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# Title: Environmental impact of wastewater discharges containing surfactants and their effect on biomass in anaerobic reactors during treatment

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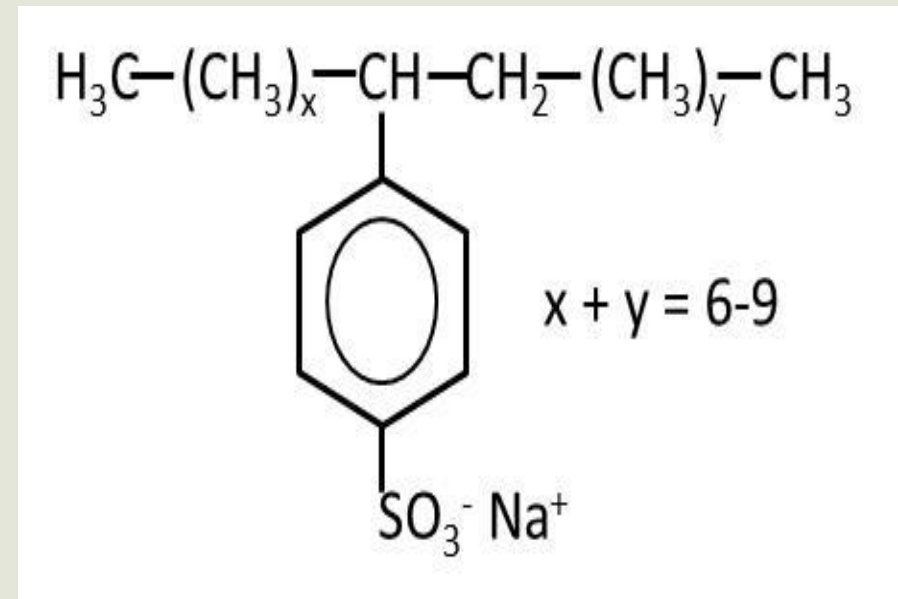
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# 1. INTRODUCTION

Chemicals are an integral part of life and everything that surrounds it. There is no doubt that their use brings benefits given that they are employed in virtually all areas of human activity, including industrial processes. However, under certain conditions of exposure and improper handling, these substances, along with the discharge of toxic waste, pesticide residues, non-biodegradable materials, fertilizer residues, greenhouse gases, sludge produced during wastewater treatment, and the waste of hazardous chemicals, etc., pose significant risks to the environment and human health (PNUMA, 2012).



**Figure 1.** Molecular structure of linear alkylbenzene sulphonate .

# PRODUCTION

In Mexico, a production of 528,481 tons/year is reported, internationally, it occupies the 5th place among detergent producers (4.4%), United States (16.5%), Brazil (6.4%), China (5.0%) and Germany (4.7%). This means that per capita consumption in Mexico is high, at 10 kilos per year, a figure higher than that of other countries given the population growth rate, according to INEGI, (National Institute of Statistics, Geography and Informatics, 2013).



## 2. PROBLEM

In recent decades, the intensive use of surfactants in household, industrial, and agricultural products has raised concerns about their environmental impact. These compounds, essential in detergents, pesticides, and cosmetics due to their ability to interact with fats and water, have been persistently detected in aquatic and terrestrial ecosystems. Their accumulation in living organisms can alter biochemical processes, generate toxicity, and endanger human health and biodiversity. This research analyzes the bioaccumulation of surfactants, their pathways of entry into the environment, their effects on biological tissues, and strategies to mitigate their impact.



## 2. PROBLEM

The background of the slide is a high-speed photograph of water splashing, creating numerous droplets and ripples. The color palette is dominated by various shades of blue, from light sky blue to deep navy. Overlaid on this background are several dark blue, semi-transparent circular shapes of varying sizes. One large circle is centered in the lower half of the frame, containing the main title text. Other smaller circles are scattered around it, some partially overlapping the main circle and others in the background.

