Long-term BOD to Assess the Effects of Ozone and UV on the Biodegradability of Organic Matter

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INTRODUCTION

There are many disinfection processes used to remove undesired bacteria from the effluents of Wastewater Treatment Plants (WWTPs). Disinfecting agents based on oxidative processes may also affect the bioavailability of organic matter, acting on the bonds of complex molecules. Thus, the practice of disinfection can also modify the biodegradability of the organic substance contained in an effluent. One of the methods used for the quantification of organic matter is the Biochemical Oxygen Demand (BOD). It defines the bioavailable fraction of organic matter and is based on the quantification of the consumption of oxygen by the metabolic processes of the microbial community in the analyzed sample.

We compared the influence of two different disinfectants on the biodegradability of the organic matter in terms of BOD, following the parameter trend continuously. The chosen disinfectants were ozone, which is a strong oxidizing agent, and UV, whose disinfecting action derives from a damage to bacterial DNA.

METHODS

The present work has been performed using the system BOD EVO, manufactured by VELP Scientifica (Italy) for the conduction of respirometric tests and for the quantification of the biochemical oxygen demand over time. The system is composed by a sensor, which is put directly on the bottle containing the sample; the Wireless DataBox, which receives the data automatically sent by the sensor and transfers them in a computer; the dedicated software BODSoft. The sensor evaluates the progressive decrease of the internal pressure, providing a direct measurement of the oxygen consumed by the microorganisms in mg/L, within a closed environment. The remote data transmission ensures a high reliability. The software BODSoft allows the operator to monitor and record the progress of the analysis.

The tests have been carried out on samples of the effluent coming from a WWTP receiving a mix of domestic and industrial wastewater.
The effluent is known to have a significant fraction of organic matter which is not or is slowly biodegradable (this is shown by a high COD/BOD_5 ratio). The effluent samples were treated either with ozone (2 mg/L with a contact time of 45') or with high UV irradiation (40 mJ/cm2) Subsequently, a 10 mL inoculum of wastewater was added in all samples, including the effluent without disinfection. The samples, arranged in duplicates, were placed in an incubator, which was left closed in the following 28 days, with BOD EVO sensors capable of transmitting remote data. A reference sample made of the inoculum in tap water was also prepared, in order to determine the BOD value of the inoculum. Four replies of the trial have been made.

RESULTS

The trend of BOD values over time reflected the typical degradation of organic matter in the presence of a suitable microbial community. At the end of the tests the values of BOD_5 and BOD_{28} (considered as the total BOD) were evaluated for the different samples and for the WWTP effluent without treatment (Figure 1 A, B).

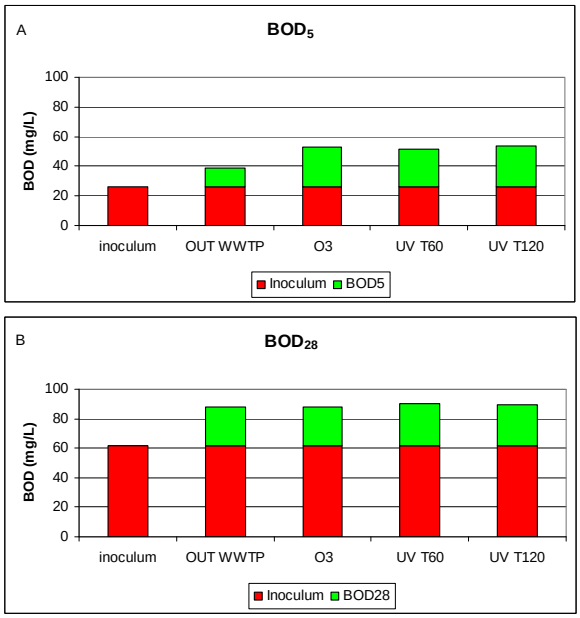

Figure 1 - (A) BOD_5 values for the various samples (from the left: inoculum, effluent without disinfection, effluent treated with ozone, effluent treated with UV); (B) BOD_{28} values for the various samples (from the left: inoculum, effluent without disinfection, effluent treated with ozone, effluent treated with UV).

DISCUSSION

The inoculum, which had been collected at the entrance of the same WWTP from which the effluent has been taken, had a mean BOD_5 value of 26.3 mg/L, and a mean total BOD value of 61.3 mg/L. The low BOD_5/BOD_{28} ratio, equal to about 0.43, showed the presence of scarcely biodegradable organic matter.

The BOD_5 value, after subtracting the value of the inoculum, in every trial was much higher in the three effluents treated with the disinfectants (26.5 mg/L for the sample treated with UV and 26.9 mg/L for the sample treated with ozone) compared with the untreated effluent (15.9 mg/L). At the end of the measurement cycle, after 28 days, on the other hand, the total BOD showed similar results for the various samples, including the untreated effluent (26.7 mg/L): 27.0 mg/L for the ozonated sample, 29.0 mg / L for the UV treated sample. The relationship between BOD_5 and total BOD, as a result, was higher in all the samples (0.60 for the untreated effluent, 0.92 for the UV treated sample and over 0.99 for the sample treated with ozone) if compared to the ratio of the inoculum (0.43). The ratio showed a noticeable difference between the untreated effluent, on the one hand, and all the disinfected samples, on the other.

CONCLUSIONS

The adopted equipment allowed to assess the availability, in the first 5 days, of a greater amount of biodegradable organic matter in the samples containing the disinfected effluent (higher ratio of BOD produced in the first 5 days in disinfected samples with respect to the total, represented by BOD_{28}). The possibility of following the BOD curve over a long period is particularly interesting when studying effluents containing slowly degradable molecules or even in order to verify the activity of sewage sludge.
The tests confirmed what is reported in literature [1][2], namely that the use of ozone and UV rays increase the biodegradability of the organic matter subjected to treatment, even if their way of action is substantially different (oxidation with ozone, photochemical breakdown with UV).

References:
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