporidium cysts. The drawback is that it requires constant monitoring of water quality with time.

In reverse osmosis (RO), one uses a semi-permeable membrane. In this method, an applied pressure is used to overcome osmotic pressure. This process can remove many types of molecules and ions from solutions. In this method, the solute (the impurities) is retained on the pressurized side of the membrane and the pure solvent (potable water) is allowed to pass to the other side.

This treatment removes approximately 90 percent of dissolved solids and 98 percent of organic impurities, insoluble matter and microbiological organisms. But this process removes only about 10 percent of ionic impurities and/or dissolved gases (How Do Reverse Osmosis Filter Systems Work & What Do They Do?).

Theoretical Discussions

For the pressure cooker method, one needs to understand properties of water (Holman, 2002; Steam). At an atmospheric pressure (0 bar gauge), water boils at 100 °C, and 419 kJ of energy is required to heat 1 kg of water from 0 °C to its boiling temperature at 100 °C (refer to Figure 1). It is from these figures that the value for the specific heat capacity of water (c_p) of 4.19 kJ/kg °C is derived for most calculations between 0 °C and 100 °C.

When we heat water at constant pressure as in a pressure cooker, the temperature increases from point A to B and the water approaches its boiling condition at B. If the pressure remains constant, adding more heat does not cause the temperature to rise but causes the water to form a saturated steam. The temperature and pressure of the boiling water and saturated steam within the same system is the same, but the heat energy per unit mass (enthalpy) is much greater in the saturated steam.

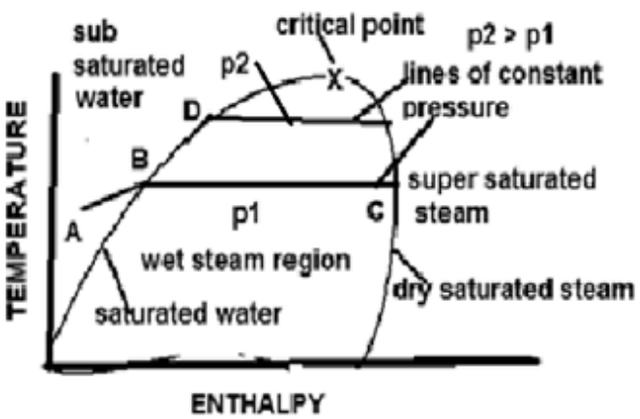

Figure 1: Temperature enthalpy diagram.

At the atmospheric pressure, the saturation temperature is 100 °C. However, if the pressure is increased, this will allow the addition of more heat and an increase in temperature will result without a change of phase. As the water in the pressure cooker is boiled, steam starts generating at 100 °C but supplying more heat results in the increase in pressure and a corresponding increase in temperature results as per Figure 2. Therefore, increasing the pressure effectively increases both the enthalpy of water and the saturation temperature. The relationship between the saturation temperature and the pressure is known as the steam saturation curve (Figure 2).

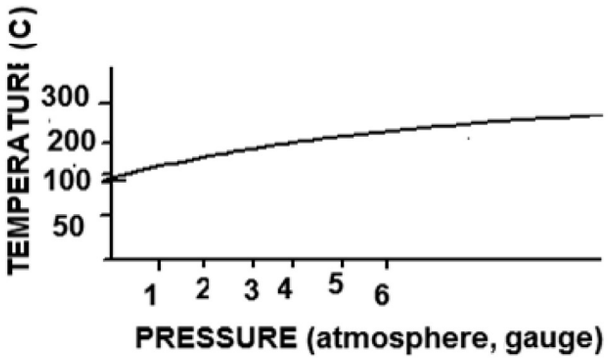

Figure 2: Variation of steam saturation curve.

If the steam is restrained from leaving the boiler, and the heat input rate is maintained, the energy flowing into the boiler will be greater than the energy flowing out. This excess energy raises the pressure, in turn allowing the saturation temperature to rise, as the temperature of saturated steam correlates to its pressure.

