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AN INVESTIGATION ON WATER SUPPLY AND DISTRIBUTION SYSTEM'S RESIDUAL CHLORINE CONTENT: A SHORT REVIEW

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Abstract: This study investigates the residual chlorine content in the water supply and distribution systems. Chlorination is a widely used method to disinfect water and ensure its safety for consumption. However, the residual chlorine levels need to be monitored to maintain water quality standards and prevent health risks associated with both under- and over-chlorination. Comparing various RC gearbox systems in the supply of water is the goal of this study. To comprehend their influence on chlorine residuals, factors including water flow rates, pH levels, temperature, and infrastructural features are taken into account. The study analyses possible dangers to infrastructure and public health, determines what influences residual chlorine levels, and analyses the efficacy of chlorine disinfection procedures. When doing final test on consumer-supplied water, understanding the residual chlorine (RC) is essential. The World Health Organization, also known as the WHO, states that the ideal range for RC levels is between 0.2 and 0.3 mg/L. Regarding IS-10500, the suitable level is 0.2 mg/l, while the highest permissible value is 1 mg/l. The RC number indicates that a significant amount of chlorine was transmitted, which maintains the water safe - contamination and stops diseases from developing in it, according the World Health Organization's Centres for the Prevention and Prevention of Diseases (2020). Finding out how much RC is in a city's home water supply is important, especially in view of the ongoing global debate about chlorine's possible health benefits.

***Index Terms* -** Drinking water distribution system (DWTS), pH , Residual chlorine, Potable water.

I. INTRODUCTION

The process of chlorinating drinking water involves adding chlorine to eliminate bacteria and sterilise the water. The quantity of chlorine left in the water following a predetermined length of contact time is known as residual chlorine. As to IS-10500, the maximum allowable amount is 1 mg/l, whereas the appropriate limit is 0.2 mg/l. Because the system that distributes water (WDS) is a delicate, dynamic, and unique system, the quality of water for drinking may be influenced as it moves from the treatment plant to the location of consumption. It is comparable to a sizable chemical and microbiological reactor with extended dwell periods.

Measuring the concentration and RC in the water is essential to ensure that it meets all regulations and is safe for consumption. Chlorination is a typical emergency water treatment technique. In the case of a sanitary crisis, having access to safe potable water is crucial. Chlorine treatment is a crucial stage in a water for use distribution system in order to stop the spread of microorganisms or viral aquatic illnesses. (DWDN).

The World Health Authority (WHO) The relevance of viruses for public health has been classified as medium to high. Examples of these viruses include rotaviruses, these viruses, astroviruses, hcv A as well as E viruses, as well as other aquatic viral illnesses. The new coronavirus known as SARS-CoV-2, which causes COVID-19, is one new addition to this group. Although there are signs that this virus cannot be spread by drinking water, the data is still ambiguous.

Currently, managing the health effects of SARS-CoV-2 requires guaranteeing access to clean water. For tasks like cleaning, hand washing, bathing, and sanitising living areas, clean water is necessary. In order to guarantee water quality, it is necessary to keep the residual chlorine level at the water supply system's endpoint at 0.5 mg/L.

Creating a model to forecast the disinfectant level is a useful technique for ensuring residual levels of chlorine in the DWDN. Chlorine content decreases when water passes through pipes because of interactions with the pipeline wall and organic and inorganic chemicals in the water. Remaining chlorine is the water source may not effectively prevent recontamination if its concentration is too low. On the other hand, excessive chlorine levels can cause corrosion in pipe networks and customer complaints. Disinfection byproducts are produced even at low Cl2 levels.

Various approaches and strategies for eliminating leftover chlorine (RC):

- Chemical Dechlorination: By mixing chemicals like sulphur dioxide, ammonium sulfite, or bisulfite with water, chlorine can be effectively neutralised.
- Reverse Osmosis (RO): By pushing water through a membrane that is semi-permeable, RO systems may eliminate chlorine and other impurities.
- Filtration with Granular Activated Carbon (GAC): GAC filters have the ability to absorb chlorine molecules and efficiently remove them from water.
- Air Stripping: Chlorine can escape into the air by running water into an aerator or airline strip tower.
- Ozone Treatment: Chlorine molecules may be extracted from water by oxidising and breaking them down with ozone.
- pills for dechlorination: These pills are made expressly to counteract chlorine in water.

