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Title: Effect of hydraulic retention time and dissolved oxygen concentration on the biodegradation

Authors: Terreros, Jesús and Gutiérrez, Guadalupe

Technological University of Toluca 0000-0003-4456-699X

Technological University of Toluca 0000-0002-2500-5954

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ECORFAN-México, S.C.
Park Pedregal Business. 3580, Anillo Perif., San Jerónimo Aculco, Álvaro Obregón, 01900 Ciudad de México, CDMX,
Phone: +52 1 55 6159 2296
Skype: MARVID-México S.C.
E-mail: contact@rinoe.org
Facebook: RINOE-México S. C.
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CONTENT

1. INTRODUCTION

In 2003, world production of phenol was 7.3 million tons.25% of total production is used in the synthesis of aniline, alkylphenols and xyphenols.70% is used in the production of bisphenol, which is an intermediate in the production of epoxy and phenolic resins. 1% is used in the manufacture of disinfectants, anesthetics, germicides, preparation of drugs, ointments, ear and nose drops, antiseptic lotions and the manufacture of cosmetics.

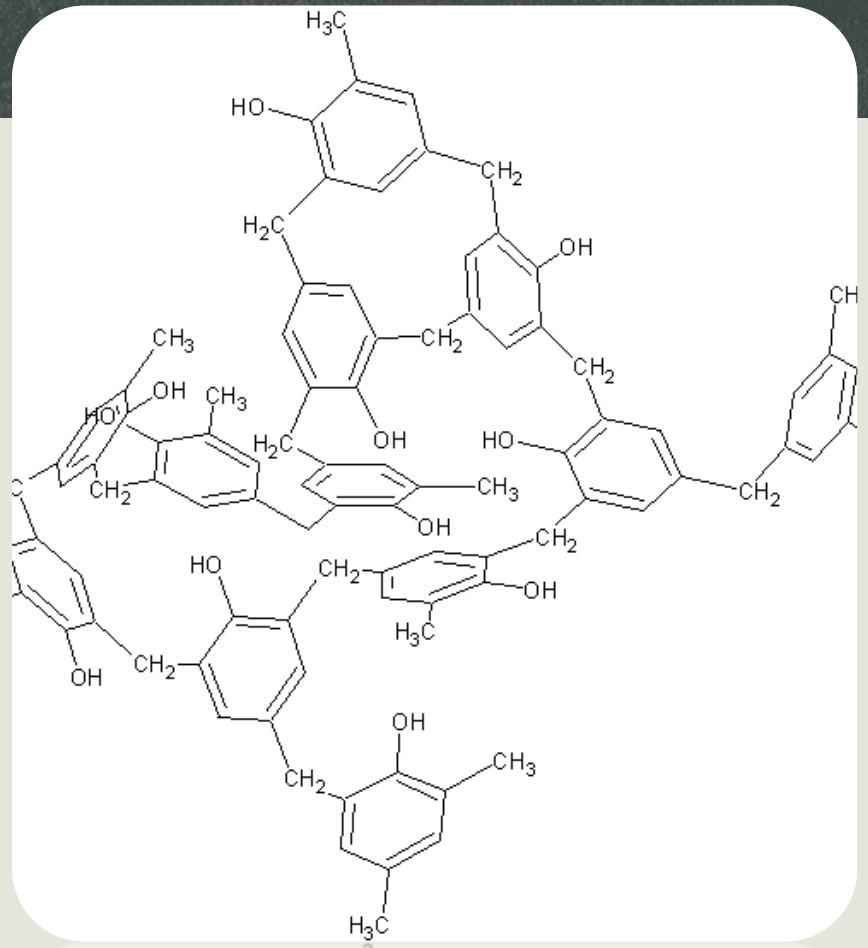


Figure 1. Molecular structure of the polymeric resin.

PHENOL

- Carbolic acid
- Phenic acid
- Phenyl acid
- Phenolic acid
- Benzaphenol
- Phenylhydrate
- Benzol
- Oxybenzene

Figure 2. Chemical structure of phenol.