Enthalpy of evaporation or latent heat is the amount of heat required to change the state of water at its boiling temperature, into steam. It involves no change in the temperature of the steam/water mixture, and all the energy is used to change the state from liquid (water) to vapour (saturated steam).

In the process suggested here, we are carrying out the process at 121 °C. The weight in the pressure cooker causes this increase in pressure or the temperature from 100 °C to 121 °C. The destruction of the bacteria or virus is dependent upon temperature, pressure and time.

Water has a very high specific heat capacity (4.187 kJ/kgK) – the second highest among all the hetero-atomic species (after ammonia), as well as high heat of vaporization (40.65 kJ/mol or 2257 kJ/kg at the normal boiling point), both of which are a result of the extensive hydrogen bonding between its molecules.

In the ordinary boiling method, we continuously supply heat where steam is continuously formed and much of it leaves. Otherwise, the pressure will increase. The steam that leaves carries away the energy supplied. However, in the pressure cooker method, the steam condenses within the cooker. So when naturally cooled, the water temperature is maintained at a higher value due to the latent heat of condensation. Secondly, the temperature which is needed to kill bacteria etc. is maintained for a lot longer without supplying energy due to a slow cooling.

Thirdly, the system is sealed while cooling without air getting into the water. In the pasteurization process, the French chemist and microbiologist Louis found out experimentally that it is sufficient to heat a young wine to only about 50–60 °C (122–140 °F) for a brief time to kill the microbes, and that the wine could be nevertheless properly aged without sacrificing the final quality.

If we combine the information about (a) specific heat, (b) a vaporized heat, and (c) the sufficiency of the process at 60 °C, it would be quite beneficial if we reach the temperature of 121 °C (the boiling point of water) at 1 atmosphere gauge in the pressure cooker (the boiling point increases with the increase in pressure) and cools slowly thereby remaining above 60 °C for a longer time without consuming the vaporized energy which is quite high for water. By remaining at a higher temperature, the viruses also get eliminated. This principle of saving energy and time can be tested through experimentation.

The fact to be noted here is that the water is heated in the pressure cooker only until the third whistle blows which ensures reaching 121 °C. The process of slow cooling can be done in still air or by insulating the pressure cooker. This therein ensures that the loss of heat occurs at a slow rate without any cost. One should note the difference between heating process in this work and that in Sharan (2014), here, one has to heat until one hears the third whistle instead of just one. This difference was selected to compete with the performances of the commercial machines.

Experimentation and Results

The experiments were carried out at Patna, India on two different sources of underground water from below 300 feet in each of the cases. Figures 3 and 4 show the machines used in the experiments.

Tables 1 to 3 show the results of water analysis from Source 1. Table 1 shows the results of the analysis of un-treated water. The bacteriological test result

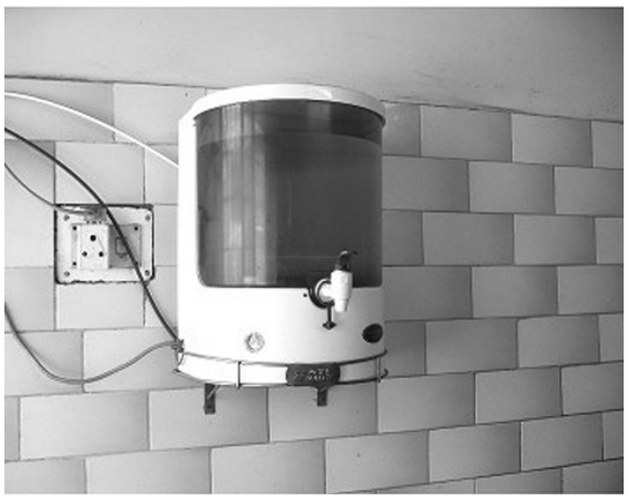

Figure 3: The RO machine.

Figure 4: Ultra-violet machine.

(shown towards the bottom) indicates that this water is not suitable for drinking. This conclusion is based on the number (12.3) which is greater than 10 as per the WHO (World Health Organization) standards. Table 2 shows the results obtained by the RO method and Table 3 – using the pressure cooker method where water was heated until three whistles were heard and then allowed to cool naturally without releasing the pressure. There was no filtering done in this third case as the objective here was to control the water-borne diseases in accordance with the accepted standards. In the pressure cooker method, we just wanted to see whether the treatment was sufficient to produce potable water from the bacterial point of view.

