Water Treatment Methods and Its Applications for Electrochemical Oxidation

Mukesh Kumar[1]* Dr. Nimisha Kiran[2]

[1] Research Scholar, Department of Chemistry, Sri Satya Sai University of Technology & Medical Sciences, Sehore, Madhya Pradesh

[2] Supervisor, UTD Sri Satya Sai University of Technology & Medical Sciences, Sehore, Madhya Pradesh

Abstract – By producing hydroxylic radicals, electrochemical oxidation offers an incredibly efficient oxidation environment that allows adequate water purification to eliminate persistent contaminants. In this study we have discussed about the scarcity in terms of quantity and quality, need for water and wastewater treatment, common water treatment methods, electrochemical oxidation, applications of electrochemical oxidation in wastewater treatment, need of water disinfection which is concluded that Water fewer flowed through the waterways will minimize piping, rehabilitation and sediment disturbances, while creating an infrastructure best maintained. This can indicate fewer drainage of the storm by collectors for infiltration. Maybe one day, with improved storage and distribution methods, water supply problems would be overturned.

Keywords – Water Treatment, Electrochemical Oxidation, Method, Application

\- X -

INTRODUCTION

The water that falls from heaven is the source for life on Earth, consciously or implicitly. The key role of water for our world and its citizens is also summarized by the term "water is life." It is also named "Universal Solvent" owing to its excellent attribute. Water is an increasingly endangered, yet sustainable resource in our Blue World. We live in a time of great transition and human behavior has imposed growing pressure on all the resources of the planet, including the most important, water.

As 2/3 of Earth is covered by water, Earth is considered the wet world. There is plenty of water on earth, with water reaching about 70 percent of the land of the globe. Although the world's gross water volume is 1.4 x 109 cubical kilometers, the remainder is oceanic saltwater just 2.0%. Or 3.5 x 107 cubic km. The overall available availability of freshwater to wildlife and citizens is less than 1 percent and just 0,01 percent of Earth's water is 2 x 105 kilometers of water. The average global consumption of this accessible resource is 10 per cent per year, with the fraction growing, especially in dry regions with high population or economy growth. The decline in water quality and quantity is symptomatic of wider issues with the climate, primarily attributed to human interventions that refuse to consider broader repercussions.

Although everybody worries about the price of fuel, water shortages and water are two issues of rising importance that could rapidly and easily solve the petrol crisis. Fossil fuels can substitute renewable energy sources – but freshwater cannot be substituted. Providing safe, abundant human freshwater is one of the world's most urgent challenges today.

SCARCITY IN TERMS OF QUANTITY AND QUALITY

Symptoms of physical water shortage may give rise to many environmental problems, including degradation in river quality, a decline in groundwater and water distribution problems where some groups benefit at the cost of other groups. Researchers report 1.2 billion people in areas defined by physical water scarcity, where there is inadequate resources for meeting all demand, they also estimate that an additional 1.6 billion people live in areas which face "economic water shortages," i.e. where water resources are abundant relative to water usage, but investors are not in the growing requirement for water. In general, around 2.8 billion inhabitants, more than 40% of the global population, are therefore expected to reside in the river basins, of which one type or the other of water shortage needs to be taken into account. With respect to future, this condition is expected to be compounded by a variety of factors. The first aspect is the growth in the global population, which presently stands at 7,045 trillion and is estimated to exceed 8.2 trillion people by 2030.

Groundwater is widely known to be pristine and usually not poisoned. Groundwater pollution, on the other side, is even more harmful since Aquifers retain around 97 per cent of the world's groundwater, supplying about a third of the planet's citizens with clean water. More than a billion citizens in Asia alone depend on drinking groundwater. The global growth of irrigated farmland has centered more over groundwater. As such, groundwater pollution poses an unprecedented danger to biodiversity and human sustainability. Safe water – in many areas of the world a need has become a privilege.

NEED FOR WATER AND WASTEWATER TREATMENT

Water is becoming ever more important as blue gold. Contingent imbalances are well known and demonstrate the unsustainable existence of water use trends in the global water supply and demand. The world's water supply and demand equilibrium is stressed by three main factors: rural/urban displacement, climate change, and emissions. The assumption that the market exceeds output is the bottom line. In the 20th Century, global water use was sixfold, double the population growth rates over the same time. According to the Bureau Of Statistics. This rate continues today, with population development and strains on their capital for water supplies to support industrial growth in countries like China and India. In short, the old reports of water shortages appear to be realistic.

