

A Review on Treatment Process of Biological Contamination of Water

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Abstract—Water contamination occurs due to the exposure of the water with the source like; domestic waste water, organic solid wastes etc. These sources contain organism like; bacteria, viruses, protozoan etc. Such biological contaminated water is the reason of different diseases. Cholera, typhoid fever etc. are some dangerous diseases which are water borne. Every year many people in India dies due to the biological contaminated water. There are different methodologies developed to treat such contaminated water. The process of removal of biological contamination mainly related to the removal of the organic matters and killing of pathogenic organisms. In this paper review on the different methods to treat the biological contaminated water is done.

Keywords: Contamination, water pollution, Pathogens.

Introduction

Crisis of drinking water is one of the biggest challenges of the modern era. River, lakes, aquifer, ground water etc. are major sources of the drinking water. Population is growing rapidly day by day. With growing population human activities are causing different impacts on the nature. Pollution of water is one of the negative impacts of the human activities. Water pollution is basically resulting of the mixing of the contaminants in the water source. Domestic, Industrial, agriculture etc. are the major sources of such contaminants. Such pollution causes serious public health related. Water pollution due to different reasons alter physical, chemical and biological characteristics of the water and causes different diseases like; cholera, typhoid, malaria etc. [1] As per World Health Organization (WHO) waterborne diseases causes 1.5 million human deaths every year. In India to control the water pollution three major acts are passed: the water act 1974 (for prevention and control of pollution), water cess act 1977 and the environment protection act 1986. Different institutions like; Central Pollution Control Board (CPCB) and State pollution control boards (SPCB) are setup to control the water pollution. To avoid the death due to the polluted water there is need to provide drinking water to reduce disease [2].

Water pollution

Water pollution is basically pollution of the different water sources like; lakes, rivers, oceans etc. Based upon the source of water, water pollution can be divided as ground water pollution and surface water pollution. Ground water which is one of the sources of the drinking water get contaminated due to the leachates which includes, pesticides, fertilizer etc. Surface water get polluted due to the nitrates, phosphate, domestic sewage etc. Based upon the source water pollution can be divided as point source pollution and non-point source of pollution. Point source contamination is originated from single source. Leaking septic systems, chemical and oil spills etc. are the example of single source of water pollution. Nonpoint source means the contamination from diffuse sources. Pollution from agriculture, storm water etc. are example of the non-point source pollution [3].

The major sources of the water pollutant are; Agricultural activities, sewage, oil leakage, etc. Agriculture activity consumes most of the earth surface water supply. It is also one of the major sources water pollution. It is because of the utilization of the fertilizers, pesticides etc. excessive nitrogen and phosphorous in water causes 'Nutrient pollution'. Water utilized in domestic activities also generate huge amount of the waste water. Due to poor treatment facilities the waste water contaminates the water sources. Oil leakage or due to the mining activities water source also get contaminated [4].

Waterborne Diseases

Basically there are four types of water related diseases: water borne disease, water washed disease, water-based diseases and water related diseases due to insects [5]. Waterborne diseases are mainly transmitted by consumption or due to the contact with the water which is infected by microorganism. Water-washed diseases take place due to the contact of skin and eye with contaminated water. Water based diseases caused by parasites found in intermediate organisms living in contaminated water. Water-related diseases caused by insect

vectors hosted in water, especially mosquitoes. Problem of water borne disease is less in developed country. Table 1 shows the deaths due to water related diseases. Microorganisms like; protozoa, bacteria, virus etc. causes waterborne diseases. Table 2 shows some of the different diseases and micro-organisms.

Table 1: Selected water-related diseases and its effect [5]

| Diseases | Estimated effect per year | Estimated deaths per year |
|----------------------|---------------------------|---------------------------|
| Diarrheal diseases | 1,000,000,000 | 2,200,000-5,000,000 |
| Intestinal helminths | 1,500,000,000 | 100,000 |
| Schistosomiasis | 200,000,000 | 200,000 |
| Dracunculiasis | 200,000,000 | 200,000 |
| Trachoma | 150,000,000 | - |
| Poliomyelitis | 114,000 | - |
| Trypanosomiasis | 275,000 | 130,000 |

Table 2: Diseases and microorganism [7-11]

| Diseases | Microbial agent | General symptoms |
|------------------------|----------------------------------|---|
| Acanthamoeba | Acanthamoeba spp (Protozoa) | Eye Pain |
| Amoebiasis | Entamoeba histolytica (Protozoa) | Abdominal discomfort |
| Cyclosporiasis | Protozoan parasite | Fever, muscle aches |
| Microsporidiosis | Protozoan phylum (Microsporidia) | Diarrhea |
| Botulism | Clostridium botulinum | Dry mouth blurred, double vision |
| Cholera | Bacterium vibrio cholerae | Cramps, diarrhea, vomiting fever |
| E-Coli | Escherichia coli | Diarrhea, dehydration |
| Dysentery | Shigella and salmonella | Frequent passage of feces with blood |
| Typhoid fever | Salmonella typhi | Fever, diarrhea, liver enlarge |
| SARS | Coronavirus | Fever, lethargy, cough |
| Hepatitis A | Hepatitis A virus | Fatigue fever, abdominal pain, nausea, diarrhea |
| Poliomyelitis (Polio) | Poliovirus | Headache, fever, spastic paralysis |
| Polyomavirus infection | JC virus and BK virus | Kidneys, respiratory system damage |
| Demodermis infection | Demodermis armatus | Fungal infection |
| Dracunculiasis | Dracunculus medinensis | Slight fever itchy rash, vomiting, diarrhea |

Measurement of the biological contamination

Generally Bacteriological analysis is used for biological contamination. Three group of bacteria is found namely the coliform, the anaerobic lactose-fermenting sporeformers and fecal streptococci. Coliforms group are closely like the pathogens and they get affected by the different purification

process. So, the absence of the coliform organisms indicates the absence of pathogens [12]. The Escherichia and the Aerobacter are two genera of the coliform group. This group is defined by 'Standard Methods for the Examination of water and sewage' as all aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod shaped bacteria that ferment lactose with gas and acid formation within 48 hours at 35° C. This group is also known as Coli-aerogenes group, Escherichia-aerobacter group, B. coli and Bact. Coli.

