BIODEGRADATION OF LINEAR ALKYLBENZENE SULFONATE (LAS) AND ALKYLBENZENE SULFONAT (ABS) BY *Pseudomonas aeruginosa* BACTERIA

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ABSTRACT

LAS and ABS are the detergent active compounds and the presence of its should always be monitored because they are pollutants. The accumulation of LAS and ABS is a toxic to various aquatic organisms and can form foam that can reduce the environmental aesthetics such as lowering dissolved oxygen content, and when foam is blown by the wind, it can spread microbial pathogens. Detergent treatment has been done by way of adsorption, flocculation, coagulation and advanced oxidation, but the process can produces unwanted sludge that need further processing. One alternative technology that is used to treat wastewater is biological treatment using the bacteria *Pseudomonas aeruginosa*, because detergent is an organic substance that derivatic accumulations cause increased COD and BOD so that the processing is very suitable to use biological techniques, besides biological treatment is very economical when compared with other processing method. With this method LAS and ABS was degradable to CO_2 and H_2O. In this study, LAS and ABS successfully degraded 99.73%. With the longer time CO_2 formed was increasing, and the biggest CO_2 at pH 7 and the 50th hour, concentration of CO_2 was 127.6 mg / L.

Keywords: Biodegradation, , LAS, ABS, *Pseudomonas aeruginosa* bacteria.

1. INTRODUCTION

Linear alkylbenzene sulfonates (LAS) are the most popularly used synthetic anionic surfactants in commercial detergents. Their basic structure consists of a benzene ring connected to a sodium sulphate group (the hydrophilic end) and an alkyl chain containing 10–13 carbon atoms (the hydrophobic end). The commercially available LAS are very complex mixtures of various homologues and phenyl positional isomers. Large amounts of LAS are disposed in municipal wastewaters due to their wide daily use (Constantina *et al*., 2007).

In the United States and Europe, linear alkylbenzene sulfonates (LAS) have been used since the early 1960s, when the low rate of biodegradation of branched-chain alkylbenzene sulfonates (BAS/ABS) was recognized. In some Latin American countries, ABS are currently used in different detergent formulations due to their low costs. Water pollution by ABS is a significant environmental problem in these countries (Jesús Campos-García *et al*., 1999) .

Biodegradation is an important process responsible for the removal of LAS from both raw wastewater and sludges in sewage treatment plants, while it also enhances the removal of untreated or partially degraded compounds in the environment after their disposal in natural receptors (seas, rivers, lakes etc.), reducing thus their impact on biota. During biodegradation, microorganisms can either utilize LAS as the sole carbon source or co-metabolize LAS by microbial metabolic reactions (Constantina *et al*., 2007 ; García-L. E *et al*., 2009; Jean C.,S., and Marie.H.N, 1992; Kristian,2001).

The most important ecological property of any surfactant is the relative ease of their biodegradation. Biodegradation is most often performed by soil or aquatic microorganisms and leads to generation of water and carbon dioxide (CO_2) gas (Nour Amirmozafari *et al*., 2007). In this study LAS and ABS degraded by *Pseudomonas aeruginosa* bacteria and the decreasing concentration of LAS and ABS were monitored with CO_2 formed.

2. MATERIALS AND METHODS

2.1. Chemicals

The material used is a mixture of linear alkilbenzen sulfonate (LAS) or sodium laurel sulfate $C_{12}H_{25}OSO_3Na$ from merck and ABS. For the analysis used, fenolftalin indicator solution 0.5%, solution of sodium hydroxide NaOH 1M from merck , River water, the bacteria *Pseudomonas aeruginosa* bacteria , Cation Resin, Anion Resin, Methanol Analysis from, solution of HCl 1M merck,. Solvents used were aquades.

2.2. Equipment

Equipment used in research are cation and anion exchange column, a set of aerobic batch reactor, pH meters, glassware, Bunsen, a set of distillation equipment, and stative burrete for titration.

2.3. Analitycal methods

In this study, 1000 ml mixture of LAS and ABS 100 mg / L included in aerobic batch reactors. Added Pseudomonas aeruginosa bacteria that have been *acclimation,* as much as 20grams. The variable of time used are: 12, 24, 36, 42, 48, 54, 60 hours and pH: 6, 7, 8, 9. Analysis conducted on the LAS and ABS that has been degraded in aerobic batch bioreactor for a certain time interval analysis method of CO_2, with titration analysis.

2.4. Determination of Carbon Dioxide by Titration

Gas stream of carbon dioxide (CO_2) produced into 100 mL solution of NaOH (1M). NaOH that does not reaction, titrated with solution of HCl (1M). added solution of phenolphthalein indicator. The amount of HCl that reacts is eqivalent to the amount of CO_2 formed.

3. RESULTS AND DISCUSSION

3.1. Effect of pH and time on the amount of CO_2 fomed.

The enhanced culture exhibited an almost complete LAS elimination after a few days of cultivation (Constantina *et al.*, 2007). A *Pseudomonas aeruginosa* strain (W51D) was isolated with the ability to mineralize linear alkylbenzene sulfonate (LAS) at a significant rate (Nour Amirmozafari, 2007) and which is able to mineralize at least 70% of a BAS commercial mixture and completely degrade LAS has been isolated (Jesús Campos-García *et al.*, 1999). Analysis of the final degradation of LAS and ABS in CO2 has been done. The CO_2 is trapped in barium or sodium hydroxide and is measured by titration of the residual hydroxide or as inorganic carbon (Constantina *et al.*, 2007).