Clean water market is causing strides in the handling of water and wastewater. The main explanation for the disposal of pollution is that less than 1% of the water in the world is appropriate for drinking, while the remainder is brackish. As a consequence, new and safe water, in particular for drinking purposes, is urgently required. As the demand for safe water and waste water processing has risen, waste water treatment for good quality pure water has become compulsory. This raises the need for high-quality water after treatment systems that do not affect citizens or the ecosystem.

The consistency of the water they drink today scares citizens. Although water covers over 70% of the planet, just 1% of the earth's water is drinking as well. And the valuable resource is polluted by our culture. Water is a natural solvent noted for its nature. It falls into contact with several different substances, including organic and inorganic substances, pharmaceutical materials, and other toxins until it hits the tap of the user. Most municipal water supplies utilize chlorine to disinfect water to destroy pollutants that may exist in water generating diseases.

COMMON WATER TREATMENT METHODS

Generally, the traditional techniques utilized in water treatment involve the physical treatment of filtration and sedimentation, the use of electrical radiation such as ultraviolet light and biological processes such Como slows and or activated sludge.

Physical Methods

This covers methods that do not make any significant chemical or biological improvements and are strictly helpful in upgrading or handling wastewater. This typically consists simply of storing the wastewater in a cistern for a short period, enabling the heavy solids to settle and the "clarified" effluent to be collected. Aeration, i.e., the adding of physical oxygen, is typically one of the most regular physical treatments utilized by the treatment; another physical therapy consists of aeration. Filtration also includes some physical phenomena seen in therapy. Waste water is moved to separate solids using a filter medium here. One example is the usage of sand filters to extract the expressed solids from a wastewater treatment.

Chemical Methods

Chemical refining requires the use of certain additives or chemical reactions to enhance the consistency of water. Chlorination is perhaps the most widely used chemical method. Chlorine is used to destroy microbes using a heavy oxidizing agent. The handling of water is achieved by chemical neutralization, chemical coagulation, chemical precipitation, chemical oxidation and chemical disinfection.

These oxidizing agents control the bacterial biological production process, thus rendering the water available. In industrial wastewater treatment, a chemical procedure called neutralization is widely used. Acid or base is then applied to the water to change its pH to neutrality. Lime, which is primarily used in the neutralization of acid waste, is a popular basis in this method.

Biological Methods

Microorganisms, such as microbes, are used in the biological water management method to biochemically break down wastewater to stabilize the finished product. Biological system of water treatment shall consist of two anaerobic and aerobic subdivisions. During the aerobic process, the sludge is fermented to a specific temperature in the absence of oxygen, and bacteria use organic material to convert it in the presence of oxygen to carbon dioxide.

Composting is just another aerobic method of handling sludge with carbon sources like sawdust. More microorganisms are produced or sludges and a part of the waste is turned into biomass, water and other end-use items. Finally, it might even be appropriate to handle odors, postpone biological activity or the elimination of pathogenic species.

ELECTROCHEMICAL OXIDATION

Electrochemical oxidation or electrosurgery is the most popular electrochemical procedure for extracting organic compounds from wastewater. This process has recently been used to paint aqueous dyes and decay them. This involves the degradation of toxins by an electrolytic cell:

- Direct anodic oxidation (or direct electron anode transition) leading to very weak decontamination. Chemically consumed by anodized water release electrogene species "action oxygen," "active oxygen" (Physio-sorbent hydroxyl-adsorbent (*0H)) or chemisorbed "active oxygen" (MO) oxygen grating). The absolute or selective decontamination of these oxidizing bacteria is responsible for respective.

- The two main methods for mitigating wastewater emissions suggested through indirect oxidization or controlled oxidation of diverse heterogeneous water-disposal species:

- The method of electric conversion by which refractory organic materials are selectively transformed to biodegradable substances, usually carboxylic acids with chemisorbed "active oxygen.'

- The electrochemical combustion phase where organic compounds, i.e., inorganic and CO2-oxidized ions have completely mineralized, have been physiosorbed "Yeah." The radical oxidant, the second strongest after fluorine, is able to achieve the maximum degree (E°=2.80V vs SHE), which makes CO2 simple to react with other organic materials.