Multiple-tube fermentation technique, membrane filtration technique or chromogenic substrate coliform tests are used for the measurement of the coliform. Eckner [13] has done comparative study on the membrane filtration and multiple tube fermentation by colilert and enterolert methods for detection of coliform. It is found in this study that colilert method is more sensitive.

Treatment of biological contamination

There are several process are used in treatment of the water like; sedimentation, filtration etc. In all these process solid and chemical contaminants are removed. Along these contaminants microorganisms are also get separated. But some specific methods are used to remove specially the microorganism from the water. These methods are known as disinfection methods. These disinfection methods can be classified as physical and chemical disinfection [14]. The examples of the physical treatment of the biological contaminations are Ultraviolet radiation, solar radiation, Ultrasound etc. while, the chemical treatment includes treatments through chlorine, iodine, ozone etc [15].

Utilization of the ultraviolet radiation (UV) is one of the most used disinfection methods at household level. In the water treatment machines in houses this process is used for disinfection. In this process water is passed through the chamber with ultraviolet light. UV light has potential to damage the genetic components of the microbes [16]. This method is only used for the killing of the microbes. This method has advantages like; effective to kill many pathogens without affecting the minerals in water. Since none of the chemical compounds are introduced in the water, so chances of the formation of the toxic compound is minimum. It has some limitation also like; before utilization of this process, water needs to be treated earlier to remove the solids in form of suspension or dissolved should be removed. This process doesn't work effectively in presence of high levels of solids. Other disadvantage is need of electricity. Since UV ray source need electricity, so in the area where electricity is not present this method cannot be utilized.

In place UV-ray solar radiation can also be used for the treatment of water. Solar radiations have also potential to remove the pathogens. In this process contaminated water is placed inside transparent bottles like; plastic bottles for 6 hour [14]. Sunlight also contains the UV light which kills the pathogens. This method is easy to use, inexpensive and no

electricity is required. It has also no impact on the minerals of water. Also chances of generation of the toxic materials are less. But for this method requires sun light, so climatic condition affects this method, less turbidity is required in case of this method. Also, this method is not effective for the all types of parasites.

Another physical method of disinfection is utilization of ultrasound. Ultrasounds have greater frequency than the audible range of the sound. Due to the higher frequency these sound have greater energy and penetrate different mediums. So, these sound waves can penetrate the cells of microbes and able to kill these pathogens. This method is easy to use and this is major advantage. But this method is cannot be used alone and there is chances of regrowth of the microbes.

Ozone O₃ is one of the chemical used for disinfection. Ozone is unstable in nature, but it is very effective oxidizing agent [17-18]. Due to the high oxidizing power it has potential to alter the organic compounds and to change in the aldehydes and ketones. Due to this characteristic it is effective in killing microbes. Potential to kill the microbes through the ozone is more than the chlorine. Ozone basically destroys the cell wall and exposed the microbe cell to the environment. Ozone is formed by passing the UV light through the oxygen. Ozone also help in clarity of the water by reacting with Fe (II) and Mn (II). This method can be used immediately at site and it produces water without residue. But disadvantage with this method is that ozone is explosive in nature and it affects skin eyes respiratory system.

Utilization of the chlorine is most common way to disinfection. In the water supply system in India for disinfection of water chlorine is used. Chlorine is one of the strong oxidant. Chlorine is very effective to kill the pathogens specially bacteria and protozoa [19-20]. Advantage of this method is the simplicity of process and cheap chemicals. But there are some disadvantages associated with utilization of the chlorine. Chlorine reacts with organic compounds present in the water and produce aids like; halomethanes, haloacetic acids, which are cancerous in nature [21]. To reduce these cancerous compounds, it is preferable to reduce the organic compounds in the water. SO, utilization of the chlorine is preferable after removal of the organic materials. In many places bleaching powder is also used in place of the chlorine. But access use bleaching powder causes odor and taste related problem. This has also potential to oxidization. So,, can be used for killing the pathogens.

Iodine is also one of the oxidizing agents. So, it is also used as disinfection like chlorine. It can be used to neutralize the pathogens in short periods of time [22]. The advantages of this oxidizing agent are the killing capability of different types of the pathogens, also helping to fulfill the requirement of iodine. But as compared to chlorine its oxidizing capacity is less, so for disinfection purpose more iodine is required to neutralize the pathogens. Also, cost of iodine is more than the chlorine.

Hydrogen peroxide is another oxidizing agent used for the purification of water. It is not used alone for disinfection. It is used with other disinfection techniques like; UV-radiation or ozone [23]. Advantage of using this method is that, it doesn't produce any residue. But disadvantage with this method is that this material have impact of irritation in skin, eyes etc.

Conclusions

In this study a review on the biological contamination of water and its treatment methodology is done. Different diseases happen all over the world due to the contamination of the water. It affects millions of the people worldwide. There are set of methodologies available for the treatment of biological contaminated water. All these methods have some advantages and disadvantages. Based upon the utility these methods can be used in combination or alone.

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