Issue 9 vol 3 ISSN: 2321-8134

IJFEAT

INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

STUDY OF METHODS OF DISINFECTION IN WATER

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Abstract

The Chlorine is used as disinfection agent worldwide. But, it had proved that chlorine may produce Trihalomethanes (THM's) that are toxic. So, there is need to find alternative methods of disinfection. This paper mainly discusses methods other than chlorination for disinfection of water. These methods of disinfection are classified into following three categories – Physical Methods; Chemical Methods; and Membrane Processes. The Physical methods of disinfection mainly includes – (a) Boiling (b) Solar (c) U-V radiation; and (d) Activated Carbon; The chemical methods used for disinfection of water are (a) Ozone (b) Hydrogen peroxide (c) Lime; and (d) Anodic Oxidation. The Membrane Processes include (a) Micro filtration & Ultra filtration (b) Reverse Osmosis and The limitation and suitability of all the methods are also discussed. A study on domestic waste water characterization has been performed followed by the design of sewage treatment plant. The present review study involves the analysis of pH value, total solids, total suspended solids, hardness, acidity, alkalinity, chloride, chlorine, BOD, DO and heavy metals such as Iron, Copper, Zinc, Magnesium, Nickel, Chromium, Lead, Calcium, Aluminium, Silicon, Potassium. A sewage treatment plant is some what necessary to receive the domestic and commercial waste and removes the materials which pose harm for general public. But It could be expensive and hence we used these methods for purify the water and keep people away from dangerous diseases such as Typhoid, , paratyphoid, bacillary dysentery, gastroenteritis, E coli, Cholera, Diarrhoea and Stomach disease. Its objective is to produce environmentally-safe fluid water for peoples.

Keywords: Disinfection, Physical Methods, Chemical Methods, Membrane Processes.

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1.0 INTRODUCTION

Water constitutes one of the important physical environments of man & has direct effect on itself. There is no gain saying that contamination of water leads to health hazards. Safe & adequate drinking water should be provided to the consumer. Water supplied should be aesthetically clean & biologically safe. Coagulation, flocculation and filtration remove bacteria up to 99% but 1% of bacteria entering water may be pathogen and may cause some disease. So, disinfection of water is necessary before supply of water for drinking purpose. The growing environmental pollution needs for free from contaminating waste water result in the study of characterization of waste water, especially domestic sewage. In the past, domestic waste water treatment was mainly confined to organic carbon removal. Recently, increasing pollution in the waste water leads to developing and implementing new treatment techniques to control nitrogen and other priority pollutants.Chlorine, which is applied to water at various points in a water treatment plant for various, proposes including the main purpose of disinfection, combines with naturally occurring organic matter present in trace amounts in raw water to generate certain unwanted chemicals known as disinfection by products (DBPs) in general and halogenated DBPs in particular. Amongst the halogenated DBPs Trihalomethanes (THMs) represent the largest fraction are toxic. So, there is need to discover alternative methods of disinfection. When microorganisms are not removed from drinking water, drinking water usage will cause people to fall ill. However, during the sterilization process all present microorganisms are killed, both harmful and harmless microorganisms. Media Disinfection can be attained by means of physical, chemical and membrane disinfectants. These alternative methods are termed as minor methods of disinfection, since disinfection through chlorine share major proportion of disinfection all over the world. The use of these methods are been restricted to selected areas due to lack of precise knowledge about their disinfecting power and cost effectiveness. At present these methods may not appear as a replacement to chlorination but few of them certainly appear to be attractive alternative to chlorine.

1.1 What is Disinfection of Water?

Water disinfection is defined as the removal, deactivation or killing of pathogenic microorganisms. Microorganisms are destroyed or deactivated, resulting in termination of growth and reproduction. When microorganisms are not removed from drinking water, drinking water usage will cause people to fall ill. Purification of drinking water is a very important problem in day to day life and as well as

environmental engineering. Purification of drinking water is typically achieved via adding a disinfectant. Chlorine is the most common disinfectant used in drinking water purification systems because it is inexpensive but, it has been proved that chlorine may produce Trihalomethanes (THM's) that are toxic.

1.2 Diseases Caused By Impure Water

The Scientists believe that there may be hundreds of disease-causing organisms present in sewage and wastewater that have yet to be identified. Bacteria are microscopic organisms that are responsible for several wastewater related diseases, including typhoid, paratyphoid, bacillary dysentery, gastroenteritis, E coli, and cholera. Due to drinking of impure water the rate of deaths of people are increasing day by day in world wide.

2.0. LITRATURE REVIEW

2.1 Methods Of Disinfection In Water

Methods of disinfection can be broadly classified into categories –

(A) Physical Methods;
(B) Chemical Methods; and
(C) Membrane Processes.

[I]. Physical Methods

(A) Boiling Method

This is the very basic and simplest method of disinfection. Temperature of water is raised to its boiling point and maintained for 15-20 min to kill all the bacteria. This method is suitable for household purpose or in case of epidemics. This method can be easily used in house.