BIOACCUMULATION OF  
SURFACTANTS

## 2.1 TOXICITY

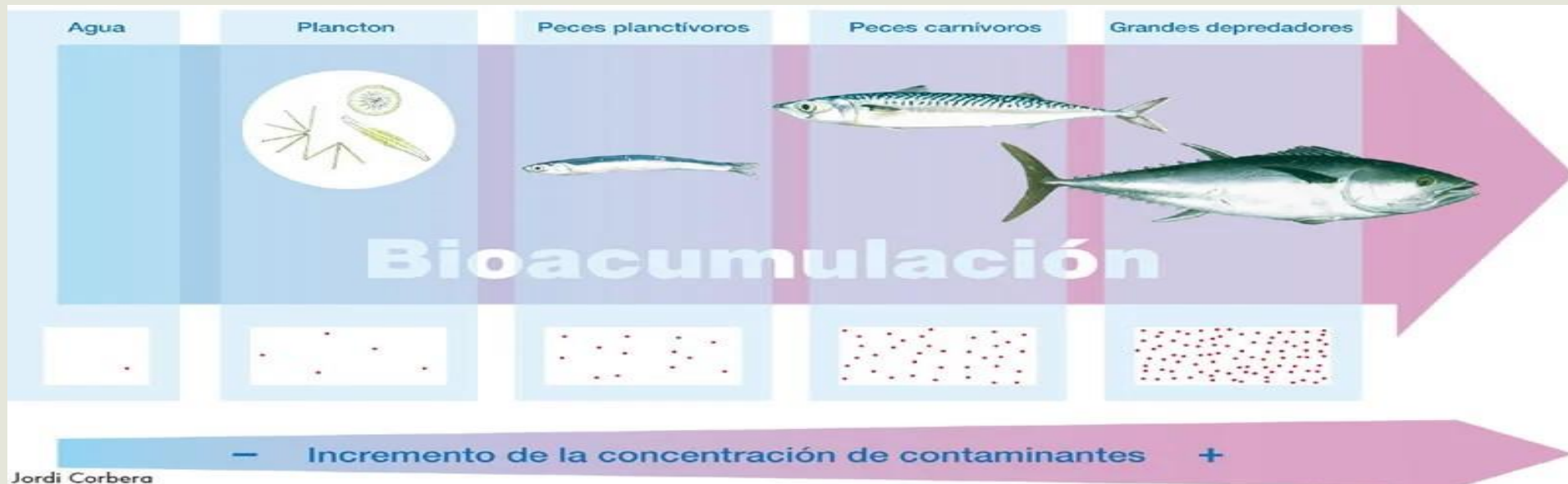
Their bioaccumulation can cause serious alterations in plant metabolism: a) Reduction in plant growth; i.e., stem shortening, decreased leaf mass, and b) Interference with nutrient uptake: Due to competitive blockage or root damage. c) Oxidative stress: Production of reactive oxygen species (ROS) that damage lipids and proteins.



Hernández-Baranda, 2023

## 2.1 TOXICITY

LAS toxicity data (lethal concentrations, EC50) for aquatic organisms range from 1 to 10 mg per liter in short-term tests. LAS is approximately equally toxic to fish and invertebrates, while its toxicity to algae varies widely (Hashim & Kulandia, 1992).



**Figure 2.** Absorption mechanisms in aquatic organisms.

## 2.1 TOXICITY

Exposure of coastal vegetation to surfactants results in an indirect absorption of sodium chloride and a reduction in water surface tension, caused by the erosion of the epicuticular wax of plants.

At doses of 30 ppm, it induces inhibition of coastal organisms (Bressan et al., 1991).



## 2.1 TOXICITY

Anaerobic microorganisms appear to be the most affected by the presence of surfactant (Van Hamme et al., 2006). The toxicity of surfactants in the environment is affected by various physical, chemical and biological factors that interact with each other, such as temperature and pH. Buhl & Hamilton (2000) suggest that the toxicity of the anionic surfactant sodium dodecyl sulfate (SDS) increases with increasing temperature.



