ADVANCED OXIDATION PROCESSES AS AN ALTERNATIVE TO MUNICIPAL WASTEWATER DISINFECTION

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RESUMO – The disinfection of urban effluents is an excellent strategy to preserve the environment, as it protects the receiving bodies of pathogenic microorganisms and enables the use of treated effluent as a source of water for reuse. The objective of this work was to verify the efficiency of $\text{O}_3/\text{H}_2\text{O}_2$, $\text{O}_3$ and $\text{O}_3/\text{UV}$ treatments to disinfect municipal effluents and observe the effect of treatment time on the inactivation/destruction of the indicator microorganisms. The treatment was carried out for 25, 50, 75 and 100 min to verify the time required for the inactivation and the time necessary for the destruction of the indicator. A regrowth test was performed each 8 hour until 24 hours. The results demonstrated that the time of cell destruction varies according to the treatment and that the ozone alone was the less effective in the inactivation and destruction of the indicators.

1. INTRODUCTION

The protection and conservation of natural resources is one of the main priorities of modern society. Water is perhaps our most valuable resource, and thus should be recycled. Many of the current recycling techniques for polluted water only concentrate the pollutant without degrading it (1). In this sense, advanced oxidation processes are possibly one of the most effective methods for the treatment of wastewater containing organic and inorganic products. As some advantages of AOP one can cite: strong oxidizing power; total mineralization of pollutants and oxidation of inorganic species; versatility and efficiency; decomposition of the reagents used as oxidants in products with less impact on the environment (2, 3). Although some studies show that the energy consumption can be reduced, these processes generally have as disadvantage the economic limitation that is related to the high cost (4).

AOPs are also very efficient to the inactivation of bacteria and virus, however, the influence of the wastewater components on the disinfection is not completely understood (5).

The objective of this study was to verify the influence of treatment time on the disinfection of urban wastewater by ozone/$\text{H}_2\text{O}_2$, ozonation and ozone/UV. The regrowth after the cited treatment was also evaluated after 8, 16 and 24 hours of disinfection.
2. MATERIAL AND METHODS

The analyzes for the physical-chemical characterization of the wastewater were performed according to the procedures described in the Standard Methods for the Examination of Water and Wastewater (6), where the pH, Temperature (°C), Alkalinity (mg CaCO₃ L⁻¹), Turbidity (NUT), TSS (mg L⁻¹), COD (mg L⁻¹) and BOD (mg L⁻¹).

For the AOP treatments O₃/H₂O₂; O₃ and O₃/UV the wastewater solution was kept under constant agitation during the treatment using a magnetic stirrer. The treatment was carried out for 25, 50, 75 and 100 min to verify the time required for the inactivation and the time necessary for the destruction of the indicator microorganisms. A test of regrowth of the indicators was performed during 24 hours, every 8 hours. 5 mL of the samples were taken at 0, 15, 25, 50, 75 and 100 minutes for the disinfection analysis, which the *Escherichia coli* and total coliform were measured by a commercial chromogenic test named Colillert® (7). To assess the bacteria reactivation we kept the wastewater treated in bottles for 24 hours (8, 16 and 24 hs) and after this time, the *E.coli* and total coliform were measured by Colillert®.

3. RESULTS AND DISCUSSION

The O₃/H₂O₂ and O₃/UV processes were more efficient than ozone alone. The reaction may have been favored by the action of hydrogen peroxide, which promotes the faster decomposition of organic matter and the formation of a greater amount of hydroxyl radicals in the medium.

For disinfection analysis, the wastewater samples were subjected to ozonation, O₃/UV and O₃/H₂O₂ and then analyzes of total inactivation of coliforms and *E. coli* were performed. Secondary effluent samples from the pilot plant located on the School of Technology campus (UNICAMP, São Paulo, Brazil) were collected, treated and analyzed (Table 1). The biological reactor was a hybrid: septic tank - anaerobic filter. The reaction time was also adjusted within 100 minutes and, during the experiments, the samples were withdrawn at 0, 5, 10, 15, 25, 50, 75 and 100 minutes for further preparation and measurements by the commercial method Colillert®.

| Parameter | Value       |
|-----------|-------------|
| pH        | 7.04 ± 0.4  |
| TSS       | 40.0 ± 3.2  |
| Alkalinity| 302.2 ± 30.4|
| Turbidity | 63.4 ± 4.6  |
| COD       | 95.7 ± 12.3 |
| BOD₅      | 37.2 ± 6.4  |
The three treatments promoted the inactivation of the indicators in 25 min. Another important factor to be studied during wastewater disinfection by AOPs is the regrowth capacity after the microorganism inactivation. For this evaluation the samples were treated by the three studied methods. If present, the residual hydrogen peroxide was quenched. Disinfected wastewater samples was transferred to 100 mL bottles, and stored for 8, 16 and 24 hours under room temperature, and then analyzed for concentrations of total coliforms and *E. coli*. Bacterial regrowth was evaluated by the ratio of the number of individuals alive after disinfection.

After 8 hours of the 25 min treatment, the indicators were reactivated for the three treatments. After 8 hs of the 50 min treatment, there was reactivation for ozone/UV and ozonization. After 75 and 100 min of treatment there was no reactivation of the indicators, demonstrating that in 75 min there is the destruction of the indicators for the three treatments.

4. Conclusions

Comparing the three treatments studied, the treatment time for the destruction of the indicators was higher for ozonation than for ozone/H2O2, and ozone/UV, suggesting that the addition of UV and hydrogen peroxide to ozonation enhanced the ozonation process.

The inactivation of total coliforms was less sensitive to reactivation than *E. coli*, suggesting that they are inactivated by different mechanisms.

5. Acknowledgments

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