Different techniques for removal of residual chlorine are:

- Boiling : Boiling water for several minutes can effectively evaporate chlorine.
- Standing Time : Allowing water to sit for a few hours can also allow chlorine to dissipate naturally.
- Ultraviolet (UV) Irradiation : UV light can break down chlorine molecules, rendering them harmless.
- Filtration : Filtration methods like activated carbon or particulate filters can trap chlorine particles and remove them from water.
- Chemical Dechlorination: Chlorine can be neutralised in water by adding chemicals like sodium bisulfite, sulphur dioxide, or sodium sulphate.
- Ascorbic Acid (Vitamin C) : Adding ascorbic acid to water can effectively neutralize chlorine.
- Reverse Osmosis : RO systems can remove chlorine along with other contaminants by forcing water through a semi-permeable membrane.
- Aeration : Allowing water to aerate by exposing it to air can help chlorine to dissipate.

II. LITERATURE REVIEW

- Investigation of the amount of residual chlorine in Samarra City, Iraq's water supply distribution network [1]

The study presents that the free chlorine at user point was slightly greater than 0.3 ppm, which is higher than WHO standard at 0.2-0.3 ppm. Ten stations of the city were selected to take the tap drinking water samples. According to the test results, residual chlorine concentrations vary from 0.1 to 0.3 mg/l. There are variations in RC concentrations between unaccepted low 0.1 mg/l on July and high 1ppm on Nov. and Dec.-2010 in most stations. The high concentration of RC may have negative effects, especially when organic compounds like phenol are present and forming carcinogenic material. High RC is not recommended except in cases of waterborne epidemic diseases, especially Cholera. This study may be attributed to the random addition of chlorine that is carried out by WSP operators. The fact the warm water speeds up the breakdown of chlorine & vice versa may help to explain this. However, since the majority of Samarra households rely on elevated small storage tanks that are directly exposed to the weather, higher temperatures may be expected at midday in July and lower temperatures at night in December. [1]

- The way residual chlorine behaves in the little water supply system's a distribution system [2]

The behaviour of residual chlorine in a small drinking water supply in La Sirena, Cali, the capital of Colombia, is investigated in this study using computer modelling. To validate and recalibrate the model, fieldwork and laboratory data are combined. The results show that remaining chlorine action in such systems may be well described by first- and second-order kinetics as well as mixed-order kinetics. The study presents a valuable tool for water quality monitoring in the distribution system by demonstrating the applicability of residual chlorine models in this particular network. It's crucial to continue adhering to water quality regulations.

The drinking quality of water can be impacted by its path from wastewater treatment plants to final consumers. This is because water distribution networks, which have extended residence durations, are fragile and complicated devices. Therefore, to protect water quality across the distribution network, efficient management and monitoring are crucial.. Consequently, it is essential to guarantee a certain disinfectant concentration throughout the distribution system, considering that if its concentration is reduced below the guideline value through the network, it can promote bacterial growth with consequent health risks if a minimum concentration is not provided. Water with a short contact time in the supply sources stays chlorinated for a long period (a few hours to several days) before being used in the pipelines and storage tanks. [2]

- The residual amount of free chlorine in the water for consumption supply system [3]