Phenolic compounds and their derivatives are considered potentially carcinogenic or lethal at concentrations between 5 and 25 mg/L.

2. PROBLEM

- 73.3% of water bodies contain this pollutant because in most cases industrial wastewater (petrochemical, textile, pharmaceutical, among others) is discharged into the sanitary network without any prior treatment, which, due to damage to the sanitary network, leads to contamination of groundwater where its presence has been reported (Kyshino et al., 2000; Mohásn et al., 2004).

Table 1. Toxicity.

INSTITUTION	LMP
Europea Council	0.5 $\frac{\mu g}{L}$ (drinking water)
OMS	1$\frac{\mu g}{L}$ (drinking water)
USEPA	1$\frac{\mu g}{L}$ (drinking water)

2.1 TOXICITY

- Kidneys, liver, blood vessels, lungs and heartIts lethal
- Effect in blood occurs at around 150 mg/100 mL
- At concentrations of 5 mg/mL, it causes skin irritation.
- Ingestion of 1 g is fatal.
- It affects humans at concentrations between 10 and 24 mg/L

Fountain: Ahmed *y col*.,2012

3. BACKGROUND

PHYSICAL-CHEMICAL METHODS

- Chemical coagulation (Ozbolge et al., 2002).
- Solvent extraction (Yang et al., 2006).
- Membrane techniques (Kujawski et al., 2009).
- Adsorption (Lina and Juang, 2009).
- Microfiltration (Wei et al., 2014).
- Reverse osmosis (Ipek et al., 2014)

BIOLOGICAL METHODS

Activated sludge

- Anaerobic microorganisms

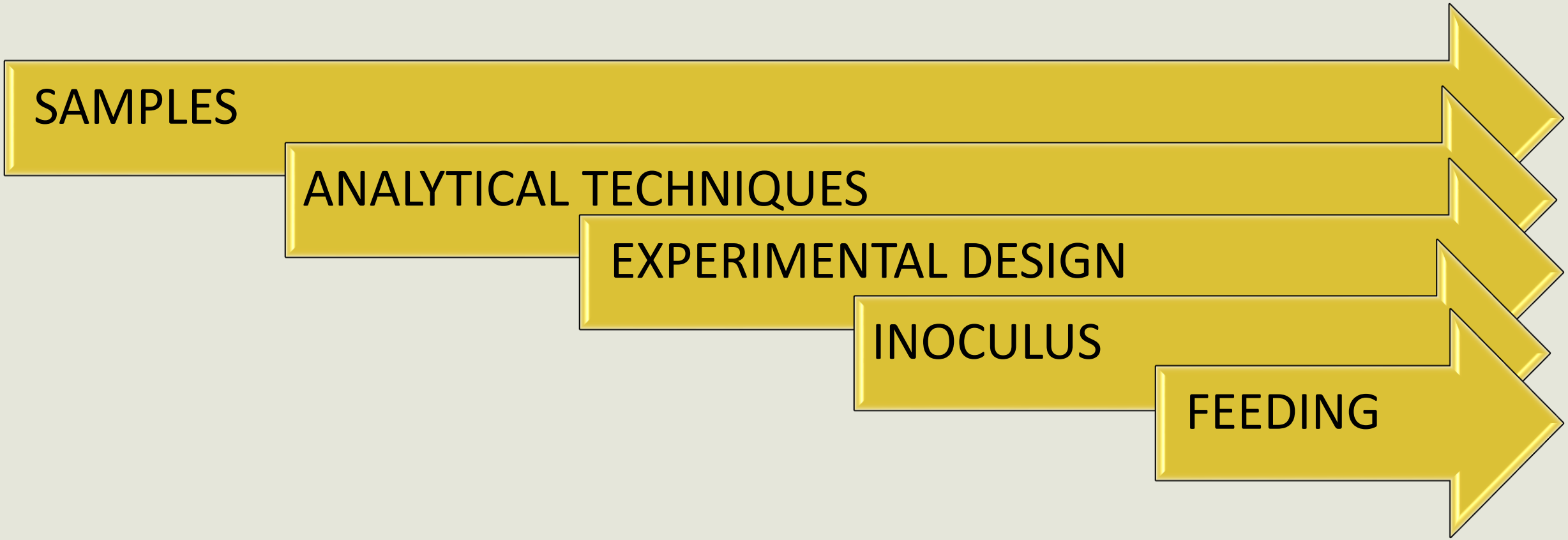
Psudomonas Putidas
Serratia
Marcescens
Bacillus Sutillis
Bacillus Brevis
Candida tropicalis