The results in Tables 2 and 3 show that both processes are equally effective in destroying bacteria. Hence, the coliform problem goes away (coliform is absent) with treatment in the pressure cooker.

Table 4 shows the results of both the chemical and biological analysis of untreated Source 2 water. It shows that the Source 2 water, without any treatment, is not fit for drinking. Table 5 shows results of the ultra-violet method of bacteria removal and Table 6 shows results from the pressure cooker treatment. Tables 5 and 6 show that they meet the specifications.

The method using the pressure cooker is the only practical method in situations like floods, earthquakes, refugee camps etc. where people affected are large in number and no electricity supply is available. Finally, in the pressure cooker method, it is desirable to filter the water first and then boil it. These filters can be purchased separately.

Additional Considerations in Using These Methods

First of all comes the cost. This pressure cooker method addresses the needs of poor and their ability to acquire a means to purify drinking water. Both, the RO and ultraviolet machines require far heavier initial capital than a pressure cooker. So, these machines are beyond the affordability of such people. Secondly, many such people do not have electricity which makes it impossible for them to have such machines. Thirdly, portability is an advantage with pressure cookers as many of these people move around from place to place in search of work.

When one goes from the first to the third whistle, higher water temperature is maintained for longer time than going for first whistle only.

The third point is that when heated in a pressure cooker, the steam generated does not leave the system which during the slow cooling stage gives off the latent heat which is large and keeps higher water temperature for longer time. This way, large amount of thermal energy is recovered in this phase transformation (steam condensation). In contrast, in ordinary boiling larger amount of steam is lost along with its high heat content.

Conclusions

In this work, the energy saving pressure cooker method of water purification was discussed in detail. To illustrate

Table 1: Results of untreated water analysis from Source 1

STATE LEVEL WATER TESTING LABORATORY(SLWTL),
PHED, GOVT. OF BIHAR,
CHHAJJUBAGH, PATNA-800001
(Technical Consultancy by-Scientific Research Laboratory)

TEST CERTIFICATE

Report No:-PHE/Patna-DWfeb/D/Pat/14-3	**Date of Reporting:-** 24/02/2014
Name of the Organisation/ Person:-Mr. Anand Mohan saran	
Ref.Memo No:NM	**Sample Received on:-**17/02/2014
Location: -NM	**Source of Sample:-** Sample-03
Date of Sampling :-17/02/2014	
Sample Collected By :-sample not collected by us	

PHYSICO-CHEMICAL TEST REPORT

Sl.No.	Parameters	Desirable Limit*	Permissible Limit* in absence of alternate source	Method of Testing Parameters	Result
1	Colour, Hazen unit, Max	5.0	25.0	3025(part4)	7.0
2	Odour	Unobjectionable	Unobjectionable	3025(part5)	Odourless
3	PH Value	6.5-8.5	No relaxation	3025(part 10):1984	7.8
4	Turbidity,NTU,Max	5.0	10.0	3025(part II):1985	1.8
5	Total Dissolved Solid,mg/l,Max.	500.0	2000.0	3025(part 16):1984	235.0
6	Total Hardness(asCaCO3), mg/l,Max	300.0	600.0	3025(part 21):1983	287.0
7	Calcium(as Ca),mg/l,Max	75.0	200.0	3025(part 40):1991	71.0
8	Magnessium(as Mg), mg/l,Max	30.0	100.0	IS 3025:1964	21.0
9	Chloride(as Cl),mg/l, Max.	250.0	1000.0	3025(part 32):1988	82.0
10	Alkalinity(as CaCO3),mg/l,Max.	200.0	600.0	13 of3025:1964	209.0
11	Iron(as Fe),mg/l,Max.	0.3	1.0	32 of3025:1964	0.090
12	Nitrate(as NO3),mg/l,Max.	45.0	No relaxation	3025(part 34):1988	BDL
13	Sulphate(as SO4),mg/l,Max.	200.0	400.0	3025(part 24):1986	4.74
14	Fluoride(as F),mg/l,Max.	1.0	1.5	23 of3025:1964	BDL
15	Arsenic(as As),mg/l,Max.	0.01	No relaxation	3025(part 37):1988	BDL