### 3. TREATMENT TECHNOLOGIES

Various technologies have been employed for the treatment of wastewater containing high concentrations of anionic, cationic, non-ionic and ampholytic/zwitter ionic surfactants, including; adsorption processes, chemical oxidation, ozonation, hydrogen peroxide, ultraviolet light irradiation, iron salts (Ikehata and El-Din, 2004), advanced oxidation processes, photocatalytic degradation (Bandala et al., 2008), sonochemical processes (Dehghani et al., 2010), ultrasound (Naldoni et al., 2011) electrocoagulation, nanofiltration, aerobic or anaerobic biological processes and electrochemical processes (Korzenowski et al., 2012).



## 4 OBJECTIVE

Based on previous studies, this research focused on evaluating the toxic effect and accumulation rate of the surfactant "LAS" on the biomass of UASB anaerobic reactors during the treatment of wastewater with high concentrations of detergents.

# 5. METODOLOGY

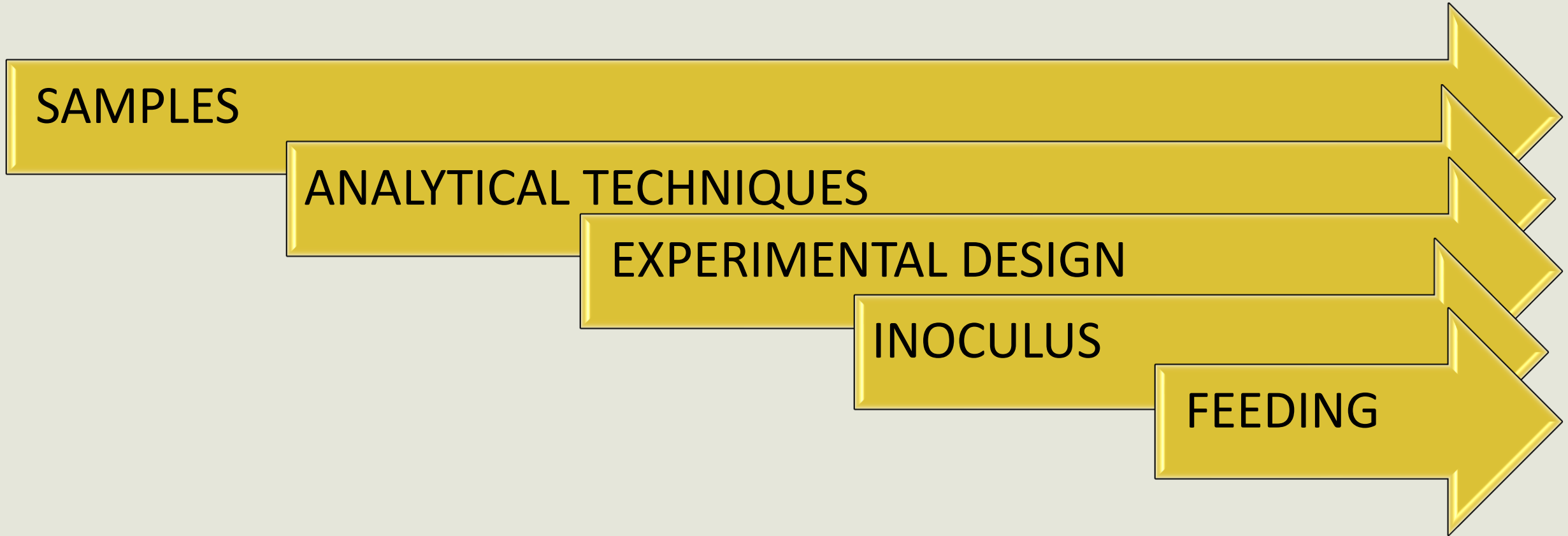
SAMPLES

ANALYTICAL TECHNIQUES

EXPERIMENTAL DESIGN

INOCULUS

