Journal of Scientific Research ISSN 0555-7674
Vol. XXXVIII No. 2, December, 2008

REMOVAL OF BACTERIOLOGICAL CONTAMINATION FROM DRINKING WATER USING UV TECHNIQUE

***M.Tahir Butt, **Makshoof Ather , *Ammarah Habib, *Naz Imtiaz, *Tahira Shafique**

*Centre for Environmental Protection Studies, PCSIR Labs. Complex, Lahore
**Institute of chemistry, University of the Punjab, Lahore

Abstract: In this study 36 samples were collected from different points and characterized microbiologically for the identification of pollutants and then to devise a useful method to treat these samples for the removal of contaminants using UV source to avoid health risks. The tool could bolster efforts to use UV light to improve the quality and safety of tap water. It is more cost effective to use these processes for only purposes such as toxicity reduction and removal of micro pollutants. However, the most important point is the optimization of the reaction conditions for the process of concern. Most of the samples were characterized for the viable count, total coli forms per 100 ml and E.coli/ml. All samples were 100 % polluted by viable count and total coli form, 2% samples were polluted by E.coli and coliforms.

It is a well-known fact that clean water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all human beings. Yet it has been observed that millions of people worldwide are deprived of this. Fresh water resources all over the world are threatened not only by over exploitation and poor management but also by ecological degradation. The main source of freshwater pollution can be attributed to discharge of untreated waste, dumping of industrial effluents, and run off from agricultural fields; industrial growth, urbanization and the increasing use of synthetic organic substances have serious and adverse impacts on freshwater bodies.

It is generally accepted fact that the developed countries suffer from problems of chemicals discharged into the water sources main ground water while developing countries face problems of agricultural run off in water sources. Polluted water like chemicals in drinking water causes problems to health and leads to water borne diseases which can be prevented by taking measures. Measures can be taken even at the household level.

Water borne diseases are infectious diseases spread primarily through contaminated water. Though these diseases are spread either directly or through flies or filth, water is the chief medium for spread of these diseases and hence they are termed as water borne diseases. Most intestinal diseases are infectious and are transmitted through faecal waste. Pathogens which include virus, bacteria, protoza and parasitic worms are disease producing agents found in the feces of infected persons. These diseases are more prevalent in areas with poor sanitary conditions. These pathogens travel through water sources and interfuses directly through persons handling food and water. The reason to plan this study was as in the last year and present year two incidents took place in Karachi and Faisalabad due to

1-For Proof and Correspondence: **M. Tahir Butt**

microbial contamination a large population was affected. The UV-applications range from primary disinfection prior to marginal chlorination and sole treatment where water is of high quality and where regulations do not impose a residual treatment (1- 2). There is a need to preserve the quality of available water resources. UV-oxidation is gaining in popularity as a multi-functional part of a water treatment process that can provide both disinfection and treatment of chemical contaminants (2-3). To achieve high-quality water; many applications require a variety of treatment steps. Such as air stripping for volatile organic compounds, biological treatment and UV for the removal of different pollutants. In addition, the need to disinfect groundwater is underscored "Although ground water has historically been thought to be free of microbial contamination, recent research indicates that some ground waters are a source microbial contamination of waterborne disease (4).Cryptosporidium is the leading cause of waterborne disease in people. UV treatment may effectively lower Cryptosporidium levels in drinking water (5) .The effects of this microbial contamination can be especially serious for sensitive subpopulations such as the elderly or young children. Without adequate disinfection, these deadly microbial contaminants remained in the distribution system. This tragedy underscores the importance of disinfection of groundwater, both primary disinfection and residual disinfections (3). Chemical contamination of source waters has become an issue. The sources of chemicals in the water supply are varied. Watersheds are under pressure from industry, agriculture, animal feeding operations, and wastewater discharge, among many other sources. In treating chemical contaminants with UV, there are two photochemical processes UV-photolysis and UV-oxidation. UV-photolysis involves UV light alone; UV-oxidation requires the addition of hydrogen peroxide (8-12). UV-photolysis is the process by which chemical bonds of the contaminants are broken by the energy associated with UV light. When light is incident on an object, the photons may be reflected, transmitted, or absorbed. When UV photons enter a medium, they are both transmitted and absorbed by the medium and its constituents (dissolved species including organic and inorganic substances). Photons that are absorbed may initiate a photolysis reaction. A contaminant molecule will undergo the photolysis reaction if the contaminant molecules in water are capable of absorbing UV photons and if the energy holding the chemical bonds in the molecule together is less than the energy of the UV photons absorbed. UV-oxidation is a photochemical process that breaks down organic constituents in water by the process of oxidation. The UV-oxidation reaction is initiated by the UV-photolysis of hydrogen peroxide. When UV photons are absorbed by hydrogen peroxide dissolved in water, hydroxyl radicals are formed. Hydroxyl radicals are highly reactive chemical species that attack the contaminant molecule. Second only to fluorine the hydroxyl radical is the most reactive species known (6).

