EFFECT OF EXTRACELULAR HYDROLYTIC MATERIAL ON MICROBIAL POPULATION

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Abstract

The increased production of sludge from the treatment of domestic sewage and/or urban, is creating serious problems regarding the proper storage and management of them. In order to solve these problems, it has carried out one of the strategies described in the literature, to minimize the volume of sludge generated in the activated sludge unit. This method is based on the effects of certain extracellular enzymes, resulting from aerobic digestion of sludge, on the solubilization of colloidal and particulate organic matter present in wastewater.

The addition of extracellular hydrolytic material resulting from a process of aerobic sludge digestion to a conventional activated sludge system, produces very encouraging results related to the reduction of sludge production.

In this study, we have established the operating conditions which result a higher solubilization of endoplasmatic material that have an effect on the reduction of sludge generated.

The essays were realized in batch regime during a period of 24 hours, adding differents concentrations of extracelular material. The results obtained show that a digestion period of 15 days, produce a material containing a large amount of exoenzymes that favor the reduction of biomass generated in the activated sludge system.

Keywords: exoenzymes, solubilization, aerobic digestion, activated sludge, biomass.

Introduction

The sludge generated in the activated sludge process, has a high amount of organic matter composed of macromolecules consisting of a complex mixture of carbohydrates, aminoacids, alcohols and volatile fatty acids mixed with polymers and heteropolymers including proteins, polysaccharides and lipids.These macromolecular compounds cannot be directly assimilated by bacteria and must be hydrolised enzymatically into smaller compounds by extracelular enzymes to be trasnported across the bacterial cell wall (Frolund 1995, Cadoret 2002) and converted inside the cell into carbon dioxide and water (Guellil *et al.* 2001).The production of these enzymes is not continous. They are generated only under certain conditions, for example, when cells are subjested to starvation conditions, as in an aerobic digestion.

In this process, the release of extracellular enzymes takes place through the active excretion of these compounds by living cells and through the process of cell lysis in the reactor.

The introduction of exoenzymes from an aerobic digestion system to a conventional activated sludge system, allows a very positive way to reduce the production of excess sludge (Aragón C. 2009).

Methods

Glass reactors were used at laboratory scale and inoculated with sludge from the wastewater treatment plant "Guadalete" located in the town of Jerez de la Frontera (Cádiz). Each reactor had a useful capacity of 1.75 L and the aeration was maintaned for 24 hours before the start of the essay, using porous fine bubble diffusers to maintain the homogenization of its content. The concentration of dissolved oxygen was maintained around 4 mg/L, with a temperature of 20°C and a concentration of suspended solids of 3000 mg/L.

Test were realized in batch mode to establish the optimal conditions in which extracellular material be added to a conventional activated sludge system, to reduce the production of excess sludge generated.

The appropiate percentaje of extracellular material from an aerobic digester to apply, was determinated working at different sludge age between 7 and 21 days.

The rate of microbial growth observed $Y_{x/s}$ was determined to evaluate the effect of extracellular material on the microbial metabolism, measured as an increase in suspended solids (mg VSS) for consumption of organic matter (mg COD) during 24 hours.

The variables determined during the essay were the volatile suspended solids and soluble organic matter present in each reactor.These determinations were performed according to standar methods APHA- AWWA-WPCF (1998).

To complete the study, the specific respiration rate (SOUR, $mgO_2 \cdot gSVS^{-1} \cdot d^{-1}$) was determinated according to the procedure defined by Awong et al (1985) and the percentaje of organic matter removal (measured as COD).

Results and discussion

Evolution of suspended solids.

The evolution of suspended solids shows in Figure 1.

