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Performance of Solar Driven Disinfection Systems Based on Anodic Oxidation and UV Techniques in India.

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ABSTRACT

In developing countries, the widespread of technologies for domestic wastewater treatment achieve significant reduction of major pollutants like organic matter, suspended solids, nitrogen and phosphorus. However, for disinfection, the most common method that is being applied is chlorination. The main problem associated with conventional chlorination is the formation of THM that may have carcinogenic effects if mixed with residual organic matter. In order to overcome with these issues, disinfection systems based on Anodic Oxidation (AO) and UV have been validated through a research project "SWINGS". This project has been implemented at three places in India (Aligarh, Kalyani and Amarkantak) with aim to treat the wastewater for its optimum use for agriculture, public flushing and fish farming. The treated effluent after constructed wetlands has been applied separately on these two novel methods. Study has revealed that coliforms removal in both the systems has been extra-ordinarily very high. At many times, the effluent after AO & UV has been found with almost zero coliforms. However, the E-coli in the effluent are always found nil. The operating cost of these two pilot disinfection systems is also very low as no external energy or chemicals are required to run these novel systems.

Keywords: Oxidation, Constructed Wetlands, Ultra Violet Treatment, Wastewater.

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INTRODUCTION

Maintaining a high microbial quality of drinking water is a keystone of public health. The untreated sewage is one of the main contributors of different types of pathogens to the environment. The fecal pollution present in water bodies may constitute a risk of transmission of waterborne diseases, especially in bathing zones or shellfish farming areas. In past few decades, public health has been suffered from infectious bacteria such as *Shigella, Escherichia coli, Vibrio cholera* and enteric viruses. It is thus important to treat sewage by adequate processes to remove pathogens.[1]

In developing countries, disinfection of sewage water is commonly achieved with the help of two methods, chlorination and ultra-violet radiation (UV). With these methods, significant reduction of the pathogen load can be obtained. But in the former case, there is a risk of toxic, mutagenic and carcinogenic properties of their by-products. In addition to this, these techniques have high-recurring costs. In the case of chlorination, the usage of chemicals is huge. Whereas in an UV system, the energy cost is the main financial burden. In developed nations, chlorination is not being preferred due to ill-effects of residual chlorine. Some other technologies that are used in these countries are Ozone, micro-filtration, Distillation etc. In developing countries like India, a much emphasis is being given to find out new solutions for disinfection. The focus is on to explore inexpensive methods that are technologically compatible with other treatment processes.

This paper present the results of the study conducted within the research project "SWINGS" supported by the Government of India and European Commission. Under this study, two pilot plants to disinfect treated sewage have been deployed and validated.

MATERIALS AND METHODS

Pilot Plants Set-up:

This study was carried out on two different pilot disinfection units installed in a Sewage treatment plant located within the campus of Aligarh Muslim University (AMU) at Aligarh (UP), India. This treatment plant uses technology based on UASB followed by constructed wetlands comprises of both vertical and horizontal wetlands. The plant consists of screening, grit chamber, an equalization tank, UASB reactor, Vertical wetlands, horizontal wetlands, disinfection units in the same order. After a successful removal of 95 % organic pollution through UASB and constructed wetlands, treated water is collected in a common effluent tank, from where it is pumped into two solar driven disinfection units based on anodic oxidation and Ultra-Violet system. A complete flow sheet diagram for wastewater treatment plant at AMU is given in figure 1.

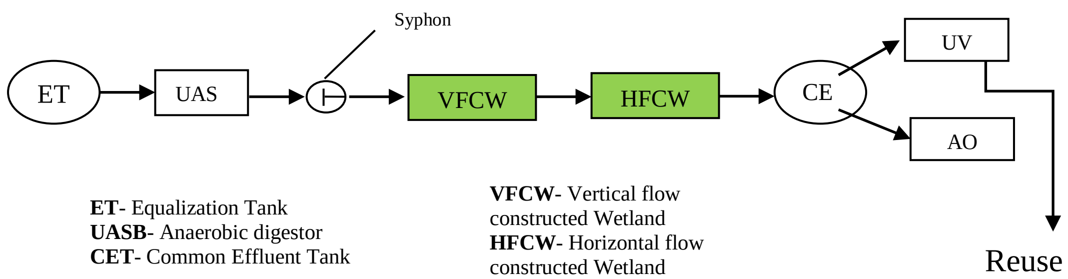

Figure 1: The Flow sheet diagram for the wastewater treatment plant at AMU

Anodic Oxidation:

The solar driven system pumps the water from the effluent tank to the AO-reactor. The AO reactor consists of electrolytic cell in which some part of chlorides already present in the treated wastewater is converted into Chlorine gas. The Electrolytic cell consists of electrodes which are made up of titanium, coated with mixed oxides of the platinum group. The working of Electrolytic cell is shown in figure 2.

