Proceedings of the 3rd International Conference on Materials Chemistry and Environmental Engineering (CONF-MCEE 2023), Part II
DOI: 10.54254/2755-2721/7/20230520

The contrast of water treatment process before and after Covid-19

Qiongyuan Zhang*

Fordham University, New York, 10458, US

*oliviazqy614@gmail.com

Abstract. The impact of water sources on humans has many facets. Our daily consumption is only a small part of the water that is used to irrigate plants, raise fish and fowl, and so on. The environment we live in and the survival of the organisms around us all depend on the safety of the water source. Water sources need to adhere to strict standards for pathogens, oxygen, salt, heat, heavy metals, and more. Otherwise, unclean water sources can cause disease and even be fatal. Since covid-19 broke out in 2019, it has had many impacts on people's lives, and it is no different for water treatment. The original treatment of water sources needs to be protected and improved to ensure the safety of the water. This article will analyze and list the original water treatment process, the impact of covid-19, and some of the current solutions.

Keywords: water treatment, plant, Covid-19, influence of Covid-19.

1. Introduction

Water is a necessity in the daily activities of humans and living things. The demand for freshwater grew 2.5 times from 1961 to 2014, and nearly one-third of the world's population lives in places with “high water scarcity"[1]. Water pollution and treatment have been a global concern for environmental engineering and are closely related to ecology and the health of humans and animals. Continuous water pollution can cause social and ecological problems in various areas, such as biodiversity, food chain integrity, drinking water supply, agriculture, and economic development[2]. Water pollution is long-term and regional in nature[3]. If water is contaminated in one area, then adjacent human and biological sources of drinking water can be destroyed, for example, through commodity trade[4]. Water that is contaminated by chemicals can have an impact on the environment. Chemically contaminated water can affect all organs of the body, causing childhood defects, cancer, and other diseases[5]. Since the outbreak of the Covid 19 in the spring of 2020, there have been different effects on water contamination and purification. On the bright side, reducing active human damage to the environment has mitigated further contamination of water resources[6]. However, due to the spread of the virus, developing regions like middle-east countries lack the technology and medications to deal with water contamination in the event of an outbreak, further threatening people's health[7]. The economic depression has also made it difficult to invest in environmental water conservation in places other than some developed countries and regions[8]. In the past, there has been research about the Covid 19 for economic, educational, health, and social issues[9]. However, the researchers lack emphasis on the impact of the epidemic on water control. For example, at the beginning of the NCCV, some rivers in China detected chlorine at levels as high as 4 mg/L, far exceeding the 0.019 mg/L standards [10]. In this work, we will analyze the impact of the epidemic on drinking water treatment, current measures, and future concerns.

1.1. Water Treatment

Water sources exist in many places that we are able to access, oceans, lakes, glaciers, air, and trees. Of the freshwater reservoirs, groundwater and surface water are the most used water sources by people. Groundwater has about a hundred times the storage capacity of surface water. However, people have easier access to surface water, so more surface water is being used. [11] Table 1 shows the percentage of freshwater and its resources. It reflects the fact that people have access to only a small amount of total water resources. Before Covid 19, people already had complete treatment plans for surface water and groundwater respectively.

Table1. Percentage distribution of purified water [11].

Sources	Percentage of all	Percentage of freshwater
Ocean	96.5	
Ice and snow	1.8	69.6
Groundwater	1.69	30.1
Surface Water	0.01	0.3

2. Surface Water Treatment

Surface water treatment is usually carried out in a water treatment plant and involves a number of processes, including both chemical and physical treatment. Figure 1 shows the sequence of the fresh water treatment processes.

2.1. Collection.(Physical)

Surface water is defined as any body of water above the ground and is divided into three main categories: perennial, ephemeral, and man-made. Perennial surface water, such as rivers, exists continuously throughout the year and can be replenished with groundwater when precipitation is low. Transient surface waters such as streams and water holes exist part of the time. Man-made surface water is engineered, such as dams[12]. People usually apply fresh surface water from streams, rivers, lakes, wetlands, reservoirs, and creeks. Surface water is easy to access and utilize, and people usually use a series of pipes and pumps to transport surface water from multiple locations to treatment plants[13].