Some chemicals are preferentially treated by the UV-photolysis process; others are preferentially treated by the UV-oxidation process. In most cases, UV-photolysis and UV-oxidation act simultaneously to break down chemical contaminants. Applied in a treatment plant, water moving through an optimized UV reactor is both disinfected and treated for organic chemicals. Thus,

UV has the ability to act as a multi-functional part of a multi-barrier system.

EXPERIMENTAL:

Apparatus

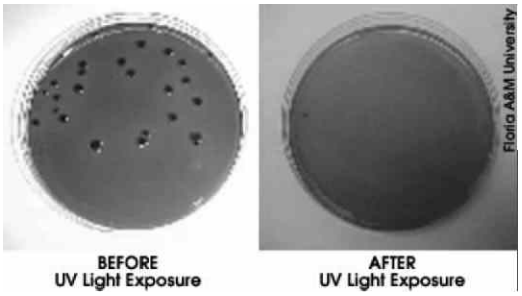
UV source, Petri dishes with solid media, Sterilized glass pipettes, Bunsen burner, Culture tubes, volumetric flasks 100 ml, Auto clave (6-7).

Regents

- **Peptone water:** Weigh 1g peptone and transfer to a 1 L volumetric flask. Dissolve in DDW and make up to 1 − L with DDW adjust the pH to 6.8. Sterilize this solution in the autoclave at 121 o C for 15 minute.

- **Eosine Methylene blue** (EMB) Media for E-coli, Nutrient Agar Media for viable count .

Result before and Fig-1 after UV treatment.



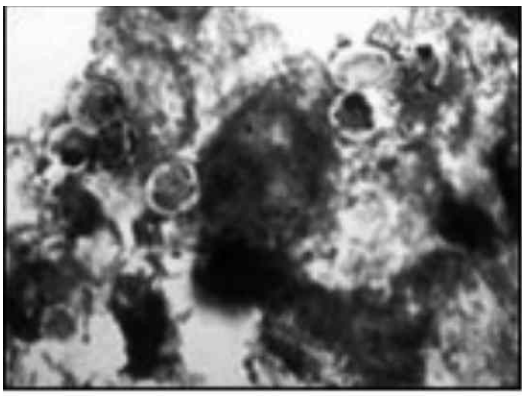


Fig-2 contamination before UV treatment.

Procedure

The 36 samples were collected and these plastic bottles were sterilized before sampling of drinking water for the microbiological analysis and then rinsed with the sample water (1). The samples were collected in one-liter quantity from water supplied WASA in different locations of Lahore City and then stored in a fridge. All the apparatus was sterilized properly using standard methods for the examination of water and wastewater (6-7). Samples were analyzed using bacteriological methods for water quality analysis, to check the degree of contamination The culture tubes containing water samples were labeled as s and the remaining seven culture flasks containing 9 ml water blanks numerically (1-7).Transfer aseptically with a sterile glass pipette, 1 ml sample from tube S to tube I containing water blank. Discard the glass pipette in the beaker containing sodium hypochlorite solution. The sample has been diluted 10 times.

Mix the contents of tube I thoroughly with a fresh sterile pipette transfer I ml from flask 1 to flask 2 containing water blank. Discard the glass pipette in the beaker containing sodium hypochlorite solution. The sample has been diluted 100 times. The dilution factor is 100 times. The required dilution can be obtained by following the dilution procedure described above. The dilution samples were then poured on NA and EMB media for the detection of E. coli and total viable count. All samples were then incubated at 37oC. For Ecoli bacteria measurement, the most possible number method (MPN), expressed in standard methods for examination of water and wastewater used for identification, enumeration of indicator bacteria and the total coli forms.

Results and Discussions:

All the 36 samples were collected and preserved according to the standard methods for the examination of water and wastewater (7). The characterization of these samples was done with respect to microbiological parameters such as viable count per ml; total coli form NPN/100 ml, E- coli form per ml. The results of all the samples shows that they are 100 % polluted with respect to viable count and total coli forms but with respect to E- coli form 2 % samples are polluted and 97 % samples are free from E-Coli pollution. All the 36 samples were treated with UV radiation using Gallon Kamp UV lamp and then these samples were again analyzed for the same parameters and after characterization these samples were found 100 % fit for drinking with different time intervals to remove the cause of pollution and then these samples were again characterized to check the quality of water and these samples were found fit for drinking purpose. There are different methods such as chemical treatment, Ozonation, ion exchange, chlorination, UV for the removal of different pollutants, it was found that if the water samples are first treated with chlorine and then these samples are treated with the UV radiation then provided to the human beings for drinking purposes. This is a very suitable method for the provision of safe drinking water and this will help us to maintain good public health and will reduce a lot of pressure on the hospitals. By the provision of quality drinking water to the public only by this one factor we can improve the public health and reduce the pressure on hospitals in our country.

Conclusion

After this study this is recommended to the water supply authorities that to supply the quality drinking water to public they should carefully check the water chemically and micro biologically and if found polluted microbiologically. They should repair /replace the water supply lines carefully and water filtration is not the solution of this problem and if from pumping to end users there is no any problem /leakage in supply line then the treatment of microbial pollutants can be effectively removed by UV light at the point where end users are using the water.