Note:-(1) * Drinking Water Specification First Revision -IS:10500:1991,Edition 2.2(2003-09)(Reaffirmed1993)
(2)BDL means Below Detection Limit
(3) All the testing parameters methods are taken by APHA 20th Edition

BACTERIOLOGICAL TEST REPORT

Sl.No.	Parameters	Permissible Limit	Method of Testing Parameters	Result
1	Coliform Organisms,MPN/100ml	**	M-Test-Tube Technique	>12.0

**(a) Throughout any year, 95% of the samples should not contain coliform organisms in 100ml
(b) No sample should contain more than 10 coliform ognanismd per 100ml
(c) Coliform organisms should not be detected in 100ml of any two consecutive samples

Note: **The sample contains high coliform organisms. Hence it is not fit for drinking purposes. The water shall be disinfected by suitable treatment.**

Lab Incharge,
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Chhajubagh,
Patna-800001

Table 2: Results of RO machine treated water from Source 1

STATE LEVEL WATER TESTING LABORATORY(SLWTL),
PHED, GOVT. OF BIHAR,
CHHAJJUBAGH, PATNA-800001
(Technical Consultancy by-Scientific Research Laboratory)

TEST CERTIFICATE

Report No:-PHE/Patna-DWfeb/D/Pat/14-4	**Date of Reporting:-** 24/02/2014
Name of the Organisation/ Person:-Mr. Anand Mohan saran	
Ref.Memo No:NM	**Sample Received on:-**17/02/2014
Location: -NM	**Source of Sample:-** Sample-04
Date of Sampling :-17/02/2014	
Sample Collected By :-sample not collected by us	

PHYSICO-CHEMICAL TEST REPORT

Sl.No.	Parameters	Desirable Limit*	Permissible Limit* in absence of alternate source	Method of Testing Parameters	Result
1	Colour, Hazen unit, Max	5.0	25.0	3025(part4)	5.0
2	Odour	Unobjectionable	Unobjectionable	3025(part5)	Odourless
3	PH Value	6.5-8.5	No relaxation	3025(part 10):1984	7.0
4	Turbidity,NTU,Max	5.0	10.0	3025(part II):1985	1.1
5	Total Dissolved Solid,mg/l,Max.	500.0	2000.0	3025(part 16):1984	120.0
6	Total Hardness(asCaCO3), mg/l,Max	300.0	600.0	3025(part 21):1983	203.0
7	Calcium(as Ca),mg/l,Max	75.0	200.0	3025(part 40):1991	46.0
8	Magnessium(as Mg), mg/l,Max	30.0	100.0	IS 3025:1964	22.0
9	Chloride(as Cl),mg/l, Max.	250.0	1000.0	3025(part 32):1988	36.0
10	Alkalinity(as CaCO3),mg/l,Max.	200.0	600.0	13 of3025:1964	166.0
11	Iron(as Fe),mg/l,Max.	0.3	1.0	32 of3025:1964	0.082
12	Nitrate(as NO3),mg/l,Max.	45.0	No relaxation	3025(part 34):1988	BDL
13	Sulphate(as SO4),mg/l,Max.	200.0	400.0	3025(part 24):1986	3.22
14	Fluoride(as F),mg/l,Max.	1.0	1.5	23 of3025:1964	BDL
15	Arsenic(as As),mg/l,Max.	0.01	No relaxation	3025(part 37):1988	BDL

Note:-(1) * Drinking Water Specification First Revision -IS:10500:1991,Edition 2.2(2003-09)(Reaffirmed1993)
(2)BDL means Below Detection Limit
(3) All the testing parameters methods are taken by APHA 20th Edition