2.2. Screening and Staining of large particles.(Physical)

Screening and staining is the first step in the treatment of surface water sources, intending to filter large floating materials, as well as settling sand and grit. It is not difficult to notice that, in rivers or reservoirs, there are different amounts of suspended and dissolved substances. They can be branches, fish, plants, garbage, or microorganisms[13]. People used to simply wrap cloth to complete the screening. Nowadays water plants usually use a metal mesh at the mouth of the pipe, called bar screen. The advantage of this step is quickly screening out large quantities of substances that are not suitable for drinking, but it does not have any effect on bacteria[14]. In addition, because of the variety of such floating materials, there are often clogs caused by hooking on the metal screen, or damage to the screen, which requires frequent manual handling[14].

2.3. Primary Sedimentation. (Physical)

Primary sedimentation (also called settling or clarification) is a sanitation technology that aims to remove particles that can settle by gravity forces, usually within a few hours. Sedimentables, sludge and gravel, are heavier than the water itself and will sink to the bottom when at rest. They will be scraped off the bottom of the water container by a scraper. There is also some suspended material, fine scum, that floats on the water surface and can be removed by skimming[15]. In recent years, chemically assisted primary sedimentation (CAPS) or chemically enhanced primary treatment (CEPT) has emerged from primary sedimentation research[16]. About 60-65% of the suspended solids will be removed by gravity sedimentation[17].

2.4. Coagulation with rapid mixing(Physical)

Coagulation(with rapid mixing) uses agitation and chemicals in order to combine dispersed particles to collide, and easy to be removed by a subsequent process. The chemical substance (coagulant) is one of the indispensable ingredients. The Egyptians began using almonds to clarify the water in 2000 B.C.[18]Initially simple coagulants, such as ferrous or alum salts, were effective in helping substances to combine accurately and quickly into larger particles. The particles in water usually have a negative charge and they repel with the same charge, so they float alone without binding. When chemicals with the opposite charge of the suspended material are added, the charge of the particles in the water is neutralized[18]. The ultimate goal is to facilitate sedimentation. In this process, the choice of coagulant is very important and advanced and suitable coagulants are constantly being invented. Usually, pH, ionic strength and the properties of pollutants, as well as the treatment efficiency and money consumption are the important criteria for selecting coagulants[19].

2.5. Flocculation(Chemical)

Flocculation is defined as a separate and independent step that occurs after coagulation. Flocculation is divided into natural flocculation and chemical flocculants, with the former being the environmentally friendly approach usually used in water treatment. Natural products like starch can be used as natural flocculants, which are more harmless compared to chemical flocculants, but costly[20]. The natural step of flocculation is that after coagulation destroys the charge on the floating particles, coagulation makes these objects bigger by the time of sedimentation and slow agitation until they are separated. Small floating objects that could not be sieved out in the previous filtration and sedimentation are destroyed independently by coagulation and then combined by flocculation[11]. These two steps usually occur together, as they are continuous and causally related.

2.6. Secondary Sedimentation(Physical)

Secondary precipitation is similar to the operation of the first precipitation in that gravity is again applied to slow the water flow and then the material is separated. The difference is that the first separation is for suspendable solids, while the second is separated again after coagulation and flocculation[21]. Combined with a long period of stillness, the second sedimentation is achieved.

2.7. Filtration(Physical)

Filtration removes the first two unsettled objects. It usually comes in many forms, the most common being filtered grit, and more sophisticated ones that can pass through bacterial membranes. There are various types of filters, such as activated carbon, which is used in factories to remove particulate matter as well as some organic compounds[22].