For concurrent oxidation of contaminants and water, high cell voltages are added to the electrochemical cell to preserve anode operation. The usage of low-cell voltages stopping O2 production also induces anode activity loss and such by-products developing as a consequence of direct anodic oxidation can be adsorbed on its surface and thus this mechanism is not used in practice to handle wastewater. The design of anode content has been shown to greatly influence both electro-oxidation selectivity and performance. In order to explain this behavior, the researchers suggested an extensive model for organic acid destruction, including the competition with the oxygen evolution reaction.

APPLICATIONS OF ELECTROCHEMICAL OXIDATION IN WASTEWATER TREATMENT

The efficacy of the electrochemical oxidation method in the handling of numerous complicated waste water containing different contaminants has been examined as an efficient treatment process. In addition, substantial attempt has been made to remove electrochemical oxidation from micro-contaminants lately. Microorganisms may usually be disabled by the direct electrochemical mechanism or the generation of 'monster' agents (e.g., OH). The combination of the removal of contaminants and wastewater disinfection in a single processing phase provides an appealing alternative, primarily in terms of water recycling and reuse where successful exclusion of pathogens is important to public health security.

Researchers also examined post-treatment of wastewater in slaughterhouse via electrochemical oxidation. Influential COD 220 mg/L, a current density of 30 mA/cm2 and 55 min period for reaction defined the most favorable parameters. The outcome was 96.8% color elimination, 81.3% BOD removal, and 85.0% COD removal. The removal performance of textile wastewater by electrochemical oxidation was 78% of COD and 92% of turbidity in optimum operating conditions (initial pH 6,9, current density of 10 mA/cm2, conductivity of 3990 micro-s/cm and electrolysis period 10min). In maximizing settings, energy and electrode usage is measured at 0.7 kWh/kg COD (1.7 kWh/m3) and 0.2kg Fe/kg COD (0.5 kg Fe/m3). The highest COD removing was obtained by 68 per cent under operating conditions of 4 h reaction period and 79.9 mA/cm2, whereas originally the COD was 1,414 mg/L electro-chemically processed leachate use graphite electrode materials by Bashir et al. (2009). Around 73% of COD, 57% of TOC, 86% of color removals with a current density of 116.0 mA/cm2 and 180 minutes of the reaction were obtained in another analysis performed by researchers. As an electrode anode, they used oxide-coated titanium. In continuous tubular reactor, the electrochemical treatment of wastewater-based industrial paint was investigated. Original COD density of 30°C, 35g/l of electrolyte and 7496 mg/L were analyzed in reaction time at the results of COD, colour and turbidity removals, with existing densities of 66.8 mA/cm2. The reactor had an ideal residence time of 6 hours for cost controlled methods, allowing the elimination of COD, color and turbidity, respectively, of 44.3%, 86.2% and 87.1%.

Researchers also studied the electrochemical treatment of environmental compounds from paper mill effluent. The findings indicate that the ratio of COD and color removals was 97% to 100%. The measurement of power usage indicates that, depending on working conditions, electricity consumption varies from 4 to 29 kWh/m3 of effluent. Another research analyzed electrochemical oxidation in paper mill effluents using a dimensionally robust Ti/RuPb (40 percent) Ox composition anode. The findings show that after 15 minutes of electrolysis, nearly 99% of COD and 95% of colors and polyphenols were extracted. The illustration of the continuum UV-Vis confirms the production of hypochlorite ions (ClO-) during electrolysis, suggesting an indirect process involving hypochlorite ions for electrochemical oxidation. The removal rates of organic goods in olive oil mills with rising current density, amount of sodium chloride, recirculation temperature have improved. Initial COD concentration of 41 000 mg/L was lowered to 167 mg/L, 99.85% turbidity reduction, 99.54% oil-grease removal was achieved at 135 mA/cm2, 2M NaCl, 7.9 cm3/s and 40°C after 7 h electrolysis. The impact on the Pharmaceutical Wastewater Performance by the method of electro oxidation of established density (40-120 A/m2) and original pH (3-11) was studied. The methods used for alumina electrode removal after 25 minutes is 24% of the COD removal in optimal operating conditions (CD 80 A/m 2; pH 7.2). The procedure used for carbon electrode removal was 35.6% after 90 minutes of treatment. An investigation was rendered with a current density of 2.1 A/dm2 of Tannery's waste water treatment utilizing graphite cathodes and Ti/SnO2/PdO2/RuO2 anodes. The catholyte was moved to the anodic space after 55 minutes of the operation. The COD was reduced by 52.0 percent after 55 minutes of electro-Fenton process. The continuation of the electrical oxidation process contributed to the depletion of ammonia at 55 minutes and a cumulative decrease of 72.9% in COD.