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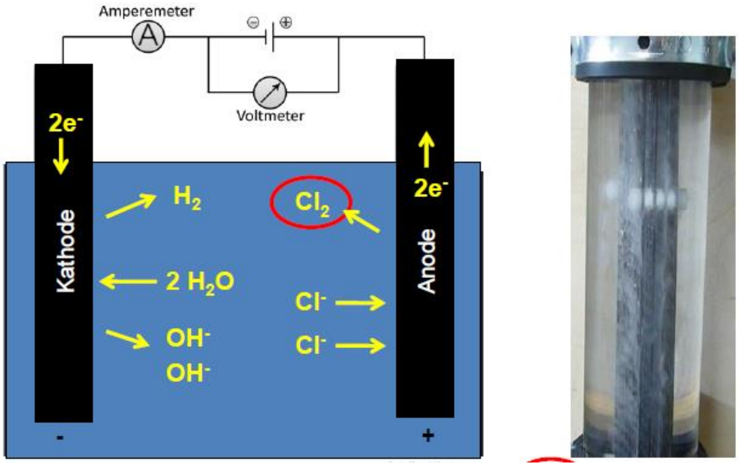

Figure 2: An Operation inside Electrolytic cell of AO system

After mixing with chlorine gas, water flows into a separate storage tank where chlorine gas has enough time to contact with the treated wastewater. Here, the water quality and chlorine production capacity is measured online. A systematic diagram of working of an AO system is given in figure 3.

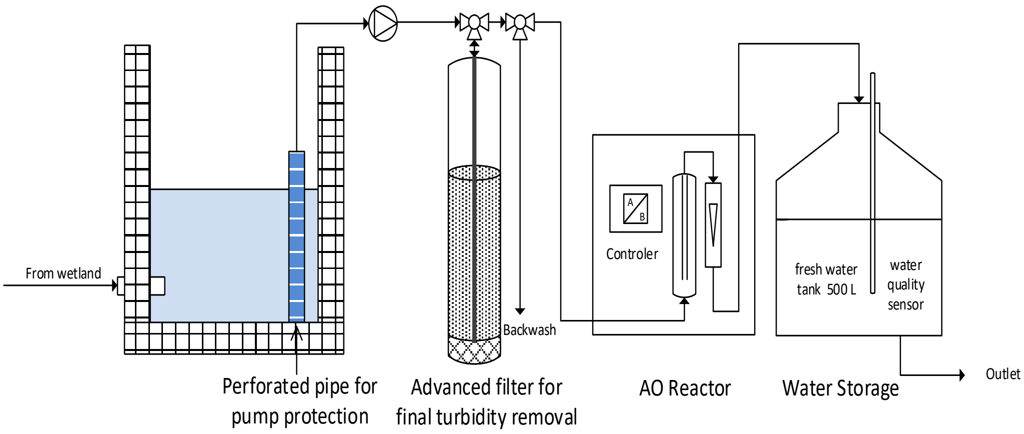

Figure 3: An Operation of AO system

Ultraviolet treatment:

The solar driven UV disinfection system was installed after the HF constructed wetland. It disinfects 5-10 m^3 of the treated wastewater per day. In the UV system, effluent is treated two times, i.e. first through an UV reactor and then through an UV rod placed in the storage tank on the roof. After treatment, the water is pumped into a separate water storage tank for quality monitoring and reuse. The intensity of UV light was remained constant, but we can control and measure flow of water through online.

RESULTS AND DISCUSSION

Dependency of disinfection efficiency of AO and UV

The efficiency of an AO system is mainly depending upon the chloride content of water as shown in figure 4.

The efficiency of UV reactor is mainly depending upon turbidity of water as shown in figure 5.