2.8. Sludge processing(Chemical)

Sludge is the sewage that has been extracted in the early stage and it contains bacteria and viruses that have the risk of contaminating the environment and transmitting germs. The components of sludge are usually suspended solids, water and dissolved organic or inorganic matter. The main source is the effluent after the first and second sedimentation. The treatment of sludge usually starts with volume compression, and the percentage of suspended solids is increased by further sedimentation, chemical or thermal treatment to discharge water[23]. The treated sludge can then be reused, usually as latent energy, or nutrient content[24].

2.9. Disinfection contact(Chemical)

Disinfection contact should be given enough time for germs to be killed. The water is very clear before this step, but viruses and bacteria may still be alive, which requires chemical disinfection intervention to help clean the water further. In the absence of specific viruses, chlorine gas, hypochlorite, etc. are usually used to help clean up the water[25]. This requires a precise enough survey of the water to ensure that the microorganisms are eliminated, usually by measuring the bacteria level or the chlorine level in the water.

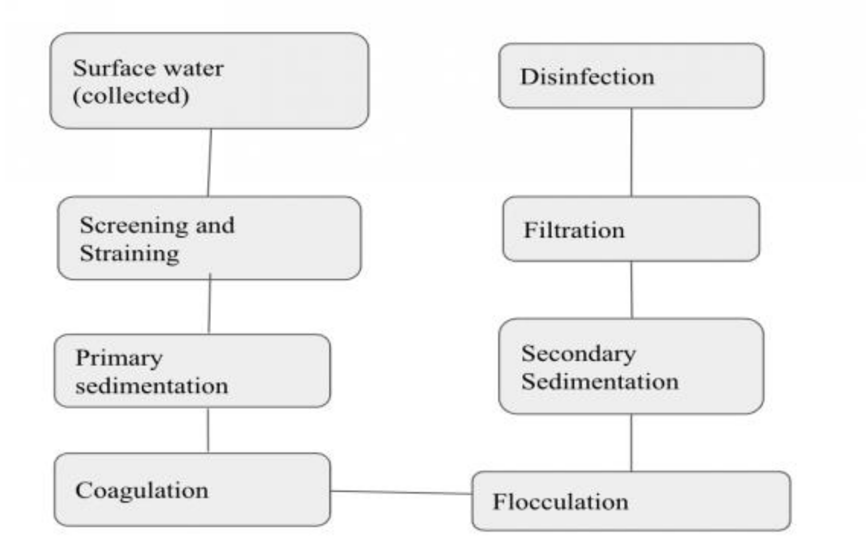

Figure 1. Surface water treatment process.

3. Groundwater Treatment

Unlike surface water, groundwater requires additional steps to meet standards. After being collected at the water treatment plant, groundwater is usually mixed with soil and gravel and is usually more turbid than surface water. It requires a stage of aeration to allow air to flow through this fluid, creating a more accessible surface area for subsequent coagulation and flocculation[26]. In addition to this, after settling, the groundwater needs to undergo recarbonation to adjust the Ph degree and alkalinity of the water to facilitate additional hard ion precipitation[27]. Figure 2 shows the sequence of groundwater treatment processes.

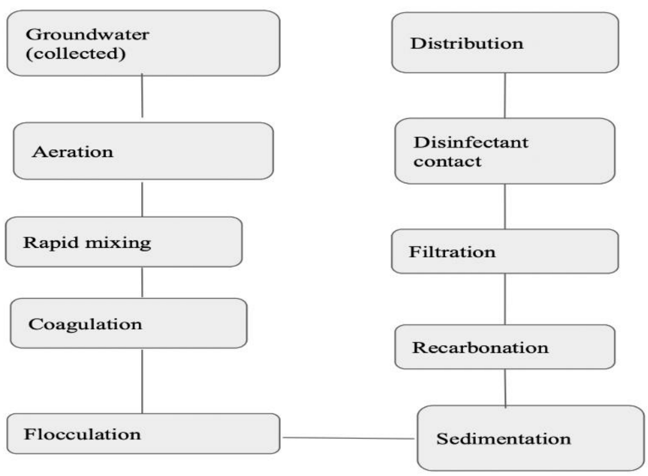

Figure 2. Ground water treatment process.