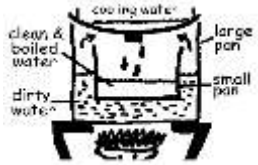

Figure 1: Purification Of Water By Boiling Method

(B) Solar Plate Method

The germicidal action of sunlight has been long recognized, but the ecological implications and the potentials for practical applications have to be researched more thoroughly. Solar water disinfection was found effective and feasible for small quantities of water. Therefore, the possibility of applying the same fundamental principles to a continuous-flow system was investigated. Accordingly, The simple prototype units were designed, and their effectiveness in decontaminating water by exposure to sunlight was assessed. The advantages of this method are no taste and odour is produced and complete destruction of microorganism. The limitations of this method are required more space and uniform solar radiation through out day.

Figure 2: Purification Of Water By Solar Method

(C) U-V Radiations Method

U-V radiation may kill a cell, retard its growth and change its heredity characteristics. The destruction of cell is maximum in the range of wavelength from 2500 – 2650 Aº. U-V radiation is produced by a low pressure mercury lamp constructed of quartz or special glass. It produces a narrow band of radiation energy at 2537 Aº and therefore most commonly used. To achieve efficient disinfection of about 99.99% (i) water should be free from suspended and colloidal substance; (ii) water should be flowing in the form of thin sheets of about 120 mm; and (iii) adequate intensity and time of exposure of U-V rays should be applied. The advantages of this method are that exposure is for short period and no taste and odour is produced and complete destruction of microorganism.

Figure 3: Purification Of Water By Ultraviolet Radiation Method

(D) Activated Carbon Method

Activated carbon can also be used for sterilization of water. GAC works on the principle of adsorption. Adsorption involves the interphase accumulation of concentration of substance at the surface of solidliquid. A water filter medium consisting of activated carbon & silver- coated activated carbon disinfects water. Similarly water passing through column containing GAC & activated carbon fibers impregnated with silver releases silver ion for disinfection of water. It assures minimum residual silver in disinfected water.

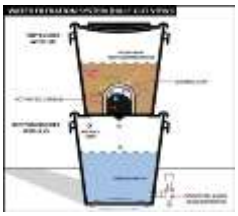

Figure 5: Purification Of Water By Activate Carbon Method

[II]. Chemical Methods

(A) Ozonation Method

It is a faintly blue gassy pungent odour. Being unstable it breaks into oxygen and nascent oxygen. Thus, nascent oxygen is a powerful oxidising & germicidal agent. Ozone is produced by the corona discharge of high voltage electricity into dry air. Ozone being unstable has to be produced on site. Ozone possesses more superior bactericidal properties than chlorine. Ozone is highly effective in removing tastes, odour, colour, iron & manganese; and the method remains unaffected by pH and temperature There is no danger of over dozing and no transport or storage problem As ozone reacts with chemical impurities prior to attacking the micro organism, it

produces essentially no disinfection unless ozone demand of water has been satisfied but much more rapid kills are achieved once free ozone residual are available. Studies have reported 99.99% kill of E-coli within less than 100 sec in presence of only 10 mg/l of free available ozone. However, disadvantages are high cost, inability to produce residual protection; and requirement of its generation on site due to its unstable nature. However, despite of these disadvantages ozone has been extensively used in Europe.

Figure 6: Purification Of Water By Ozone Method

(B) Addition Of Hydrogen Peroxide Solution Method

Hydrogen peroxide being an oxidising agent may be used for disinfection purpose. Hydrogen peroxide when added to water liberates nascent oxygen, which possess germicidal properties. One of the procedures to execute this method is sterilization by adding peroxide & removing excess by passing through filter of finely divided manganese dioxide & sand that is washed by dilute $KMnO_4$. Another method is to treat water at ordinary temperature or at 400^oC with a small quantity of hydrogen peroxide acidified with HCL. Excess acid may be neutralized. Limitation of this method is its cost; no residual protection and poor germicidal action.

Figure 7: Purification Of Water By Hydrogen Peroxide Solution

(C) Addition Of Lime Method

In water treatment, lime is generally used for water softening. It can also be used for• disinfection. Addition of lime increases the pH value of water. It has been noted that at pH value more than 9.5 all bacteria are killed, Amount of lime required to remove hardness is calculated & excess amount is added & when the softening process is over all the bacteria will also be killed. Next step is to bring back the pH to neutral. This method is not used for water treatment because of its handling and no residual effect.

Figure 6: Purification Of Water By Addition Of Lime Powder Method

(D) Anodic And Cathodic Method

Anodic Oxidation is an electrochemical disinfection method in which by an electrode and ion migration mechanism electric energy is converted into chemical energy. The process takes place inside an electrochemical reaction cell consisting of two electrodes with current connections .The cathode is the electrode which abstracts electrons (negative charge) from an external electrical circuit (reduction). The anode is the electrode which takes up electrons from the electrolyte (oxidant). In the process of anodic oxidation of non electrolyte (generally organic compounds) the take up of oxygen or loss of hydrogen is of interest. This mechanism forms the basis of killing of organisms by anodic oxidation. The advantage of this method is the portable container units can be set in rural areas as per the requirements. The system works on direct electric current and as such solar energy can also be utilized.