η > 70% (Diya'uddeen y col., 2011; Ishak y col*., 2012)*

4 OBJECTIVE

Based on previous research, the present study focused on evaluating the effect of hydraulic retention time (HRT) and dissolved oxygen (DO) concentration, on the efficiency of phenol biodegradation and COD removal from an industrial effluent of polymeric resins, at different organic loading rates (Bv) by activated sludge, in a complete mix reactor.

5. METODOLOGY



SAMPLES

- Two batches of 10 L of phenolic wastewater were processed.
- The method used for sampling is described in the standard (NMX-AA-003-1980).

ANALYTICAL METHODS

- pH
- COD (Closed reflux).
- Determination of phenol by the colorimetric method of 4-aminoantipyrine according to NMX-AA-050-SCFI-2001.

EXPERIMENTAL DESIGN

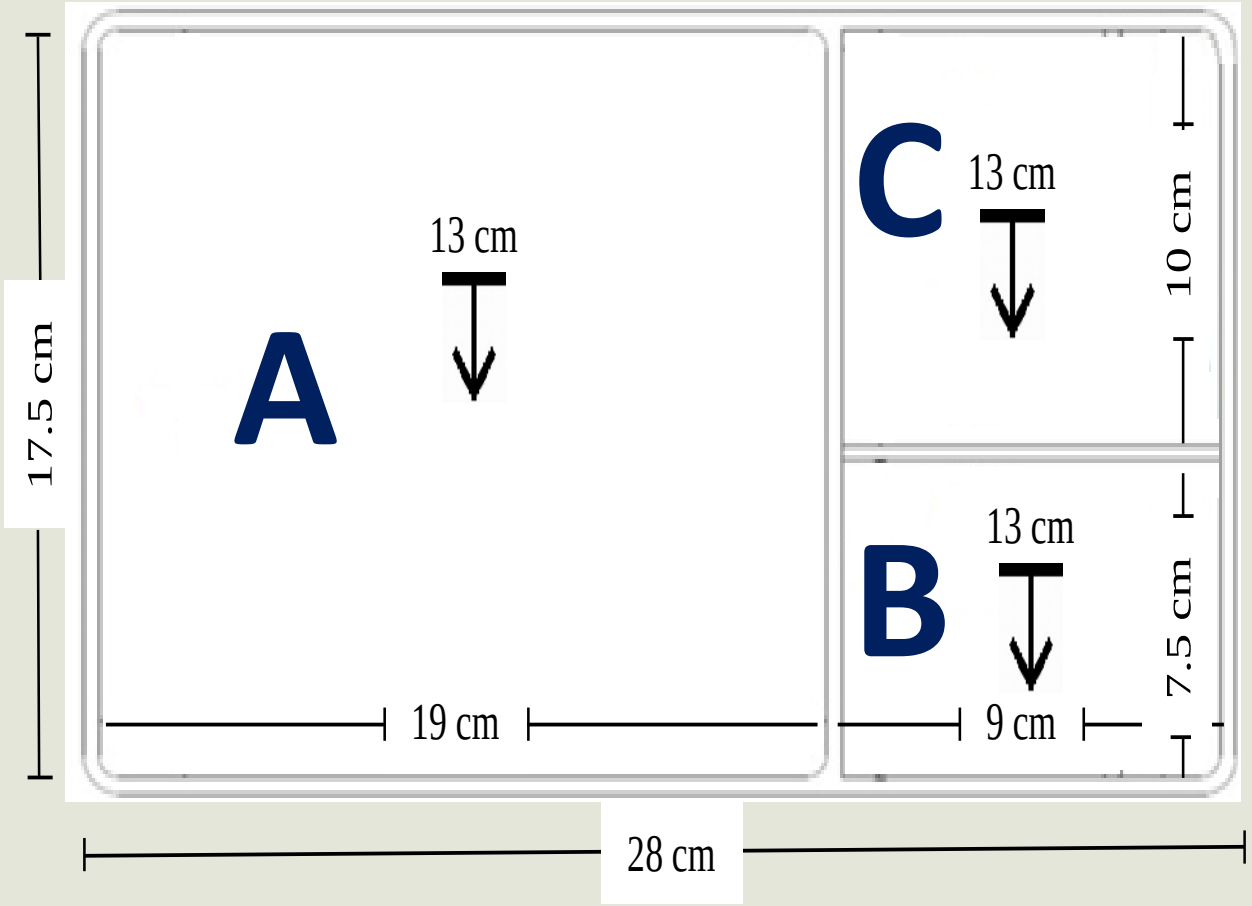


Figure 3. Schematic of the activated sludge reactor.

- Section "A" where the biological reaction takes place.
- Section "B" sludge return zone.
- Section "C" clarification zone.

INOCULUS

The biomass used as inoculum was collected from an activated sludge reactor at the Cerro de la Estrella municipal wastewater treatment plant in Mexico City, with a concentration of 12.6 g/L of ST and 9.6 g/L of SV.

FEEDING

Table 2 shows the averages of the main parameters evaluated in 2 batches of 10 L of phenolic wastewater.