4. Covid-19 influence

Since the outbreak of the new coronavirus in 2019, both its rapid and unguardable spread have had many effects on people. Environmentally, it has also reduced the level of pollution and damage to the environment at the same time, as people have been going out and socializing less. The overall quality of water has improved during the quarantine period, especially in countries with long and severe quarantine policies, such as China. However, the problems it poses to the water treatment process cannot be ignored. We know the need for precautions for patients who are being positive, but beyond that. About 30 days after a positive patient turns negative, their excrement still carries the virus and contaminates the water[28]. In addition, many positive but asymptomatic patients can easily contaminate water sources by touching them with their mouth or water without knowing they are positive[29]. In some backward areas, such as the Middle East, where there is not even a centralized water treatment plant, hospitals and other places are responsible. If the water is mishandled, whether it is drinking water or everyday water, the effects of a massive spread of water can be irreversible, especially in densely populated developing countries[30]. The spread of viral water not only affects drinking water but also the life in the river and the surrounding irrigated vegetation so that the area is contaminated in many ways[31]. Therefore, it is important to ensure the safety of water sources. In addition, it is also important to set new testing standards that will determine what standard of water is sufficient for people to drink to ensure human health.

About new viruses, water treatment methods must be improved to address related issues. Some of the most common issues are ensuring that the new virus is clear, ensuring safety around the water plant and transportation, help for disadvantaged areas, and testing standards for water[31]. These issues are worth worrying about and thinking about when new viruses are introduced, and the following are different solutions from the previous treatment under the current virus.

5. Virus being processed (SARS-CoV-2)

5.1. Screening and Straining

Physical screening and filtering alone is only for relatively large and visible items, and viruses are difficult to disappear or break down in this step. The first step usually does not target viruses, which are left with the water source for subsequent processes.

5.2. Primary Sedimentation

SARS-CoV-2 is a membrane-bearing virus, meaning that the processes of the conventional plant can have a degree of cleanup effect on it. During the sedimentation process, the colloidal nature of the virus will allow him to cling to larger suspended solids that merge together[32], in line with the initial goal of sedimentation, and the virus will be carried away from the water source to some extent. At this point the virus is separated into the sludge, but not inactivated, and further processing is required to reduce the risk.

5.3. Advanced treatment methods and disinfection

When it comes to special viruses, in addition to the most basic treatment, many countries also use more advanced techniques for viruses. As an insurance step after the basic step, ozonated chlorine and ultraviolet light are more efficient than chlorination disinfection, providing a good barrier to stop viruses from developing with the water source.

5.3.1. Ozone disinfection

Chlorination is convenient and commonly used in disinfection, but ozonated chlorine can be more effective in attacking disinfected organics. It operates electrically, at relatively low pH, to selectively attack organic contaminants and perform further degradation. During covid-19, the ozone nanobubble method has been shown to be effective and powerful against SARS-CoV-2 virus[33].

5.3.2. UV light disinfection

UV disinfection is a high-intensity irradiation of the surface of the water source and is particularly effective in opaque conditions. When bacteria and viruses in the water are irradiated, the nuclei are destroyed and thus no longer reach the possibility of transmission[32]. UVC (Ultraviolet C), with wavelength between 100-280 nm, has been shown to be effective against SARS-CoV-2[33].

6. Security in the face of the pandemic

In addition to disinfection of the virus itself at the plant, there need to be in-process restrictions to prevent the spread of the virus. First, hospitals that receive positive patients need to strictly separate patient water from regular water. Solid infectious waste, and various medical waste discharges, are not allowed to be discharged directly into the sewer. Before sending them for disposal, chlorine disinfectant should be added for initial disinfection to prevent rapid transmission. In hospitals, special septic tanks should be set up for outpatient clinics to centralize the disinfection of fecal excreta. Patients' excreta, secretions, vomit, etc. should be collected in special collection containers and disinfected with a chlorine content of 20,000 mg per liter of disinfectant solution in a ratio of 1:2 to soak for not less than two hours. The more diluted excreta should be disinfected by using dry bleach powder with an effective chlorine content of 80%, in a 20:1 dosing ratio of manure water and medicine, and fully stirred for not less than 2 hours[34].