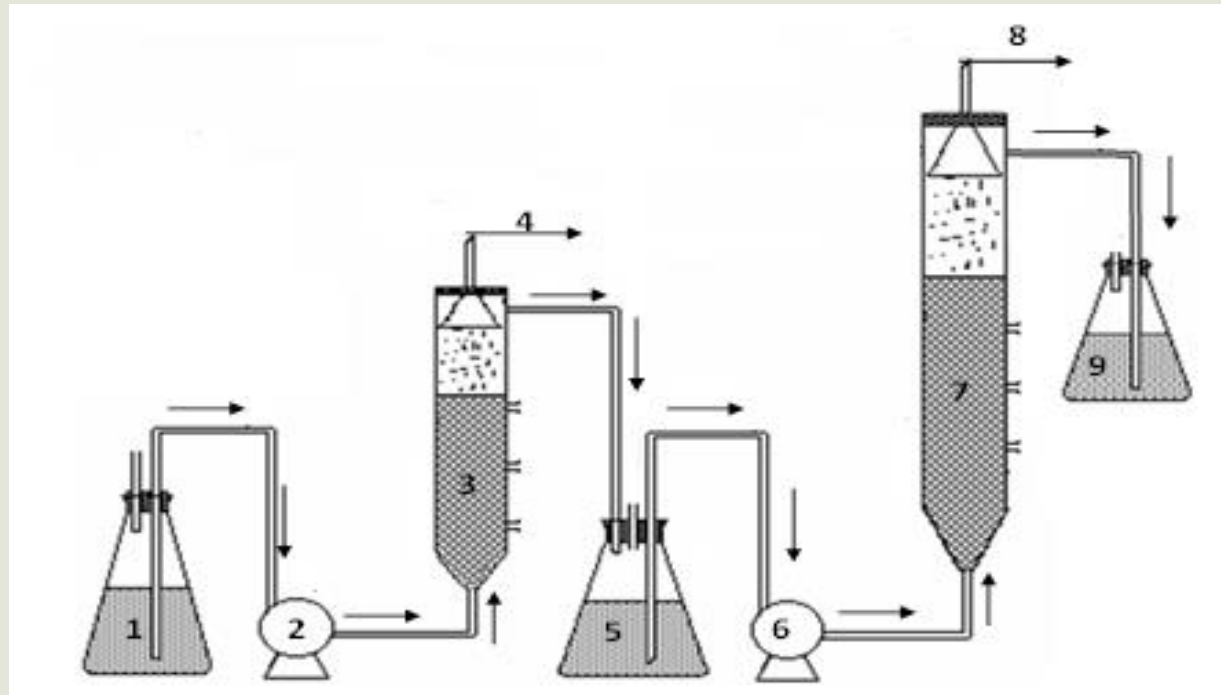
FEEDING



# SAMPLES AND ANALYTICAL METHODS

For the characterization of the synthetic water and process control, the main parameters were evaluated: Chemical oxygen demand (COD) and linear alkylbenzene sulfonate (LAS), according to standard methods (APHA, 2012) and the pH using a potentiometer (Corning pH/ion Analyzer 455).

# EXPERIMENTAL DESIGN



**Figure 3.** Process description: 1) Surfactant wastewater, 2) Peristaltic pump, 3) UASB acidogenic reactor, 4) Biogás pipeline, 5) Treated wastewater by acidogenic reactor, 6) Peristaltic pump, 7) UASB metanogenic reactor, 8) Biogás pipeline, 9) Treated wastewater by metanogenic reactor.

## INOCULUS

The biomass used as inoculum for the UASB acidogenic and methanogenic reactor was collected from a UASB reactor that treats wastewater at the Universidad Autónoma Metropolitana Iztapalapa Unit, Mexico City. It presented a concentration of 63.9 g/L TSS, 37.5 g/L VSS, and a specific methanogenic activity (SMA) of 0.15 L CH<sub>4</sub>/g VSS d.