Tabla 2. Characteristics of the wastewater fed to the biological reactor.

Parameter	Experiment	
	M1 (I, II y III)	M2 (IV)
COD (g/L)	76.99±2.85	84.48±0.9
BOD_5 (g/L)	24.54±0.1	27.94±0.14
Phenol (g/L)	14.15±4.35	15.63±1.6
pH	6.56±0.19	6.65±0.14
TS (g/L)	0.32±0.2	0.25±0.1
VS (g/L)	0.19±0.1	0.19±0.08

REACTOR OPERATING CONDITIONS

Table 3 shows the operating conditions of the reactor with continuous feed flow, at the different operations in which the experiment was carried out.

Table 3. Operating conditions of the activated sludge reactor.

Experiment	I	II	III	IV
Bv ($kgCOD/m^3 \cdot d$)	10.9±0.04	8.7±0.03	13.1±0.01	7.5±0.1
HRT (days)	1.76	1.76	1.76	2.81
Dissolved Oxygen (ppm)	2.5	2.5	1.5	1.5

6. RESULTS

Characteristics of phenolic wastewater after treatment. Table 4 shows the averages of the main parameters evaluated for the water treated by the activated sludge reactor, during the experiment under the tested operating conditions.

Tabla 4. General characteristics of treated wastewater (effluent).

Parámeter	Experiment			
	I	II	III	IV
COD (g/L)	12±5	12±1.6	15±2.9	13±3.7
Phenol (g/L)	2.5±0.5	2.6±0.3	2.6±0.6	1.7±0.4
pH	7±0.12	7.23±0.22	7.27±0.14	7.28±0.13
TS (g/L)	0.82±0.35	0.28±0.09	1.2±0.21	0.54±0.34
VS (g/L)	0.69±0.25	1.19±0.45	0.73±0.13	0.52±0.16