In addition, in the water plant, staff need to be equipped with masks, protective clothing, goggles and other measures, and avoid touching the sewage, mud and fences and other areas where the virus may be stored. Disinfection of exhaust vents and filters should be strengthened and employees should be prohibited from approaching them. Strictly control and test the quality of the water to ensure that it meets the standards, and strengthen disinfection before and after taking samples[31].

7. Conclusion

We have always experienced disasters, viruses, and accidents involving many people throughout history. Each time these things happen, we should learn from the lessons and experience to ensure that we can protect our lives and the environment in the future to the greatest extent possible. Covid-19 which that have occurred since 2019 are a good example. In this article, we have selected a module on water health, comparing and summarizing the steps of existing water plants to purify water and the steps after a virus outbreak. This paper also summarizes the special protection of people themselves and their surroundings in special situations by water plants, hospitals, and related personnel. In addition to some technological changes that deserve to be documented, it is also worthwhile to follow up on how people reacted to and protected the important natural resource water during this time. The purity of water is a matter of biological and human health in every region. Not only is it worth protecting at such a special time, but measures and procedures to purify water should continue to be improved and popularized in the future. Of course, other natural resources also deserve the same urgent attention and protection during special times such as Covid-19.

References

[1] Daily news. (2019) Global water resources: one-third of human beings “highly lack of water, https://daydaynews.cc/en/international/
[2] Koshal, R.K (1976)Water pollution and human health. Water Air Soil Pollut 5, 289–297
[3] Jayaswal, K. Sahu, V., Gurjar, B.R. (2018). Water Pollution, Human Health and Remediation. Springer, Singapore
[4] Wu, Z. Water pollution loads and shifting within China's inter-province(2017), Journal of Cleaner Production, www.elsevier.com/locate/jvlepro
[5] African Journal of Biotechnology (2010), pp. 423-427, 25 January, http://www.academicjournals.org/AJB
[6] Manoiu, V.-M.; Kubiak-Wójcicka, K.; Craciun, A.-I.; Akman, Ç.; Akman, E. (2022) Water Quality and Water Pollution in Time of COVID-19: Positive and Negative Repercussions.

