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EXPERIMENTAL EVALUATION OF A BIOLOGICAL PRODUCTS' EFFICIENCY FOR HIGH-LOAD WASTEWATER TREATMENT

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Abstract
Prior to discharge, high-loads wastewater needs intensive treatment, that can be carried out by physical, chemical or biological means towards discharge water quality. Extensive research has been carried out to identify solutions with reduced costs and high efficiencies. The paper presents the lab scale performance efficiencies of an innovative biological complex product obtained for the treatment of several samples (municipal wastewater, pig farm wastewater, wastewater from a restaurant's grease removal tank). The experiments were carried out in laboratory bioreactors, the sample volume considered ranging from 1.5L to 4L depending on the waste water load and the number of simultaneous samples. Each sample was tested in parallel under similar conditions, the only varied parameter being the dissolved oxygen concentration. The results have shown that, under the tested conditions, the product contributes to pollutants degradation, with good efficiency for nitrogen ammonium and Kjeldahl nitrogen removal, managing to partially reduce the organic load. However, after 42 days of experiment, the effluent does not meet the sewage discharge conditions imposed by NTPA 002-H.G.352.

Keywords*: Biological product, wastewater treatment*

Introduction

Biological wastewater treatment is one of the most efficient solutions for increased loads reduction and the varying compounds and charges in water requires continuous research on improved processes (Nicolau et al., 2008; Tricolici et al., 2014).
High strength organic industrial wastewater require pre-treatment prior to their discharge in sewer systems due to the stringent legislation requirement and the potential stress on the downstream wastewater treatment processes. Using conventional pre-treatment solutions for high strength wastewater such as pig farm wastewater can imply extensive costs and limited efficiencies, thus there is a need for identifying new reliable methods and solutions for reaching loads complying the discharge regulations (Durai et Rajasimman, 2011, Sonune et Ghate, 2004).
Studies regarding the use of anaerobic digestion pro high strength organic effluents showed promising results, with extensive research on improving bioreactors configurations for increased process efficiencies (Speece, 1983; Rajeshwari et.al., 2000).

Currently, the main focus is on applied research on studying different biological products efficiencies in reducing industrial wastewater loads.
The paper presents the experimental results obtained for the efficiency of a biological product based on Archaea in decreasing pollutants loads, in both aerobic and anaerobic conditions.

Experimental

The experiments were carried out in experimental laboratory installations (BIOSTAT Bplus TWIN and Diachrom), each provided with two vessels (bioreactors). Sample volume taken into consideration: 1.5 L (for aerobic and anaerobic control samples) and 4 L (for test samples with biological product under aerobic and anaerobic conditions). The quantities have been established according to the waste water quantity and available quantity. Each sample was tested in parallel under similar conditions, the only parameter varied being the dissolved oxygen concentration. For each type of wastewater, the evolution of pollutant concentrations was monitored both in the test samples and in the control samples.
The samples were subjected to a set of preliminary tests upon arrival and were subsequently stored at 4^{o}C until the experiments started.
The samples were characterized based on the results of the analytical determinations of the organic load expressed both as chemical oxygen consumption (COD) (SR ISO 6060: 1996) and as biochemical oxygen consumption (BOD) (SR EN 1899/1,2-02, 38409-87), total suspended solids (TSS) (STAS 6953-81), total Kjeldahl nitrogen (TKN) (SR EN 25663-00, SR ISO 11261:2000), NH_4^+, NO_2^-, NO_3^-, PO_4^{3-} (SR EN ISO 14911: 2003, SR EN ISO 10304/1: 2009) and total phosphorous (STAS 7184/14-79). Considering the waste water composition and the considered inoculum (the high content of suspended solids) important parameters were determined both for homogenous and filtered samples (filter paper with the pore diameter of 12-15 μm).
Throughout the experiment, the same inoculation protocol was maintained: fresh biological inoculum (2.5 g/l) was added to the tested sample every six days. Samples were collected form each tank (both for the test and control, aerated and unaerated) in the beginning, after 21 days and after 42 days. The active inoculum - archaea were delivered in a bentonite-clay based carrier.

Results and Discussion

Low efficiencies were obtained for the treatment of municipal wastewater. The concentrations decrease was insignificant and could be easily be a result of the high retention time (42 days) alone without any contribution of the biological product. The highest reduction rate was met for the total phosphorous concentrations, being of approximatively 80% for both unaerated and aerobic reactor, probably due to adsorption on the bentonite carrier of the product. Thus, the product's application for low strength wastewater treatment, in the evaluated conditions, resulted as not suitable.
In the graphs below we try to emphasize the main experimental results obtained during the performance test of the biological product on the treatment efficiency for pig farm wastewater and grease separator wastewater.

The tests have shown that the product presents a certain pollutants degradation activity for the pig farm wastewater, with good efficiencies on nitrogen ammonium and TKN removal, managing also to partially reduce the organic load (fig 1, 2). However, after 42 days of experiments, the effluents did not meet the sewage discharge conditions imposed by NTPA 002- H.G.352.