RESULTS AND ANALYSIS

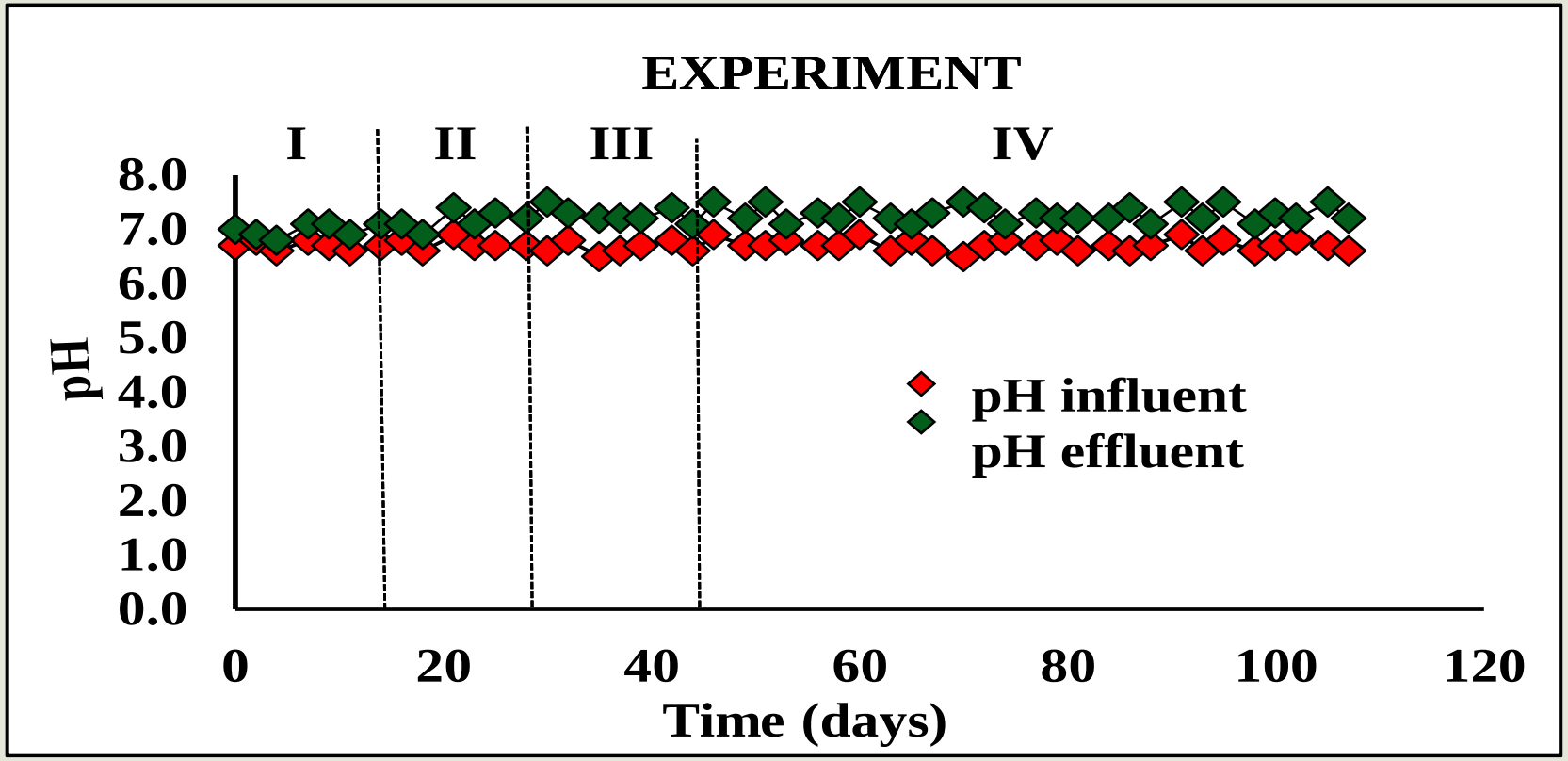


Figure 4. pH profile of the mixed liquor from the activated sludge reactor. Influent (♦) and effluent **(♦).**