BACTERIOLOGICAL TEST REPORT

Sl.No.	Parameters	Permissible Limit	Method of Testing Parameters	Result
1	Coliform Organisms,MPN/100ml	**	M-Test-Tube Technique	<1.1

**(a) Throughout any year, 95% of the samples should not contain coliform organisms in 100ml
(b) No sample should contain more than 10 coliform ognanismd per 100ml
(c) Coliform organisms should not be detected in 100ml of any two consecutive samples

Note: **The water is fit for drinking purposes.**

Lab Incharge,
SLWTL,PHED, Govt.of Bihar,
Chhajjubagh,
Patna-800001

Table 3: Results of pressure cooker treated water from Source 1

STATE LEVEL WATER TESTING LABORATORY(SLWTL),
PHED, GOVT. OF BIHAR,
CHHAJJUBAGH, PATNA-800001
(Technical Consultancy by-Scientific Research Laboratory)

TEST CERTIFICATE

Report No:-PHE/Patna-DWfeb/D/Pat/14-2	**Date of Reporting:-** 24/02/2014
Name of the Organisation/ Person:-Mr. Anand Mohan saran	
Ref.Memo No:NM	**Sample Received on:-**17/02/2014
Location: -NM	**Source of Sample:-** Sample-02
Date of Sampling :-17/02/2014	
Sample Collected By :-sample not collected by us	

PHYSICO-CHEMICAL TEST REPORT

Sl.No.	Parameters	Desirable Limit*	Permissible Limit* in absence of alternate source	Method of Testing Parameters	Result
1	Colour, Hazen unit, Max	5.0	25.0	3025(part4)	5.0
2	Odour	Unobjectionable	Unobjectionable	3025(part5)	Odourless
3	PH Value	6.5-8.5	No relaxation	3025(part 10):1984	7.1
4	Turbidity,NTU,Max	5.0	10.0	3025(part II):1985	1.2
5	Total Dissolved Solid,mg/l,Max.	500.0	2000.0	3025(part 16):1984	122.0
6	Total Hardness(asCaCO3), mg/l,Max	300.0	600.0	3025(part 21):1983	211.0
7	Calcium(as Ca),mg/l,Max	75.0	200.0	3025(part 40):1991	54.0
8	Magnessium(as Mg), mg/l,Max	30.0	100.0	IS 3025:1964	24.0
9	Chloride(as Cl),mg/l, Max.	250.0	1000.0	3025(part 32):1988	38.0
10	Alkalinity(as CaCO3),mg/l,Max.	200.0	600.0	13 of3025:1964	172.0
11	Iron(as Fe),mg/l,Max.	0.3	1.0	32 of3025:1964	0.073
12	Nitrate(as NO3),mg/l,Max.	45.0	No relaxation	3025(part 34):1988	BDL
13	Sulphate(as SO4),mg/l,Max.	200.0	400.0	3025(part 24):1986	3.71
14	Fluoride(as F),mg/l,Max.	1.0	1.5	23 of3025:1964	BDL
15	Arsenic(as As),mg/l,Max.	0.01	No relaxation	3025(part 37):1988	BDL

Note:-(1) * Drinking Water Specification First Revision -IS:10500:1991,Edition 2.2(2003-09)(Reaffirmed1993)
(2)BDL means Below Detection Limit
(3) All the testing parameters methods are taken by APHA 20th Edition

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Sl.No.	Parameters	Permissible Limit	Method of Testing Parameters	Result
1	Coliform Organisms,MPN/100ml	**	M-Test-Tube Technique	<1.1

**(a) Throughout any year, 95% of the samples should not contain coliform organisms in 100ml
(b) No sample should contain more than 10 coliform ognanismd per 100ml
(c) Coliform organisms should not be detected in 100ml of any two consecutive samples

Note: **The water is fit for drinking purposes.**

Lab Incharge,
SLWTL,PHED, Govt of Bihar,
Chhajjubagh,
Patna-800001

Table 4: Results of untreated water analysis from Source 2

STATE LEVEL WATER TESTING LABORATORY(SLWTL),
PHED, GOVT. OF BIHAR,
CHHAJJUBAGH, PATNA-800001
(Technical Consultancy by-Scientific Research Laboratory)