DOI: 10.54254/2755-2721/7/20230520

(https://doi.org/10.3390/w14071124
[7] Chu, W. Chen F. Xu, Z. (2021) Intensified Disinfection Amid COVID-19 Pandemic Poses Potential Risks to Water Quality and Safety https://pubs.acs.org/doi/full/10.1021/acs.est.0c04394
[8] S. Shanmuga P. Cuce E.& Sudhakar K. (2021) A perspective of COVID 19 impact on global economy, energy and environment, International Journal of Sustainable Engineering
[9] Sumitra P.Literature Review on Impact of COVID-19 Pandemic on Teaching and Learning, Higher Education for the Future, Sumitra Pokhrel, Phuentsholing Higher Secondary School, Ministry of Education, Phuentsholing 450, Bhutan.
[10] Chu W, Fang C, Deng Y, Xu Z.(2021) Intensified Disinfection Amid COVID-19 Pandemic Poses Potential Risks to Water Quality and Safety. Environ Sci Technol.
[11] Fitts Charles (2012) Groundwater Science [2nd Edition], Academic Press, San Diego.
[12] Aqua Tech (2021) Surface Water: Our Essential Guide To Surface Water and The Impact of Algae, https://www.aquatechtrade.com/news/surface-water/
[13] Combest, T. Municipal Water Treatment Processes, https://www.cosatx.us/home/showpublisheddocument/1010/635380914489870000
[14] Shrestha R. Spuhler Dorothee, Straining and Filtration, https://sswm.info/sswm-solutions-bop-markets/affordable-wash-services-and-products/affordable-water-supply
[15] Giovanni F. Sabino G. Maurizio G. (2008) Definition of a practical multi-criteria procedure for selecting the best coagulant in a chemically assisted primary sedimentation process for the treatment of urban wastewater, pp 229-238
[16] Mateusz M.H., Miodonski S., (2018) Chemically Assisted Primary Sedimentation as a tool to improve energy balance of a large wastewater treatment plant, https://www.researchgate.net/publication/326152050
[17] Carmel Area Wastewater District, Primary Sedimentation Tanks, https://www.cawd.org/primary-sedimentation-tanks
[18] Prakash N.B., Vimala S., Jayakaran P. (2014) International Journal of Engineering Science and Innovative Technology (IJESIT), Wastewater Treatment by Coagulation and Flocculation, https://www.researchgate.net/profile/Prakash-Nanjan-Bellie-2/publication/273638362
[19] Jiang, J. (2015) The role of coagulation in water treatment, Current Opinion in Chemical Engineering, pp36-44
[20] Unacademy, Flocculation and its usage, https://unacademy.com/content/jee/study-material/chemistry/flocculation/
[21] Ahuja N. (2017) Liquid Stream Fundamentals: Sedimentation 。 https://www.wef.org/globalassets/assets-wef/direct-download-library/public/03---resources/wsec-2017-fs-022-liquid-stream-fundamentals--clarification-sedimentation_final.pdf
[22] Petruzzello M. (2021) Filtration. https://www.britannica.com/science/filtration-chemistry
[23] Judd S. (2021)What is sludge treatment? https://www.sludgeprocessing.com/sludge-basics/what-is-sludge-treatment/
[24] Rakotonimaro, T.V, Neculita, C.M, Bussière, B. et al (2017) Recovery and reuse of sludge from active and passive treatment of mine drainage-impacted waters: a review https://doi.org/10.1007/s11356-016-7733-7
[25] Hai Faisal I, (2014) Removal of Pathogens by Membrane Bioreactors: A Review of the Mechanisms, Influencing Factors and Reduction in Chemical Disinfectant Dosing
[26] https://www.mdpi.com/2073-4441/6/12/3603
[27] J.Glinski (1985)Soil Aeration and Its Role For Plants,CRC Press, Boca Raton
[28] Noura S. Al-Deffeeri, (2008)The release of CO2 in MSF distillers and its use for the recarbonation plant: a case study, pp579-591
[29] Quilliam Richard S., (2020) COVID-19: The environmental implications of shedding SARS-CoV-2 in human feces,

https://www.sciencedirect.com/science/article/pii/S0160412020312873
[30] Chatterjee S. (2020) Resources, Conservation & Recycling, https://pdf.sciencedirectassets.com/
[31] S. Lahrich, F. Laghrib, A. Farahi, M. Bakasse, S. Saqrane, M.A. El Mhammedi, (2021) Review on the contamination of wastewater by COVID-19 virus: Impact and treatment, Science of The Total Environment, https://doi.org/10.1016/j.scitotenv.2020.142325.
[32] WHO. (2020) Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19, https://apps.who.int/iris/rest/bitstreams/1292822/retrieve
[33] Chen C. Hayward K.; Khan S. Örmeci B. (2021) Role of wastewater treatment in covid-19 control. https://iwaponline.com/wqrj/article/56/2/68/79659/Role-of-wastewater-treatment-in-COVID-19-control
[34] Leon G. Lens, Dai T., Alessandra N. S. (2021) Shedding UVC light on Covid-19 to protect dentistry staff and patients https://iopscience.iop.org/article/10.1088/1612-202X/ac0bc5/meta
[35] Christina M. M. Samantha H., Pearce R., Gerrity D. Eric C. Wert, (2022) Ozone disinfection of waterborne pathogens and their surrogates: A critical review, Water Research. https://doi.org/10.1016/j.watres.2022.118206.
[36] Wang J., (2022) Research progress on distribution and removal characteristics of novel coronavirus in wastewater treatment plants, https://www.h2o-china.com/news/337052.html