RESULTS AND ANALYSIS

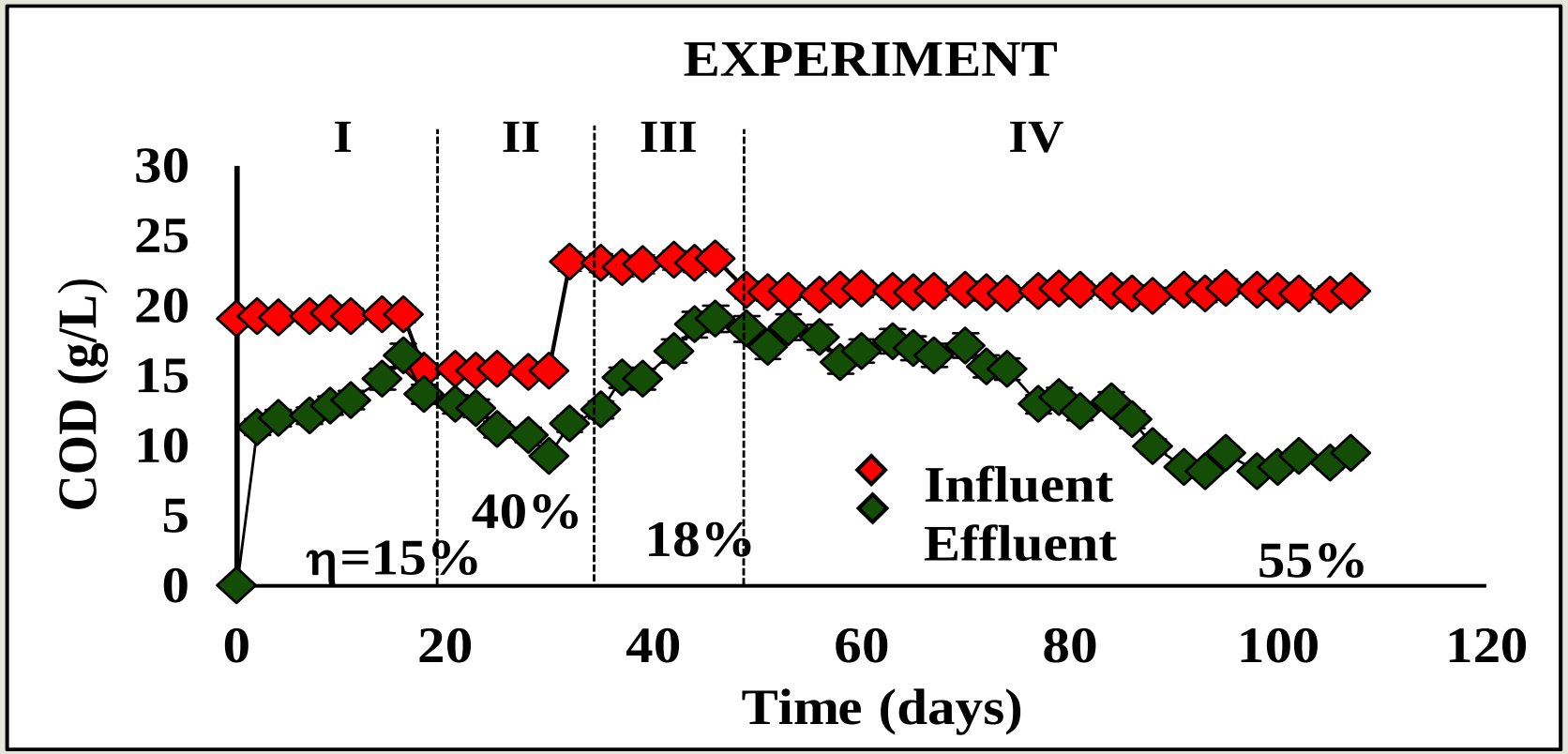


Figure 5. COD removal in the activated sludge reactor. Influent (◆) and effluent (◆).