This essay discusses the process of chlorination and reveals the amount of free chlorine that remains in the water supply distribution system on the Malaysian Peninsula. The study found that user areas had slightly higher free chlorine levels above the WHO standard of 0.2–0.3 mg/l, at around 0.3 mg/l. However, there was no assurance that the amount of germs would be decreased because the findings showed that the overall coliform bacterial count exceeded the Malaysian Waters Association's suggested level. Therefore, since the water from the faucet at the in-take station cannot be utilised for direct consumption, extra treatments like filtering and boiling are required. Most microorganisms can grow well in temperatures between 25ºC and 35ºC, and this temperature range also accelerates the chlorine evaporation rate, which lowers the concentration of hypochlorous acid in the equilibrium reaction. The hydrolyzed form of chlorine in water is known as hydrochloric acid, and it has a powerful potential to eradicate a variety of diseases. Strong sunshine also causes a photo-degradation process that lowers the stability of hypochlorite. Additionally, the consistency of water treatment system operation is also impacted by the significant rainfall that is received annually, ranging from 1000 to 2000 mm. In Peninsular Malaysia, a drinking water distribution system free chlorine residual was discovered as a result of this study, which also included the chlorination process's basic principles. It was discovered that the chlorination procedure is ineffective in acting as a disinfectant and preventing bacteria regrowth. Furthermore, a high free chlorine residue concentration at the treatment plant and the intake point was not guaranteed to eradicate the microbial, so additional treatments like filtration and boiling are needed. The tap water at the intake point is not suitable for direct consumption. [3]

- Undiscovered: The inadvertent effects of leftover chlorine on biofilms and water quality [4]

Disinfection residuals are necessary in drinking water supply systems (DWDS) to keep germs from growing again. Nevertheless, it is frequently disregarded how these residuals affect biofilms inside the distribution network. This study used a full-scale laboratory facility to assess how various free chlorine regimes affected the characteristics of biofilms and the quality of the water.. Unexpectedly, higher free chlorine levels resulted in deteriorating the condition of water, as seen via increased discolouration and inorganic loading—a typical explanation for customer complaints. Increased concentrations of chlorine decreased the number of biofilm cells, but they also promoted some potentially dangerous bacterial populations or inorganic matter. Chlorine, an indication that water was adequately treated to remove. These results cast doubt on the notion that the safety of drinking water is guaranteed by measurable free chlorine residuals. Making sure there is clean drinking water is crucial for maintaining public health. DWDS, which is made up of pipes and accessories, is essential to the delivery of treated water. But throughout distribution, the quality of the water deteriorates, resulting in poor quality and complaints from customers. Drinking water colouring is a global sign of water quality difficulties and can conceal other issues, such as microbial ones. It is often produced by high turbidity owing to components like iron. Chlorine residuals are one of the environmental factors that affect biofilm development in aquatic settings. This study offers a realistic perspective of DWDS settings and offers important insights into way biofilms react to residual chlorine in HDPE pipelines. The results highlight the significance of all-encompassing approaches to managing water quality that go beyond only preserving measurable residuals of chlorine. [4]

- Assessment of the amount of remaining chlorine in the county water supply in Uasin Gishu [5]

This study's main goal is to evaluate the amount of residual chlorine in water, especially in Uasin Gishu , where levels are higher than allowable limits and may pose health hazards, such as an increased risk of cancer-related illnesses. The residual chlorine (RC) levels are highly influenced by the distance between the treatment plant and the consumer point; longer distances result in higher rates of chlorine decay and lower RC. Naturally occurring and used for many purposes, including cleaning, disinfection, and whitening, chlorine can be harmful if breathed in as a gas or liquid can cause respiratory problems. Salts contain a lot of chlorine ions, which is one reason why it is so common in natureRemaining chlorine, also known as free chlorine, indicates that the water has been properly treated to remove germs and viruses and prevent diseases like diarrhoea. Remaining chlorine is a valuable indicator of drinkable water since it shows that there are no harmful bacteria present. When bacteria come into contact with chlorine in water, their cell membranes are ruptured. But if silt prevents direct contact with organisms, its efficacy could be jeopardised. Furthermore, chlorination is not always effective in totally eliminating some insoluble contaminants. Chlorine must come into touch with water for a minimum of thirty seconds at temperatures higher than 18°C in order to effectively disinfect it; longer contact durations are needed for water that is colder. Chlorine is an efficient waterborne sickness preventive when it is distributed through pipes, but it is superfluous and maybe dangerous to have it anywhere else than the tap. [5]