Owing to their excellent success in handling various forms of waste water, especially agricultural waste water and wastewaters that includes significant quantities of harmful and non-biodegradable compounds, electrochemical oxidation is a helpful approach to avoid the usage of traditional biological contaminants by means of refractory and hazardous pollutants. Complete COD, colour, ammonia and micro-organisms may be extracted in acceptable operating conditions.

NEED OF WATER DISINFECTION

The development of several kinds of microorganisms may be assisted by water. It is dangerous and often life-threatening if disease-causing microbes are found in water. The public has long been worried with microbiological water pollution. The **WHO** reports that 94 per cent of these diarrheal incidents will be avoided by environmental amendments, including access to clean and sanitary water and sanitation enhancements. The primary factors of diarrheal diseases and gastric infections remain groundwater and water bodies polluted with pathogenic bacteria. In human health and well-being, healthy drinking water plays an essential function. Efficient and affordable disinfectant technologies are desperately required to solve issues created by a disease outbreak.

WHO reports that about 2 million children in the developed world are now dying per year of infected water-borne infectious diseases related to drinking-water outbreaks? Failures contributing to these outbreaks are very normal and generally include heavy rain and insufficient method of disinfection. We ought to incorporate feasible preventive and treatment actions to curb these problems. Sanitation and drinking water disinfection can be provided. Water disinfection involves the removal, deactivation or destruction of pathogens, which ends the development and reproduction of pathogens.

Conventional Disinfectants and Bye Products

Conventional approaches for the disinfection of microbial pathogens and water-borne epidemics, such as chlorination and ozonation are important measures in preparing the water In order to handle both the powder and the liquid phase of chlorine goods, halogenation (usually for such products as bromination or iodization) is far more specifically necessary and is synonymous with unsafe chemical handling. In order to introduce the mass programs, ozonation is another disinfection approach, again not a cost-effective option for citizens in third world countries. An extra expensive option as it is used as a point of service is ultraviolet ray exposure for disinfection. Despite their disinfection efficacy, these strong oxidants respond to the production of a broad variety of by-products (DBP), some of them considered to be carcinogenic, utilizing natural organic matter (NOM). Therefore, it was of strong interest to find a disinfection solution with minimum DBP generation.

Silver as Disinfectant

For decades, silver's disinfectant virtues have been recognized. History is full of proof of the purification effects of silver. Aristotle instructed Alexander the Great, according to researchers, to boil and preserve water in silver vessels to avoid diseases from being spread by water. In their water tanks, colonists traversing America placing silver coins.

In board the Challenge space shuttles and the space station, NASA now employs silver to generate the CO2 chemisorption process. Today, silver is used to avoid infection in burned victims, prevent newborns from being blind, manufacture bacteria-free cosmetics, disinfected containers for water storage, like ponds, monitor legionella bacteria in hospitals and enhance drinking water filter efficiency. Silver has long been known for its antimicrobial effects.

Mechanism of Silver Disinfection

Silver is a bacteriostat that is especially powerful and that has no adverse effects on people. However, serious cases of over-exposure allow the skin to stain the cosmetic blue, including Argyria. A possible antimicrobial agent is recognized for long time as the silver ion (Ag+). The Silver ions are able to bind and inhibit the bacterial cells and enzyme (proteins) from conducting their functions in different locations and results in cell death by entering the bacterial DNA and RNA.

(a) Strip the atoms of hydrogen from bacteria and viruses from the sulfhydride groups (-SH). Sulfur atoms then enter and obstruct breathing in the cells and transferring electron.

(b) Interfere with the unwinding of DNA, avoiding duplication of DNA.

(c) Change the enzyme bacterial membrane.

Based on its large volume-to-surface ratio, silver as nanoparticles that emit more efficiently silver ions has stronger bactericidal activity. Latest experiments also shown strong antibacterial activity in distinguished silver nanoparticles. Although the introduction of nanoparticle-based disinfection in traditional treatment is currently challenging in cost-effectiveness and methods of operation, the creation of a potable water treatment device (POU) is more easily overcome through.