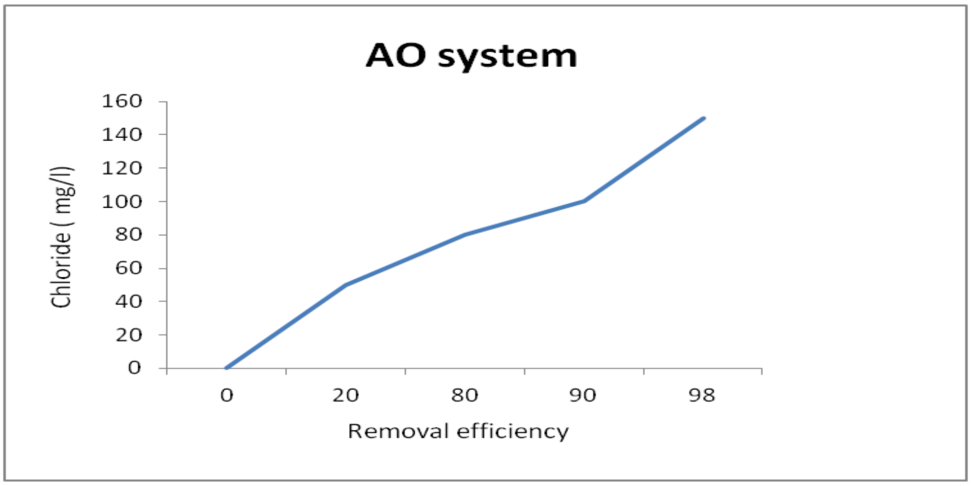

Figure 4: Graph between Removal efficiency vs. chloride concentration of AO system

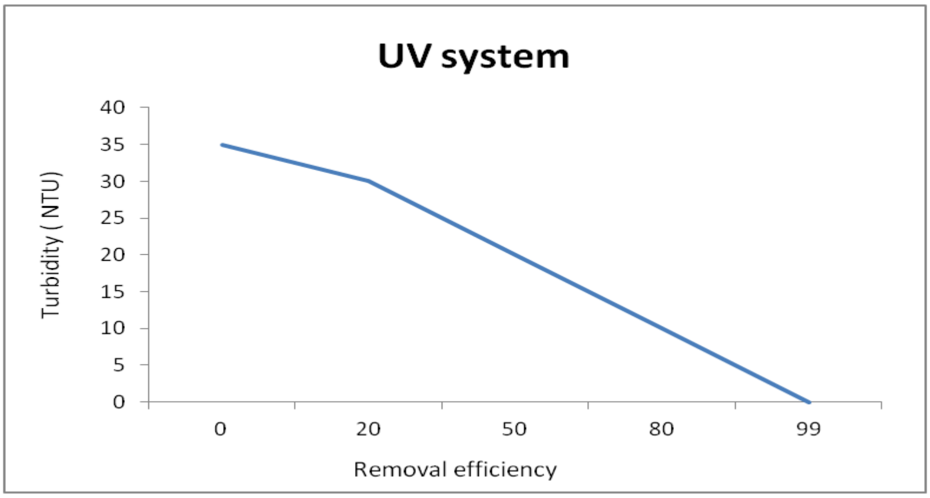

Figure 5: Removal efficiency vs. Turbidity Graph

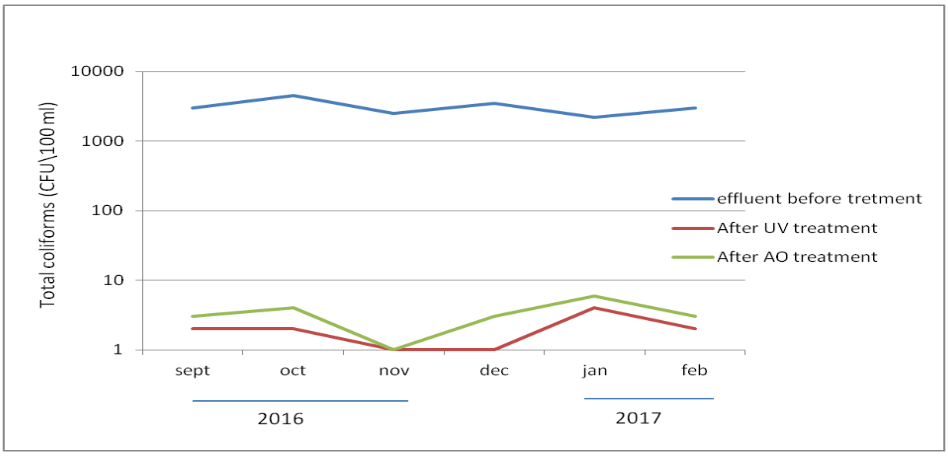

Figure 6: Graphical representation of total coliform concentration before and after disinfection

Comparison of Removal efficiency of AO, UV

Figure 6 shows the total coliform concentration before and after the AO and UV disinfection UV is found to be more efficient compared to AO because in UV system water comes in contact with UV light twice i.e. first in the reactor and then in the tank. On the other hand efficiency of AO is depending upon contact time of chlorine with water and also the chloride content of water.