- The level of residual chlorine in Kirkuk City's drinking water and its potential health risks [6]

The current study attempts to measure the amount of residual chlorine in Kirkuk City's drinking water as well as certain crucial drinking water parameters including pH, temperature, and turbidity, TDS and determine and compare them with the limit allowed in Iraqi Standards. The tests are done using LOVIBOND disk with a (DPD) detector, a powder prepared in special containers used for each test. One of the most important natural resources we use every day is water, which is treated at water treatment facilities to make it safe to drink, taste good, and be odor and contaminant-free. This has led to the establishment of a standard for drinking water quality. It is well known that the transfer units of sedimentation and filtration are used during the water treatment process to remove contaminants. Chlorine is a key component of the drinking water purification process used by the majority of water treatment facilities in Iraq, where it helps to eradicate a variety of pathogens. The present study looks at key drinking water characteristics including pH and the amount of residual chlorine in Kirkuk the Crew's water availability in order to determine the water's appropriateness for human consumption, temperature, turbidity, electrical conductivity (EC), and total soluble solids (TDS). It also examines the relationship between these parameters and compares them to the limit permitted by the Iraqi Standards. The Tigris River (Lower Zab) is the project's primary water supply, and chlorine gas is used in the project to cleanse the water. The Kirkuk Unified Water Project is situated in the Kiwan(K1) area, northwest of Kirkuk, and it pumps drinking water to all areas in the city's center. The project's five underground tanks have a design capacity of 75 million gallons per day. They are located throughout the city. In accordance with, the city was divided into five stations, and samples from each station were collected monthly at a rate of five samples per station from January to June 2017. The samples were collected from the locations using 2-liter plastic bottles after they had been rinsed twice with the sample water at each station. All necessary tests were carried out in the laboratory of the Directorate Water of Kirkuk after the plastic bottles had been securely closed and transported there. [6]

- Simulation of residual chlorine within a drinking water system during the SARS-CoV-2 pandemic (COVID-19) [7]

The recent new coronavirus epidemic has shown how crucial it is to maintain clean public water sources. Adequate chlorine levels are essential for quickly eliminating dangerous germs and viruses from the water supply distribution system (DWDN) and for leaving a protective residue. A residual chlorine decay model was created in order to solve the requirement for precise forecasting of chlorine levels inside actual drinking water distribution networks. This approach makes it possible to evaluate how much residual chlorine is present in drinking water and is especially useful while fighting COVID-19. As water traverses the distribution system post-treatment, its quality may deteriorate due to various factors, Chlorine deterioration in water supply lines is a complicated process that is impacted by a number of variables. Both organic and inorganic materials, as well as tube surfaces, react with chlorine. Chlorine's capacity to stop recontamination decreases as concentrations drop throughout the pipeline, increasing the possibility of customer complaints and infrastructure degradation. The complex link between chlorine and the dynamics of water quality is further highlighted by the fact that reduced chlorine levels might result in the production of disinfection byproducts. Liquid-phase reactions or interactions at the interface between liquids and solids are both responsible for the decrease in chlorine content. In water quality models, free chlorine is the least conservative element. It usually decays first-order, representing an exponential decline in concentration. Furthermore, the presence of organic matter in water causes chlorine to react, therefore the rate at which it reacts with the bulk weight of water (kilobyte, bulk decay) must be taken into account. It's also important to recognise that materials in drinking water might stick to pipeline walls and change the dynamics of chlorine degradation there. [7]

- Chlorine level that is still present in a basic water consumption distribution system with intermittent water supply analysis [8]