RESULTS AND ANALYSIS

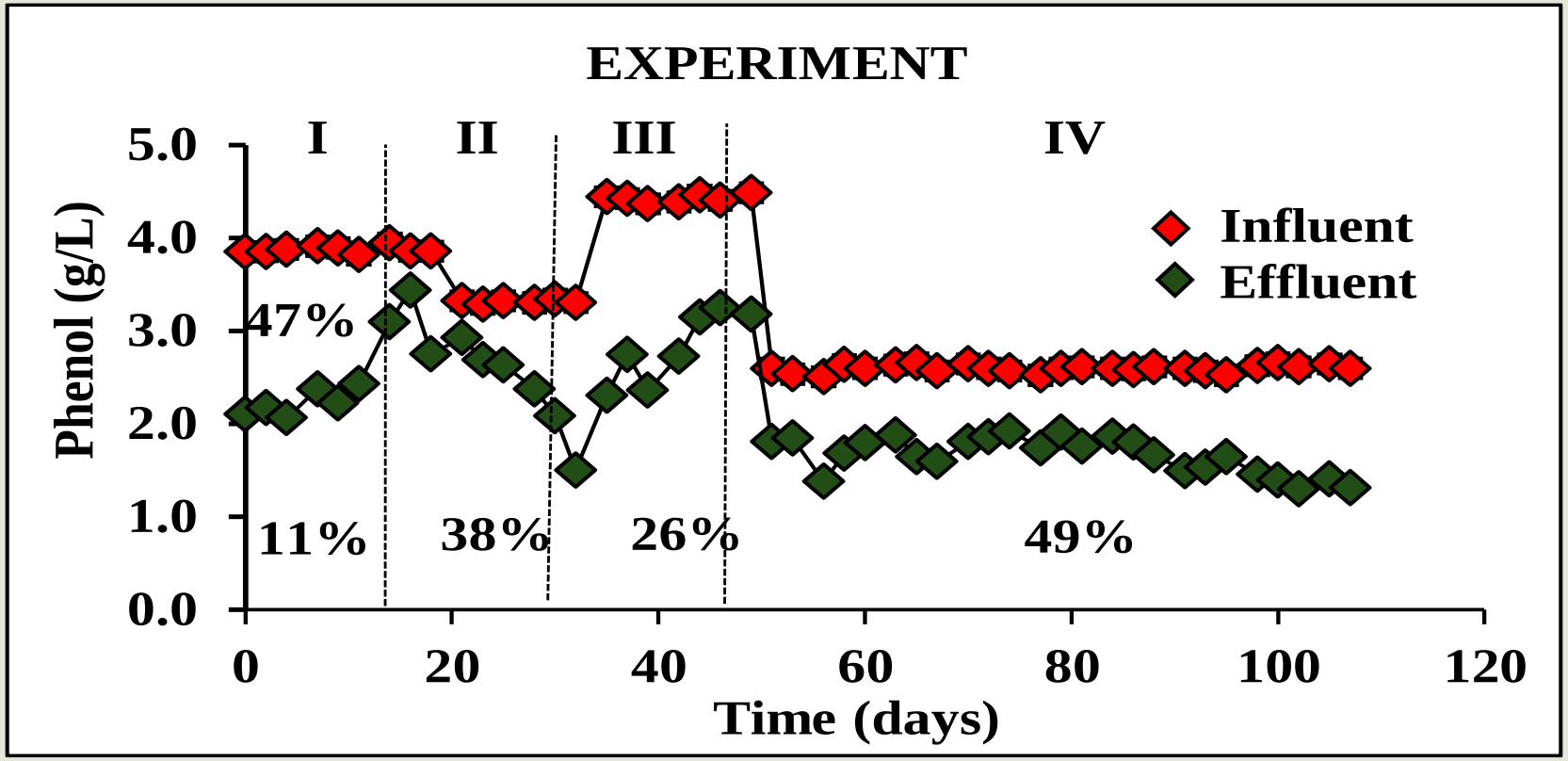


Figure 6. Phenol biodegradation profile in the activated sludge reactor. Influent (◆) and effluent (◆).

7. CONCLUSIONS

- With this contribution, new studies can be carried out testing higher organic loading rates in order to find the best operating conditions for the fully mixed activated sludge reactor that allow achieving the maximum rate of phenol removal from industrial wastewater, to produce treated water of excellent quality for reuse in the agricultural and industrial sectors, as well as for artificial recharge of the aquifer in accordance with the regulations for this purpose, mitigating as far as possible its effects on environmental pollution, damage to human health, biodiversity and ecosystems.

7. CONCLUSIONS

- This research undoubtedly strengthens the progress in the field of scientific research on water resources, in the generation of new knowledge on sanitation and in the solution of real problems of environmental pollution due to industrial discharges highly contaminated by chemical compounds of this nature.

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