TEST CERTIFICATE

Report No:-PHE/Patna-DWfeb/D/Pat/14-5	**Date of Reporting:-** 24/02/2014
Name of the Organisation/ Person:-Mr. Anand Mohan saran	
Ref.Memo No:NM	**Sample Received on:-**17/02/2014
Location: -NM	**Source of Sample:-** Sample-05
Date of Sampling :-17/02/2014	
Sample Collected By :-sample not collected by us	

PHYSICO-CHEMICAL TEST REPORT

Sl.No.	Parameters	Desirable Limit*	Permissible Limit* in absence of alternate source	Method of Testing Parameters	Result
1	Colour, Hazen unit, Max	5.0	25.0	3025(part4)	8.0
2	Odour	Unobjectionable	Unobjectionable	3025(part5)	Odourless
3	PH Value	6.5-8.5	No relaxation	3025(part 10):1984	7.9
4	Turbidity,NTU,Max	5.0	10.0	3025(part II):1985	1.7
5	Total Dissolved Solid,mg/l,Max.	500.0	2000.0	3025(part 16):1984	244.0
6	Total Hardness(asCaCO3), mg/l,Max	300.0	600.0	3025(part 21):1983	293.0
7	Calcium(as Ca),mg/l,Max	75.0	200.0	3025(part 40):1991	73.0
8	Magnessium(as Mg), mg/l,Max	30.0	100.0	IS 3025:1964	24.0
9	Chloride(as Cl),mg/l, Max.	250.0	1000.0	3025(part 32):1988	83.0
10	Alkalinity(as CaCO3),mg/l,Max.	200.0	600.0	13 of3025:1964	211.0
11	Iron(as Fe),mg/l,Max.	0.3	1.0	32 of3025:1964	0.082
12	Nitrate(as NO3),mg/l,Max.	45.0	No relaxation	3025(part 34):1988	BDL
13	Sulphate(as SO4),mg/l,Max.	200.0	400.0	3025(part 24):1986	4.61
14	Fluoride(as F),mg/l,Max.	1.0	1.5	23 of3025:1964	BDL
15	Arsenic(as As),mg/l,Max.	0.01	No relaxation	3025(part 37):1988	BDL

Note:-(1) * Drinking Water Specification First Revision -IS:10500:1991,Edition 2.2(2003-09)(Reaffirmed1993)
(2)BDL means Below Detection Limit
(3) All the testing parameters methods are taken by APHA 20th Edition

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Sl.No.	Parameters	Permissible Limit	Method of Testing Parameters	Result
1	Coliform Organisms,MPN/100ml	**	M-Test-Tube Technique	>9.2

**(a) Throughout any year, 95% of the samples should not contain coliform organisms in 100ml
(b) No sample should contain more than 10 coliform ognanismd per 100ml
(c) Coliform organisms should not be detected in 100ml of any two consecutive samples

Note: **The sample contains high coliform organisms. Hence it is not fit for drinking purposes. The water shall be disinfected by suitable treatment.**

Lab Incharge,
SLWTL,PHED, Govt.of
Bihar,
Chhajjubagh,
Patna-800001

Table 5: Results of ultra-violet machine treated water from Source 2

STATE LEVEL WATER TESTING LABORATORY(SLWTL),
PHED, GOVT. OF BIHAR,
CHHAJJUBAGH, PATNA-800001
(Technical Consultancy by-Scientific Research Laboratory)

TEST CERTIFICATE

Report No:-PHE/Patna-DWfeb/D/Pat/14-4	**Date of Reporting:-** 24/02/2014
Name of the Organisation/ Person:-Mr. Anand Mohan saran	
Ref.Memo No:NM	**Sample Received on:-**17/02/2014
Location: -NM	**Source of Sample:-** Sample-04
Date of Sampling :-17/02/2014	
Sample Collected By :-sample not collected by us	