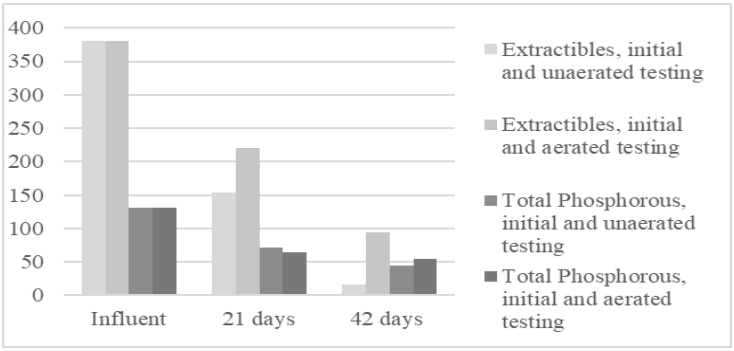

Figure 1. Pig farm wastewater experimental results (1)

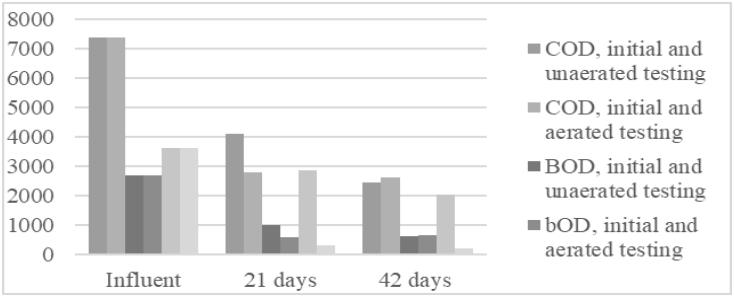

Figure 2. Pig farm wastewater experimental results (2)

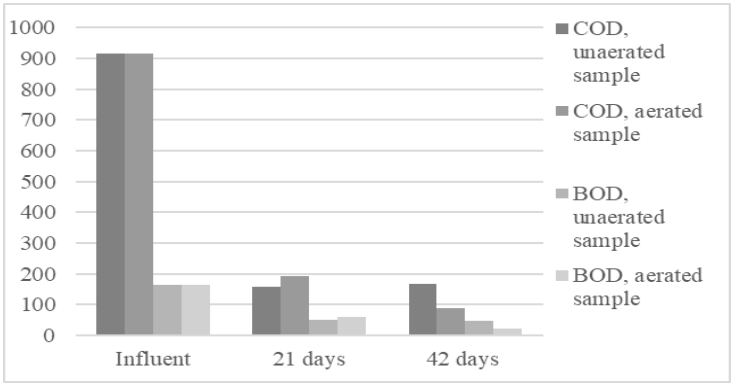

Figure 3. Grease separator wastewater experimental results (1)

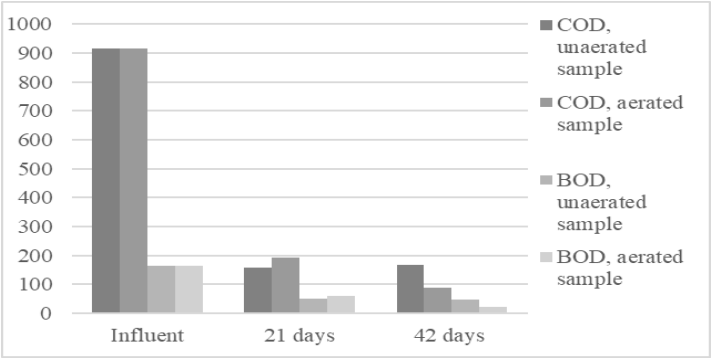

Figure 4. Grease separator wastewater experimental results (2)

After 21 of experimental days, conclusive treatment efficiencies have been obtained for the grease separator wastewater. Due to the high solids concentration of the biological product, high total suspended solids (TSS) concentrations were resulted in both aerated and unaerated samples. The concentration of extractible was reduced by more than 50% for both aerated and unaerated samples. Organic load reduction (expressed as COD and BOD) ranged from 47 to 83%. Higher removal efficiencies were obtained for both samples with biological product for Pt, ranging between 67 and 85%.

After 42 experimental days, the concentration of extractible substances was reduced by 29% in the unaerated sample and by 59% in the aerated sample. The organic load removal efficiency, expressed as COD is 90% for the aerated sample and of 81% the unaerated one. After 42 days of experimentation the reduction of Pt concentration by 90% was obtained.

Conclusions

Based on these preliminary results, we can conclude that the product is not suitable or does not have superior performances compared to any conventional treatment for low strength municipal wastewater. However, even if more tests are required to assess the minimum retention time with no impact on treatment performances, there is a potential for the product to be used in the pre-treatment of high strength wastewater such as the ones from grease separators and pig farms.

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References

Durai, G., Rajasimman, M., Biological treatment of tannery wastewater-a review, Journal of environmental science and technology, vol4, 2011, pp. 1-17.

Nicolau, M., Patroescu, V., Cosma, C., Dinu L., Bumbac, C., Constantin, L., Intensive Biological Process Based on SBR Reactor for Industrial Wastewater Treatment, Rev. Chim. Vol. 59, no. 10, 2008, pp. 1106-1111.

Rajeshwari, K.V., Balakrishnan, M., Kansal, A., Kusum Lata, Kishore, V.V.N. State-of-the-art of anaerobic digestion technology for industrial wastewater treatment, Renewable and Sustainable Energy Reviews, vol. 4, iss. 2, 2000, pp. 135-156

Sonune, A., Ghate, R., Developments in wastewater treatment methods, Desalination, vol. 167, 2004, pp. 55-63

Speece, R., Anaerobic biotechnology for industrial wastewater treatment, Environ. Sci. Technol., vol. 179, 1983, pp. 416A-427A

Tricolici, O., Bumbac, C., Postolache, C., Microalgae-bacteria system for biological wastewater treatment, Journal of Environmental Protection and Ecology, Vol.15, No.1, 2014, pp.268-276