This research suggests merging hydraulic then and water quality techniques to calculate the remainder of chloride content in a simple branching system. It does this by raising the chloride node for erratic water supply and applying the first-order the algorithm for chlorinated degradation. Explicit formulae are created to calculate the quantity of residual chlorine at key nodes in a system having a long distribution pipeline. The furthest node's residual chlorine in irregular water supply networks appears to be sensitive to both the duration of the chlorine journey and the hours of water delivery. It has been demonstrated that booster chlorination helps to preserve a balance between the lowest and highest chlorine concentrations. To stop water from being contaminated again in the Drinking Water Delivery Systems (DWDS), water providers need to implement the right chlorine application techniques. Scholars have investigated diverse approaches to guarantee sufficient residual chlorine concentrations during the distribution network. In this study, residual chlorine levels in a basic DWDS network are measured at several sites using a sample system that has an intermittent water supply. A comparison is conducted between two methods of applying chlorine: booster chlorination and standard methods. The purpose of this study is to quantify the residual chlorine concentration at different sites in a simple distributed distribution system for water using an experiment network that has an intermittent water supply(DWDS). A comparison is made between two methods of applying chlorine: booster chlorination and standard methods. Hydraulic and chemical water quality models are integrated for intermittent supply with booster nodes using first-order chlorine decay. Chlorine combines with both organic and inorganic substances to form hazardous disinfection byproducts, or DBPs, and this reaction happens quickly across large distances and at moderate speeds. The strategy for administering chlorine assesses the impact of transit time on residual chlorine as well, which is established by the hours of delivery. Explicit formulae based the effective assessment of the chlorine residual % at different network nodes is made possible by information on the overall rate of flow of chlorine. The reactivity of water delivery times or the transit length to residual chlorine can be used to regulate supply hours for irregular water supply systems. The link between residual levels of chlorine and booster chlorine is made clearer in this study. [8]

III. CONCLUSION

The review paper emphasises the importance of maintaining the security of water and purity while offering insightful information on remaining chlorine levels in water distribution while providing systems. It underlines how important it is to keep an eye on the amount of residual chlorine in the water's supply and delivery system. In order to effectively disinfect and guarantee the safety of water for consumption, an adequate concentration of chlorine is required. Remaining chlorine levels are greatly influenced by a number of variables, such as water use trends, pipe materials, and proximity to wastewater treatment plants.

REFERENCES

1. Abbas Hadi Abbas conducted a study on residual chlorine concentration in the water supply distribution system of Samarra city, Iraq. The findings were published in the International Review of Chemical Engineering (I.Re.Ch.E.) in September 2011.
2. Andrés Araya and Luis D. Sánchez investigated residual chlorine behavior in a distribution network of a small water supply system. Their research was published in the Journal of Water, Sanitation, and Hygiene for Development on February 8, 2018.
3. Rosalam HJ. Sarbatly and Duduku Krishnaiah examined the free chlorine residual content within drinking water distribution systems. Their work was published in the International Journal of Physical Sciences on July 2, 2007.
4. K.E. Fish, Nik R McLaren, Stewart Husband, and J. Boxall studied the unintended impacts of residual chlorine on water quality and biofilms. Their findings were published in Biofilms and Microbiomes on September 25, 2020.
5. Kiprop CK, Abuto E, Fredrick O, and Kaneza Y conducted research on determining residual chlorine in Uasin Gishu’s county water supply. This study was carried out at the University of Eastern Africa, Kenya, and published on October 18, 2021.
6. Y.H. Mahmood, B.M. Ibrahim Al-Hilali, and A.T. Kalaf investigated the concentration of residual chlorine and its health effects on the drinking water of Kirkuk city. Their research was published in the Kafkas University Institute of Natural and Applied Science Journal on October 18, 2018.
7. F.G. Ávila, A.A. Añazco, J.O. Jara, C.G. Quezada, L.F. Del Pino, and L. R. Fernández conducted modeling of residual chlorine in a drinking water network during the SARS-CoV-2 (COVID-19) pandemic. Their work was published online on March 11, 2021.

8. Roopali V. Goyal and H. M. Patel analyzed residual chlorine in a simple drinking water distribution system with intermittent water supply. Their research was published online on May 20, 2014.