PHYSICO-CHEMICAL TEST REPORT

Sl.No.	Parameters	Desirable Limit*	Permissible Limit* in absence of alternate source	Method of Testing Parameters	Result
1	Colour, Hazen unit, Max	5.0	25.0	3025(part4)	5.0
2	Odour	Unobjectionable	Unobjectionable	3025(part5)	Odourless
3	PH Value	6.5-8.5	No relaxation	3025(part 10):1984	7.0
4	Turbidity,NTU,Max	5.0	10.0	3025(part II):1985	1.1
5	Total Dissolved Solid,mg/l,Max.	500.0	2000.0	3025(part 16):1984	120.0
6	Total Hardness(asCaCO3), mg/l,Max	300.0	600.0	3025(part 21):1983	203.0
7	Calcium(as Ca),mg/l,Max	75.0	200.0	3025(part 40):1991	46.0
8	Magnessium(as Mg), mg/l,Max	30.0	100.0	IS 3025:1964	22.0
9	Chloride(as Cl),mg/l, Max.	250.0	1000.0	3025(part 32):1988	36.0
10	Alkalinity(as CaCO3),mg/l,Max.	200.0	600.0	13 of3025:1964	166.0
11	Iron(as Fe),mg/l,Max.	0.3	1.0	32 of3025:1964	0.082
12	Nitrate(as NO3),mg/l,Max.	45.0	No relaxation	3025(part 34):1988	BDL
13	Sulphate(as SO4),mg/l,Max.	200.0	400.0	3025(part 24):1986	3.22
14	Fluoride(as F),mg/l,Max.	1.0	1.5	23 of3025:1964	BDL
15	Arsenic(as As),mg/l,Max.	0.01	No relaxation	3025(part 37):1988	BDL

Note:-(1) * Drinking Water Specification First Revision -IS:10500:1991,Edition 2.2(2003-09)(Reaffirmed1993)
(2)BDL means Below Detection Limit
(3) All the testing parameters methods are taken by APHA 20th Edition

BACTERIOLOGICAL TEST REPORT

Sl.No.	Parameters	Permissible Limit	Method of Testing Parameters	Result
1	Coliform Organisms,MPN/100ml	**	M-Test-Tube Technique	<1.1

**(a) Throughout any year, 95% of the samples should not contain coliform organisms in 100ml
(b) No sample should contain more than 10 coliform ognanismd per 100ml
(c) Coliform organisms should not be detected in 100ml of any two consecutive samples

Note: **The water is fit for drinking purposes.**

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Chhajjubagh,
Patna-800001

Table 6: Results of pressure cooker treated water from Source 2

STATE LEVEL WATER TESTING LABORATORY(SLWTL),
PHED, GOVT. OF BIHAR,
CHHAJJUBAGH, PATNA-800001
(Technical Consultancy by-Scientific Research Laboratory)

TEST CERTIFICATE

Report No:-PHE/Patna-DWfeb/D/Pat/14-4	**Date of Reporting:-** 24/02/2014
Name of the Organisation/ Person:-Mr. Anand Mohan saran	
Ref.Memo No:NM	**Sample Received on:-**17/02/2014
Location: -NM	**Source of Sample:-** Sample-04
Date of Sampling :-17/02/2014	

Sample Collected By :-sample not collected by us

PHYSICO-CHEMICAL TEST REPORT

Sl.No.	Parameters	Desirable Limit*	Permissible Limit* in absence of alternate source	Method of Testing Parameters	Result
1	Colour, Hazen unit, Max	5.0	25.0	3025(part4)	5.0
2	Odour	Unobjectionable	Unobjectionable	3025(part5)	Odourless
3	PH Value	6.5-8.5	No relaxation	3025(part 10):1984	7.0
4	Turbidity,NTU,Max	5.0	10.0	3025(part II):1985	1.1
5	Total Dissolved Solid,mg/l,Max.	500.0	2000.0	3025(part 16):1984	120.0
6	Total Hardness(asCaCO3), mg/l,Max	300.0	600.0	3025(part 21):1983	203.0
7	Calcium(as Ca),mg/l,Max	75.0	200.0	3025(part 40):1991	46.0
8	Magnessium(as Mg), mg/l,Max	30.0	100.0	IS 3025:1964	22.0
9	Chloride(as Cl),mg/l, Max.	250.0	1000.0	3025(part 32):1988	36.0
10	Alkalinity(as CaCO3),mg/l,Max.	200.0	600.0	13 of3025:1964	166.0
11	Iron(as Fe),mg/l,Max.	0.3	1.0	32 of3025:1964	0.082
12	Nitrate(as NO3),mg/l,Max.	45.0	No relaxation	3025(part 34):1988	BDL
13	Sulphate(as SO4),mg/l,Max.	200.0	400.0	3025(part 24):1986	3.22
14	Fluoride(as F),mg/l,Max.	1.0	1.5	23 of3025:1964	BDL
15	Arsenic(as As),mg/l,Max.	0.01	No relaxation	3025(part 37):1988	BDL