CONCLUSION

The key goals include the measurement and review of the use of nanotechnology and electro chip techniques in the elimination of environmental contaminants from drinking water supplies in the groundwater chosen for drinking water sources. Currently there are typical issues (cracks in pipes, infiltration, plugging, etc.) whether our homes should be fitted with self-sustaining water modules. Water fewer flowed through the waterways will minimize piping, rehabilitation and sediment disturbances, while creating an infrastructure best maintained. This can indicate fewer drainage of the storm by collectors for infiltration. Maybe one day, with improved storage and distribution methods, water supply problems would be overturned. The public is deeply worried with the elimination from the metropolitan centers of major river systems of any dangerous pathogens in drinking water. Solar electricity would be best used in the future. Specific methods for bacteria cultivation would make us less reliant on resources and more productive.

REFERENCES

1. Ahmad, A. L., Wong, S. S., Teng, T. T. and Zuhairi A. (2007). "Optimization of coagulation–flocculation process for pulp and paper mill effluent by response surface methodological analysis", J. Hazard. Mater., Vol. 145, pp. 162-168.

2. Ahmad, A. L., Wong, S. S., Teng, T. T. and Zuhairi, A. (2008). "Improvement of alum and PACl coagulation by polyacrylamides (PAMs) for the treatment of pulp and paper mill wastewater", Chem Eng J., Vol. 137, pp. 510-517.

3. Balasubramanian, N. and Srinivasakannan, C. (2010). "Electrocoagulation/ electro flotation-fundamentals, present and future perspectives", In: Electrolysis: Theory, Types and Applications, Nova Science Publishers, Inc.

4. Balasubramanian, N., Toshinori Kojima and Srinivasakannan, C. (2009b). "Arsenic removal through electrocoagulation: Kinetic and statistical modeling", Chem Eng. J., Vol. 155, pp. 76-82.

5. Bayramoglu, M., Kobya,M., Eyvaz, M. and Senturk, E. (2006). "Technical and economic analysis of electrocoagulation for the treatment of poultry slaughterhouse wastewater", Sep. Purif. Technol., Vol. 51, pp. 404-408.

6. Bhattacharya, P. K., Jayan, R. and Chiranjib Bhattacharjee, A. (2005). "Combined biological and membrane-based treatment of prehydrolysis liquor from pulp mill", Sep. Purif. Technol., Vol. 45, pp. 119-130.

7. Bo Wang, Lin Gu and Hongzhu Ma (2007a). "Electrochemical oxidation of pulp and paper making wastewater assisted by transition metal modified kaolin", J. of Hazard. Mater., Vol. 143, pp. 198-205.

8. Bozzi, A., Yuranova, T., Mielczarski, E., Mielczarski, J., Buffat, P. A. and Kiwi, J. (2003). "Superior biodegradability mediated by immobilized Fe- fabrics of waste waters compared to Fenton homogeneous reactions", Appl Catal B-Environ., Vol. 42, pp. 289-303.

9. Canizares, P., Martinez, F., Jimenez, C., Saez, C. and Rodrigo, M. A. (2009). "Technical and economic comparison of conventional and electrochemical coagulation Processes", J. Chem. Technol. Biotechnol., Vol. 84, pp. 702-710.

10. Dionissios Mantzavinos and Elefteria Psillakis (2004). "Enhancement of biodegradability of industrial wastewaters by chemical oxidation pre- treatment", J. Chem. Technol. Biotechnol., Vol. 79, pp. 431-454.

11. El-Ashtoukhy, E. S. Z., Amin, N. K. and Abdelwahab, O. (2009). "Treatment of paper mill effluents in a batch-stirred

electrochemical tank reactor", Chem Eng J., Vol. 146, pp. 205-210.

12. Entezari, M. H. and Petrier, C. (2003). "A combination of ultrasound and oxidative enzyme: sono-biodegradation of substituted phenols", Ultrason Sonochem., Vol. 10, pp. 241-246.

Corresponding Author

Mukesh Kumar*

Research Scholar, Department of Chemistry, Sri Satya Sai University of Technology & Medical Sciences, Sehore, Madhya Pradesh