## FEEDING

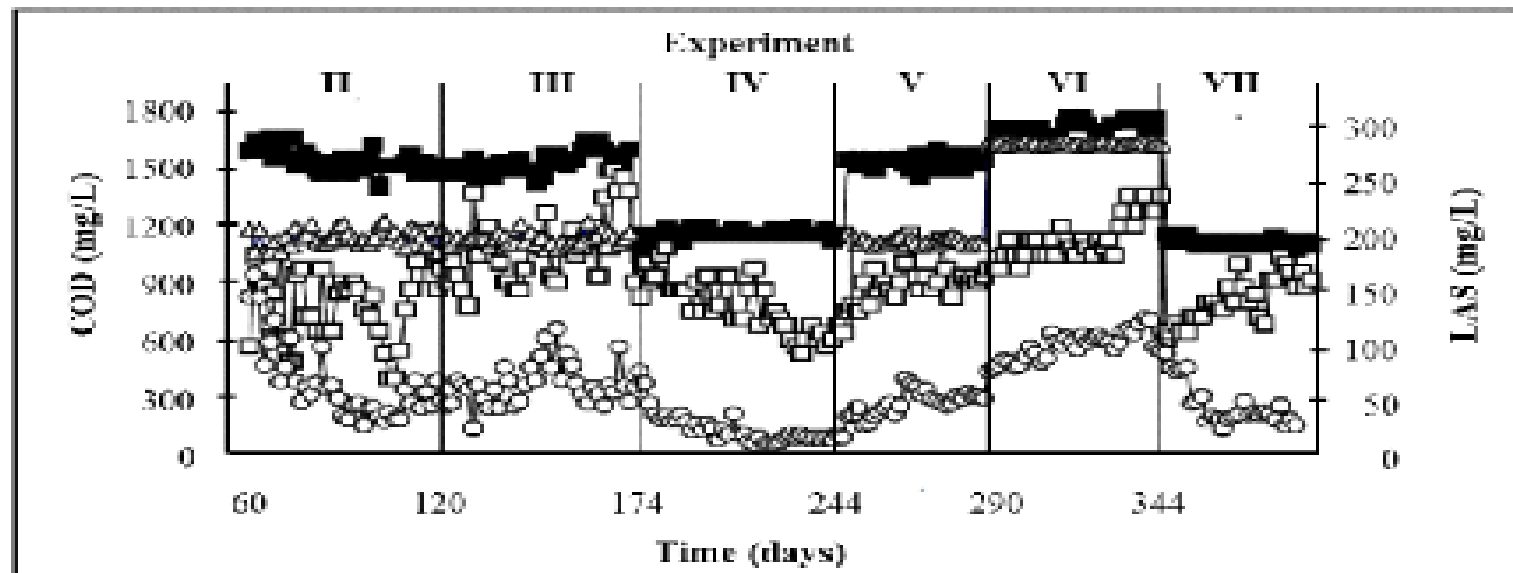
Table 1. General characteristics of the synthetic wastewater fed to the studied system.

Parameter	Experiment						
	I	II	III	IV	V	VI	VII
Time of operation (days)	0-62	63-120	121-174	175-244	245-290	291-343	344-374
pH	7.05±0.1	7.1±0.11	6.94±0.2	7.02±0.09	7.08±0.12	6.94±0.13	7.08±0.1
COD (mg/L)	1118.6±14.1	1499±18.9	1479±20.4	1123±15.1	1503±22.7	1709±24.5	1074±13.9
BOD <sub>5</sub> (mg/L)	655.6±8.1	878±10.4	866.8±10.1	658.2±8.8	880.9±12.1	1001±14.4	629.4±8.1
LAS (mg/L)	0	200±0.08	200±1.3	0	200±0.09	300±0.05	0