This work is not completed at this moment, so comparative study with chlorine disinfection cannot be carried right now although we will carry out this work in our future research work.

CONCLUSIONS

This study concluded that removal efficiency of total coliform through constructed wetland was about 99% i.e. the reduction of 4 log and removal efficiency of AO and UV was about 98% (log 2) and 99% (log 3) respectively. The quality of treated effluent after these two disinfection methods was very high. The coliform removal efficiencies were very good.

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REFERENCES

[1] E. Veschetti, D. Cutilli, L. Bonadonna, R. Briancesco, C. Martini, G. Cecchini, P. Anastasi, and M. Ottaviani, "Pilot-plant comparative study of peracetic acid and sodium hypochlorite wastewater disinfection, 2003." vol. 37, pp. 78–94.

[2] R. J. Watts, S. Kong, M. P. Orr, G. C. Miller, and B. E. Henry, "Photocatalytic inactivation of coliform bacteria and viruses in secondary wastewater effluent," , 1995, vol. 29, no. 1, pp. 95–100.

[3] A. C. Anderson, R. S. Reimers, and P. deKernion, "A brief review of the current status of alternatives to chlorine disinfection of water.," *Am. J. Public Health*, vol. 72, no. 11, pp. 1290–1293, 1982.

[4] A. Dell'Erba, D. Falsanisi, L. Liberti, M. Notarnicola, and D. Santoro, "Disinfection by-products formation during wastewater disinfection with peracetic acid," *Desalination*, vol. 215, no. 1–3, pp. 177–186, 2007.

[5] S. Garcia-Segura, J. Keller, E. Brillas, and J. Radjenovic, "Removal of organic contaminants from secondary effluent by anodic oxidation with a boron-doped diamond anode as tertiary treatment," *J. Hazard. Mater.*, vol. 283, pp. 551–557, 2015.

[6] R. Gehr, M. Wagner, P. Veerasubramanian, and P. Payment, "Disinfection efficiency of peracetic acid, UV and ozone after enhanced primary treatment of municipal wastewater," *Water Res.*, vol. 37, no. 19, pp. 4573–4586, 2003.

[7] M. D. Gómez-López, J. Bayo, M. S. García-Cascales, and J. M. Angosto, "Decision support in disinfection technologies for treated wastewater reuse," *J. Clean. Prod.*, vol. 17, no. 16, pp. 1504–1511, 2009.

[8] J. Grellier, L. Rushton, D. J. Briggs, and M. J. Nieuwenhuijsen, "Assessing the human health impacts of exposure to disinfection by-products - A critical review of concepts and methods," *Environ. Int.*, vol. 78, pp. 61–81, 2015.

[9] G. D. Harris, V. D. Adams, D. L. Sorenson, and R. R. Dupont, "The influence of photoreactivation and water quality on ultraviolet disinfection of secondary municipal wastewater," *J. Water Pollut. Control Fed.*, vol. 59, no. 8, p. 781–787 (7), 1987.

[10] W. A. M. Hijnen, E. F. Beerendonk, and G. J. Medema, "Inactivation credit of UV radiation for viruses, bacteria and protozoan (oo)cysts in water: A review," *Water Res.*, vol. 40, no. 1, pp. 3–22, 2006.

[11] M. Kitis, "Disinfection of wastewater with peracetic acid: A review," *Environ. Int.*, vol. 30, no. 1, pp. 47–55, 2004.

[12] A. Kraft, "Electrochemical water disinfection: A short review," *Platin. Met. Rev.*, vol. 52, no. 3, pp. 177–185, 2008.

[13] O. M. Lee, H. Y. Kim, W. Park, T. H. Kim, and S. Yu, "A comparative study of disinfection efficiency and regrowth control of microorganism in secondary wastewater effluent using UV, ozone, and ionizing irradiation process," *J. Hazard. Mater.*, vol. 295, pp. 201–208, 2015.

[14] S. B. Somani, N. W. Ingole, and ..., "Alternative Approach To Chlorination for Disinfection of Drinking Water-an Overview," *Technicaljournalsonline.Com*, no. 23.

[15] P. O. V. Mishra and N. Khalil, "Water Disinfection for Remote Areas of Developing Regions – An Innovative and Sustainable Approach using Solar Technology and Anodic Oxidation," pp. 1–2, 2013.