Note:-(1) * Drinking Water Specification First Revision -IS:10500:1991,Edition 2.2(2003-09)(Reaffirmed1993)
(2)BDL means Below Detection Limit
(3) All the testing parameters methods are taken by APHA 20th Edition

BACTERIOLOGICAL TEST REPORT

Sl.No.	Parameters	Permissible Limit	Method of Testing Parameters	Result
1	Coliform Organisms,MPN/100ml	**	M-Test-Tube Technique	<1.1

**(a) Throughout any year, 95% of the samples should not contain coliform organisms in 100ml
(b) No sample should contain more than 10 coliform ognanismd per 100ml
(c) Coliform organisms should not be detected in 100ml of any two consecutive samples

Note: **The water is fit for drinking purposes.**

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its use, experiments were conducted on two sources of ground water which did not meet the WHO standards of drinking water. Water from these two sources was purified using: (a) the pressure cooker method, (b) the RO method, and (c) the ultra-violet method.

The results of the pressure cooker method as discussed in this paper where one heats until three whistles are heard, showed that it performs equally well as two other accepted and commonly used (RO and ultra-violet) methods of water purification.

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Calendar of Events

2nd International Conference on Advances in Environment Research (ICAER 2016)
7th to 9th July 2016
Shanghai, China
Website: http://www.icaer.org/
Contact person: Ms. Lydia Liu
Organized by: CBEES

SDC 2016 - 4th Annual Sustainable Development Conference
7th to 9th July 2016
Kuching, Sarawak, Malaysia
Website: http://www.sdconference.org
Contact person: Vladimir Ilic
Organized by: Tomorrow People Organization

Environmental Science, Technology, and Business Conference
14th July 2016
Washington DC, United States of America
Website: http://www.advenaworld.com/environmental-science---business-.html
Contact person: Eric Schwartz
Organized by: Advena World

International Congress on Water, Waste and Energy Management
18th to 20th July 2016
Rome, Italy
Website: http://www.waterwaste.skconferences.com/
Contact person: Mónica Martins

International Conference on Geology and Geophysics
25th to 27th July 2016
Barcelona, Spain
Website: http://www.istdst.org/PSS
Contact person: Conference Secretariat

International Conference on Water Pollution and Treatment (ICWPT 2016)
25th to 27th July 2016
Kuala Lumpur, Malaysia
Website: http://www.icwpt.net/
Contact person: Ms. Lydia Liu
Organized by: CBEES

3rd Journal Conference on Environmental Science and Development (JCESD 2016)
14th to 16th August 2016
Porto, Portugal
Website: http://www.ijesd.org/jcesd/3rd/
Contact person: JCESD
Organized by: CBEES

International Civil, Architectural and Environmental Engineering Research Congress (CAEERC-16)
22nd to 24th August 2016
Kuala Lumpur, Malaysia
Website: http://earcee.org/conference/CAEERC-16
Contact person: Eva Thomas
Organized by: Eminent Association of Researchers in Civil & Environmental Engineering

3rd International Conference on Fisheries and Aquaculture (ICFA 2016)
24th to 25th August 2016
Negombo, Sri Lanka
Website: http://aquaconference.com/
Contact person: Mr Arun Francis
Organized by: TIIKM Conferences