# REACTOR OPERATING CONDITIONS

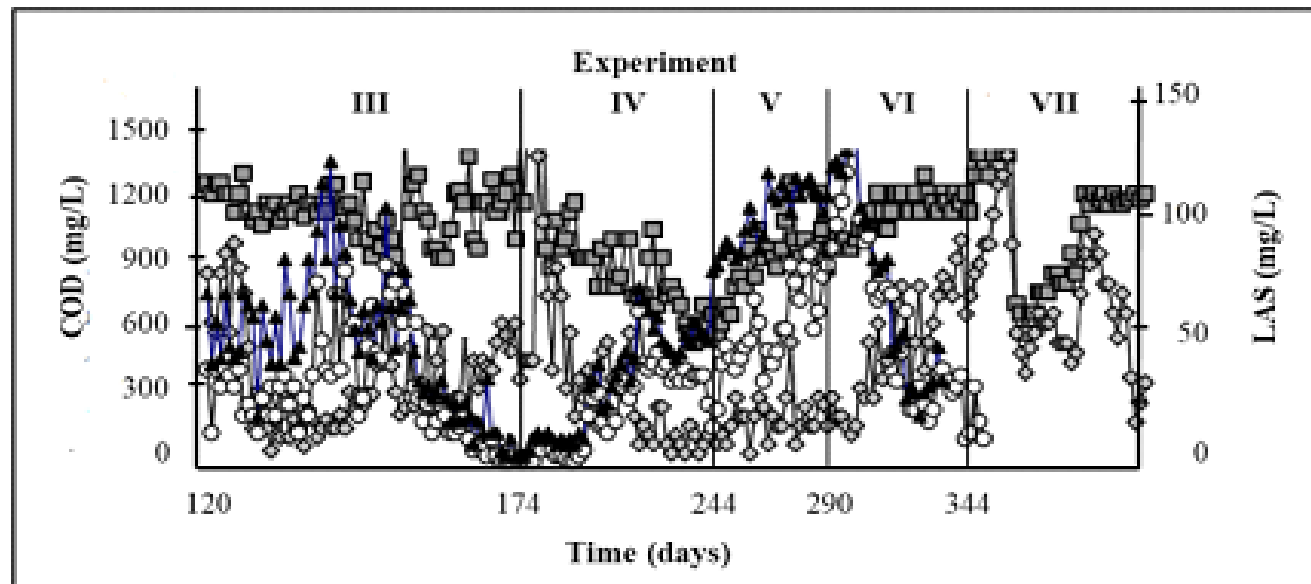
The design volume of the first reactor was 0.5 L, with a useful volume of 0.360 L, operated at a hydraulic retention time (HRT) of 0.25 days, fed with RAMM mineral medium (Shelton & Tiedje, 1984) and lactose as the sole carbon source to promote the development of acidogenesis conditions and the conversion of volatile fatty acids (VFA) during acetogenesis, forming acetate, hydrogen and carbon dioxide and with the acetate produced, promote methanogenic conditions in the second reactor. The design volume of the second reactor was 1.5 L, useful volume 1.44 L operated at a HRT of 1 day, operating both reactors at an average temperature of the order of  $30 \pm 0.5^\circ\text{C}$ .

## 6. RESULTS



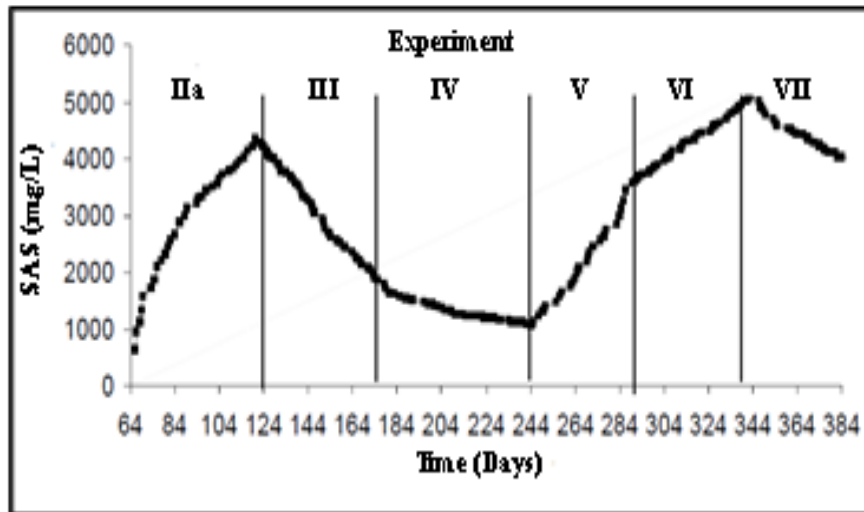
**Figure 4.** Efficiency of COD removal and surfactant biodegradation in the acidogenic reactor (■ COD and △ LAS in influent, □ COD and ○ LAS in effluent).