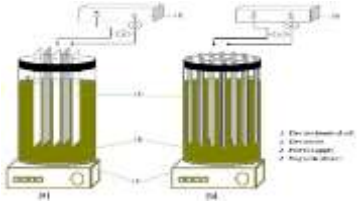

Figure 8: Purification Of Water By Anodic Oxidation Method

[III]. Membrane Process

(A) Micro Filtration and Ultra Filtration Process

It is a semi permeable membrane in which a thin layer of material is capable of separating substance when driving force is applied. Microfiltration is defined as a membrane separating process-using membrane with a pore size of approx. 0.03 to 10 microns. Representative materials removed are sand, silk, day, giardia lamblia cryptosporidium cysts, algae & some bacteria. UF involves a pressure driven separation of material from water using a membrane pore size approximately 0.002 to 0.1 micron operating pressure of approximately 200 to 700 KPa. UF can also remove some of the viruses in addition to microorganism. However, they are not complete barriers to virus. They can be used in water treatment with some other disinfectant. They will definitely reduce the dose of chemical or disinfectant.

Figure 9: Purification Of Water By Microfiltration And Ultra Filtration Process

(B) Reverse Osmosis Process

Reverse osmosis offers possible tools for effective water treatment. Reverse osmosis is normally used for desalination and can be used for disinfection. Reverse osmosis utilizes a semi permeable membrane as separating agent and pressure as a driving force. Small fractions of microorganisms do pass through the membrane, thus necessitates chlorination or ozonation.

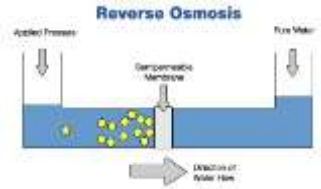

Figure 10: Purification Of Water By Reverse Osmosis Process

2.2. Advantages

(I) The removal of pathogens and chemical contaminants such as ammonia, metallic and non metallic materials.
(II) Allows for the direct reuse of the treated wastewater.
(III) The removal of Toxic substances and other harmful substances which is harmful to human body, plants and animals.
(IV) Due to pure water peoples are away from diseases such as diarrhoea, cholera, typhoid and other diseases which is cause by impure water.
(V) There is no harmful community safety risk.
(VI) Wastewater treatment transforms used water into clean and drinkable water.

2.3. Disadvantages

(I) Requires continuous monitoring of influent and effluent.
(II) Capital and operating cost can be high.

2.4. Applications

(I) UV disinfection can remove the threat to health from water borne Pathogens without the creation of disinfection by products that can be generated from drinking water chlorination.
(II) Ozone can come from a variety of sources, and often serves as an important component to a comprehensive water purification system.
(III) The Membrane Process has various applications in desalination, removal of taste, colour etc. These are also found capable of removing microorganism.
(IV) The applications of these methods are very limited in water works because of its cost and no residual effect to safe guard against future contamination.

2.5. Use of Methods

Table No. 1: Use Of Methods

Sr. No.	Name Of Method	Name Of City
(A)	**PHYSICAL METHODS**	
(I)	Boiling Method	Household (India)
(II)	Solar Method	Bengaluru, Ahemdabad (India)
(III)	U-V Radiation Method	Mumbai (India)
(IV)	Activated Carbon Method	Chennai (India)
(B)	**CHEMICAL METHODS**	
(I)	Ozonation Method	Mumbai (India)
(II)	Addition Of Hydrogen Peroxide Solution	Indore (India)
(III)	Addition Of Lime Powder Method	Urban Areas (India)
(IV)	Anodic Oxidation Method	Delhi (India)
(C)	**MEMBRANE PROCESS**	
(I)	Micro filtration & Ultra filtration	America (U.S.A.)
(II)	Reverse Osmosis	California (Los Angelis)

3.0. CONCLUSION

The methods discussed in this paper appear to be attractive methods of disinfection in certain specific situations. However, they have disadvantages like cost and no residual effect. As such chlorine is looked upon as a universal choice in the past and the present. Technological advances and development have shown the drawback in using chlorine as disinfectant and necessity of alternative disinfectant. Now-a-day ozone and UV radiation are used in developed countries. However, in developing countries use of these expensive methods is limited mainly due to lack of funds. With more advances in low cost technologies these methods may prove promising and can be an alternative to chorine in disinfection of water.

ACKNOWLEDGEMENT

I express my profound gratitude to my guide **Mr. M. A. Jirapure**, Professor, Department of Civil Engineering, J.D.I.E.T, Yavatmal. For his valuable advice and inspiring guidance which has played a vital role in carrying out this work.I express my thanks to all my department faculties for their valuable advice .I also thanks to all my friends, classmates and parents who have directly or indirectly helped in completing this project work.

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