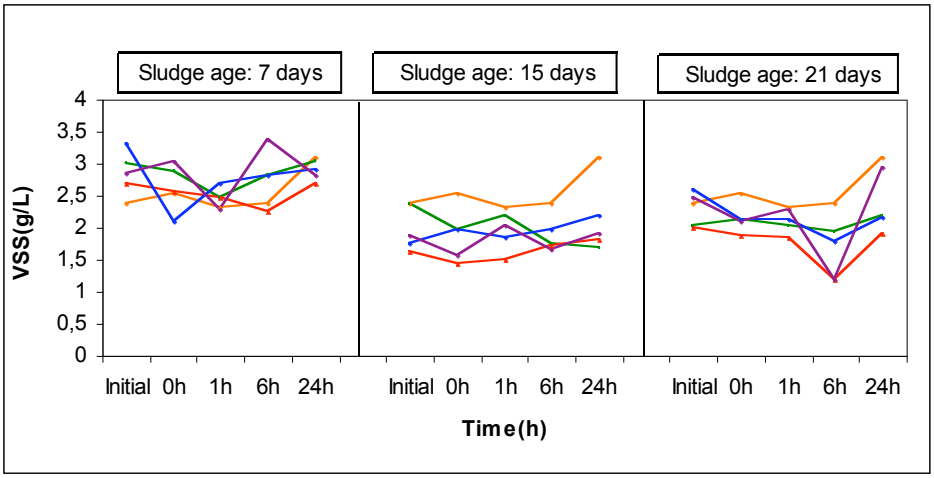

Figure 1. Evolution of suspended solid in reactors along assay. R1. Reference. R2. 10 % Digested Supernatant. R3. 30 % Digested Supernatant. 10 % Digested sludge. 30 % Digested sludge.

Figure 1 shows how solid values decrease quickly when extracellular material from the aerobic digester with sludge age of 15 days was added. This leads to a reduction of 30% of the biomass produced in excess.

Evolution of COD.

Figure 2 shows the concentration of soluble organic matter present in the reactor during the essay.

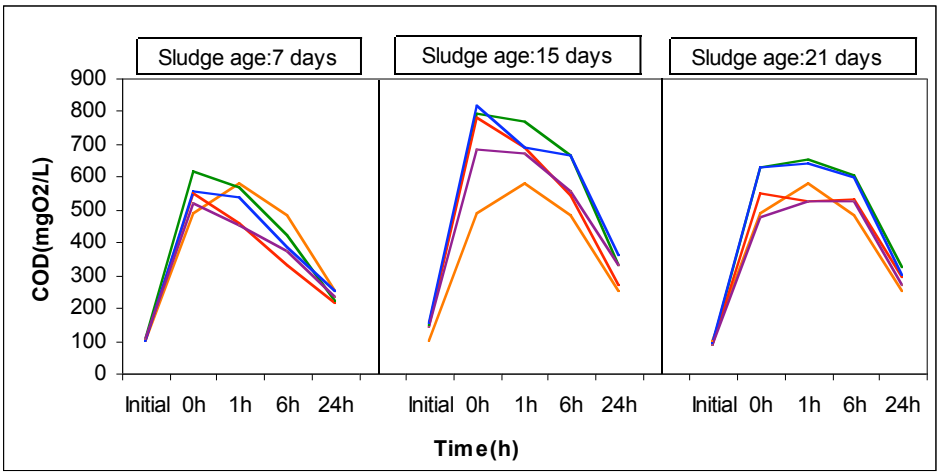

Figure 2. Evolution of COD in reactors along assay. R1. Reference. R2. 10 % Digested Supernatant. R3. 30 % Digested Supernatant. 10 % Digested sludge. 30 % Digested sludge.

There is a decrease of COD in reactors which are added the supernatant exolopymers from the aerobic digester, slightly higher than the rest of the reactors during the essay.This shows that the solubilization of sludge takes place with greater intensity in the reactors where it receives a greater contribution of colloidal and particulate organic matter.

When the supernatant exopolymers of aerobic digester with a sludge age of 15 days is added, there is a greater consumption of organic matter, resulting a lower growth of sludge during the essay period.

Conclusions

According to the results of the tests performed, we obtain the following conclusions:

· The addition of extracellular material from the supernatant generated in aerobic sludge digestion can limit the growth of microorganisms in the environment without significantly reducing the process yield.

· In contrast, in the addition of digested sludge, there is no reduction in the expected growth rate under any conditions tested.This fact can no rule the use of digested sludge to reduce excess sludge generated in a conventional activated sludge system.

·The optimum conditions to minimize excess sludge generated in an activated sludge system, are adding to the biological reactor reached 10% of the extracellular material produced in the supernatant of an aerobic digester with sludge age of 15 days.

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