# RESULTS AND ANALYSIS

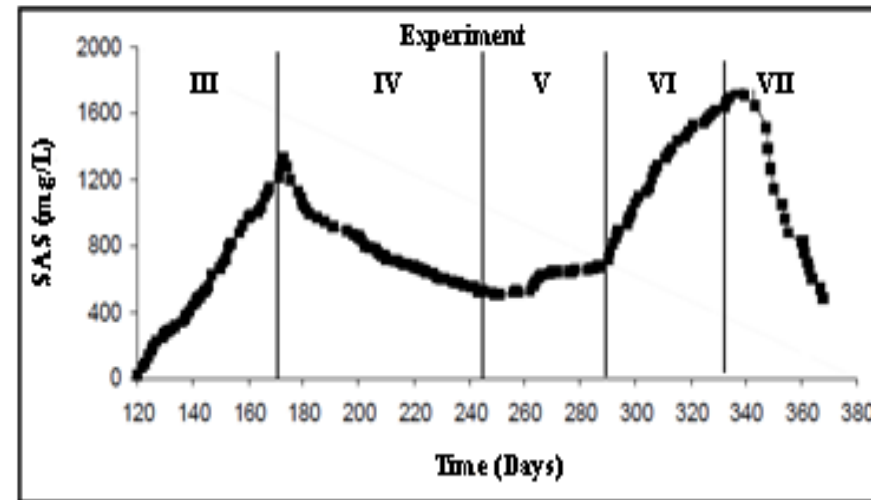


**Figure 5.** Efficiency of COD removal and surfactant biodegradation in the methanogenic reactor (■ COD and ▲ LAS in influent, ◆ COD and ○ LAS in effluent).

# RESULTS AND ANALYSIS



**Figure 6.** Trend in the accumulation of the anionic surfactant sodium alkylbenzene sulfonate (LAS) in acidogenic reactor sludge.



**Figure 7.** Trend in the accumulation of the anionic surfactant sodium alkylbenzene sulfonate (LAS) in methanogenic reactor sludge.

## 7. CONCLUSIONS

At the ecological and agricultural levels, the implications are equally relevant. The persistence of detergents in arable soils reduces fertility, alters the soil microbiota, and increases salinity, which can decrease agricultural productivity. In natural ecosystems, the phytotoxicity of detergents causes changes in plant composition, affecting sensitive species and disrupting food chains. There is also a risk of biomagnification, since contaminants accumulated in plant tissues can be transferred to herbivores and, eventually, to humans if the crops are edible.

# REFERENCES

APHA, Standard methods for the examination of water and wastewater, 22th edition edited by E. W. Rice, R. B. Baird, A. D. Eaton, L. S. Clesceri, American Public Health Association (APHA), American Water Works Association (AWWA) and Water Environment Federation (WEF), Washington, D.C., USA 2012.

[https://books.google.com.mx/books/about/Standard Methods for the Examination of.html?id=dd2juAAACA&redir\\_esc=y](https://books.google.com.mx/books/about/Standard+Methods+for+the+Examination+of.html?id=dd2juAAACA&redir_esc=y)

INEGI (Instituto Nacional de Estadística, Geografía e Informática). La industria química en México (2013).

[https://www.inegi.org.mx/contenido/productos/prod\\_serv/contenidos/espanol/bvinegi/productos/integracion/sociodemografico/Quimica/2013/702825060503.pdf](https://www.inegi.org.mx/contenido/productos/prod_serv/contenidos/espanol/bvinegi/productos/integracion/sociodemografico/Quimica/2013/702825060503.pdf)

Hernández-Baranda, Y. (2023). Effect of detergents on the germination and initial growth. Revista Colombiana de Ciencias Hortícolas. <https://www.scielo.org.co/pdf/rcch/v17n3/2011-2173-rcch-17-03-e16577.pdf>



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