In this study, a mixture of LAS and ABS degraded by the bacteria Pseudomonas aeruginosa. Gas stream of carbon dioxide (CO_2) produced into solution of NaOH and is measured by titration with solution of HCl . Figure 1. Show effect of pH on the use of HCl solution.

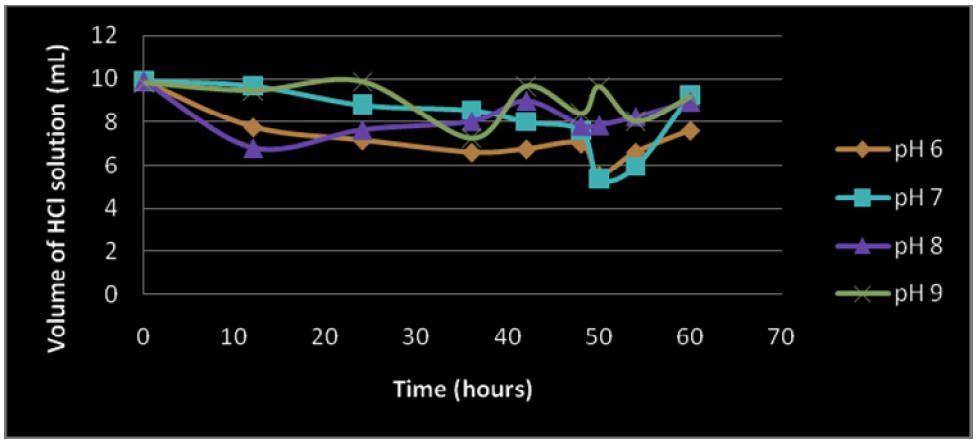

Figure 1. Effect of pH on the use of HCl solution

3.2. Concentration of CO_2 that was formed at the optimum condition.

The mineralization of LAS during aerobic degradation was also verified through carbon mass balances that were carried out in each experiment (Fig. 6). The organic carbon contained in solution (due to LAS or other compounds) and the inorganic carbon (carbonate or gaseous CO_2) produced were summed at each gaseous CO_2 sampling and, as it can be seen, the sum was almost equal to the initial amount of carbon present in the synthetic medium. This means that the carbon balance holds throughout the course of each experiment. Nevertheless, degradation did not reach 100%. Probably it happened because of limited bioavailability due to adsorption on biomass (Constantina *et al*., 2007). Figure 2. Show that maximum degradation of LAS and ABS solution was 99.73% at pH 7 and within 50 hours.

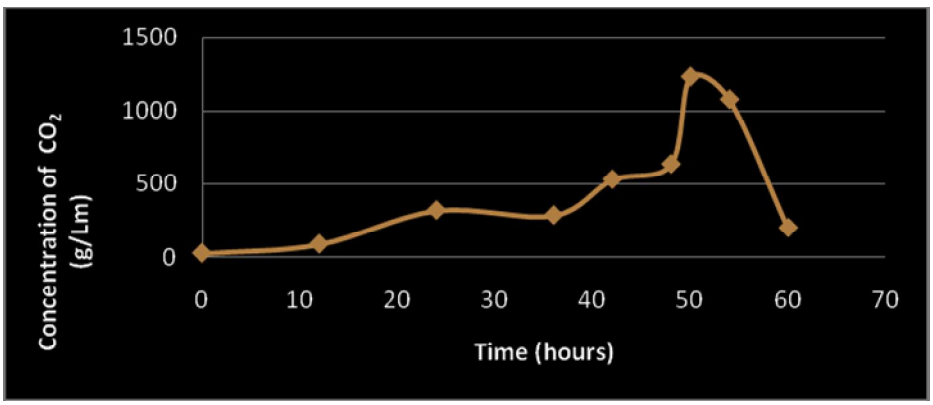

Figure 2. The concentration of CO_2 that was formed at pH 7

$$\textit{Removal efficiency of LAS and ABS}$$

$$= \frac{\textit{Initial concentration} - \textit{final concentration}}{\textit{Initial concentration}} \times 100\,\%$$

$$= \frac{100\ mg/L - 0{,}271676\ mg/L}{100\ mg/L} \times 100\% = 99{,}73\ \%$$

Figure 3. *Pseudomonas aeruginosa*

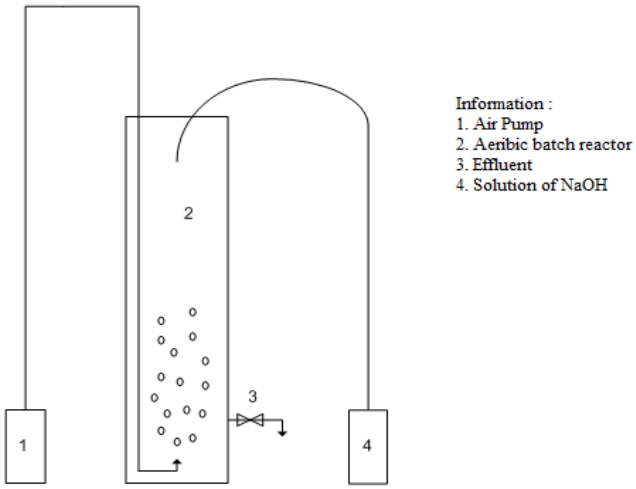

Figure 4. The series of experimental devices

4. CONCLUSION

1. In this study the optimum condition of the degradation process at pH 7 and within 50 hours. In this condition the standard solution of LAS and ABS degraded by 99.73% while the LAS and ABS are contained in river water degraded by 94, 22%.
2. With the longer time of degradation, the CO_2 that is formed more and more. The biggest CO_2 concentration obtained at pH 7 and at the 50th hour, amounting to 1227.6 mg / L.

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