Table 1: Results before UV treatment

S. No	Viable Count/ml	Total Coli form (MPN/100ml)	E.coli /ml	Potable/Not potable
01	1.62×10^4	33.0	N.D	Not potable
02	1.78×10^3	95.0	"	"
03	5.6×10^4	33.0	"	"
04	1.12×10^3	49.0	"	"
05	8.5×10^2	23.0	"	"
06	3.44×10^4	70.0	"	"
07	4.0×10^3	33.0	"	"
08	4.44×10^3	33.0	"	"
09	4.66×10^4	95.0	"	"
10	32×10^4	33.0	"	"
11	6.0×10^3	17.0	"	"
12	2.38×10^4	95.0	"	"
13	4.3×10^3	95.0	2.04×10^3	"
14	3.9×10^3	95.0	N.D	"
15	6.4×10^3	33.0	2.04×10^3	"
16	2.8×10^4	70.0	N.D	"
17	2.6×10^3	13.0	"	"

S. No	Viable Count/ml	Total Coli form (MPN/100ml)	E.coli /ml	Potable/Not potable
18	6.4×10^{2}	13.0	“	“
19	5.0×10^{2}	N.D	“	“
20	9.0×10^{3}	95.0	“	“
21	7.6×10^{2}	46.0	“	“
22	1.88×10^{3}	49.0	“	“
23	4.0×10^{3}	7.8	“	“
24	3.6×10^{4}	17.0	“	“
25	3.12×10^{3}	33.0	“	“
26	2.22×10^{3}	32.0	“	“
27	3.08×10^{3}	11.0	“	“
28	6.8×10^{2}	4.5	“	“
29	3.8×10^{3}	95.0	“	“
30	1.76×10^{3}	11.0	“	“
31	1.3×10^{3}	23.0	“	“
32	6.2×10^{2}	46.0	“	“
33	2.9×10^{3}	17.0	“	“
34	5.04×10^{3}	23.0	“	“
35	9.58×10^{3}	95.0	“	“
36	8.24×10^{3}	49.0	“	“

Results After UV Treatment

S. No	Viable Count/ml	Total Coliform (MPN/100ml)	E.coli/ml	Time of UV Treatment in Min	Potable
01	N.D	N.D	N.D	5	Potable
02	“	“	“	10	“
03	“	“	“	15	“
04	“	“	“	20	“
05	“	“	“	25	“
06	“	“	“	30	“
07	“	“	“	35	“
08	“	“	“	40	“
09	“	“	“	45	“
10	“	“	“	50	“
11	“	“	“	55	“
12	“	“	“	60	“
13	“	“	“	65	“
14	“	“	“	70	“
15	“	“	“	75	“
16	“	“	“	80	“
17	“	“	“	85	“
18	“	“	“	90	“
19	“	“	“	95	“
20	“	“	“	100	“
21	“	“	“	105	“
22	“	“	“	110	“
23	“	“	“	115	“
24	“	“	“	120	“
25	“	“	“	125	“
26	“	“	“	130	“
27	“	“	“	135	“
28	“	“	“	140	“
29	“	“	“	145	“

S. No	Viable Count/ml	Total Coliform (MPN/100ml)	E.coli/ml	Time of UV Treatment in Min	Potable
30	"	"	"	150	"
31	"	"	"	155	"
32	"	"	"	160	"
33	"	"	"	165	"
34	"	"	"	175	"
35	"	"	"	180	"
36	"	"	"	185	"

References

1. Karl .L. J, Environ. (2005) Sci and Tech. Water. Article. Vol. 6. pp.25-32

2. Kendall M. (1993). Http://www.duke.edu.

3. Oppenheimer.JA, Jacangelo.JG, Laine.J, Hoagland 1997J.E. Water. Environ.Res. 69.

4. Website. www.esemag.com; Nov 2004.

5. Rein D.A, Jameson G.M, and Monteith R.A.1992. Proc.65th Ann. Water. Environ. Fed. Conf. Vol. X .New Orleans. USA.

6. Downes FP.2004.American public Health Association. Compendium of methods for the microbiological examination of foods 4th ED.

7. Marry, Frances.2005. American Public Health Association. Standard Methods for the Examination of Water and Wastewater, 21st Ed, USA

8. Ford TE, and Colwell RR. Report.1996.Global Decline in Microbiological Safety of Water. AWWA. J. Sur. Wat. Util. Disinf. Pract. pp. 223-24

9. Ford TE, and Colwell RR.1992. American Water Works Assoc. Jour. Sur. Wat. Util. Disinf. Pract. pp. 121-128.

10. Bryant EA, Fulton GP, Budd GC. Disinf. 1992. Alter. Safe Drink. Water. New York.

11. Bull RJ. 1993. First. Inter. Conf on the Safety of Water Disinfection. Pp.239-256.

12. Clark R.M, Hurst.C.J, Reg S. 1993 Costs and Benefits of Pathogen Control in Drinking Water. pp.181-198.