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In this number is presented Feasibility Study Using Lemna Minor Treatment of Domestic Wastewater, from an Educational Institution by ORTEGA, Laura & MENDOZA, Rosendo with adcription *Intituto Tecnológico de Chihuahua II*, next article Electrochemical Corrosion on Metals in Soil by LUGO, Gabriela, GALLARDO, Ernesto, GARCÍA, Norma, OSEGUERA, José and PÉREZ ,Juan with adscription *Universidad Veracruzana*, next article Development of a process configuration using a new design anaerobic reactor at low rates of dissolved oxygen, for biodegradation of phenol in an industrial effluent by TERREROS, Jesús & MURO, Claudia with adscription *Instituto Tecnológico de Toluca*, next article Economic and Ecological Zoning Proposal for La Roqueta Island, Mexico by NIÑO Naú, NIÑO Isaías and NIÑO Elías with adscription *Universidad Autónoma de Guerrero*, next article Synthesis of biopolymer from chitosan/xanthan by ANTONIO-CRUZ Rocío, PURATA-PÉREZ, Nora Alicia, URRIETA-SALTIJERAL, Juan Manuel, GARCÍA-GAITÁN, Beatriz and SOSA-DOMÍNGUEZ, Noé with adscription *Instituto Tecnológico de Villahermosa*, next article Participatory cartography, as a support for decision-making in public health, case: Metropolitan Area of Toluca by ORTEGA-ALCANTARA, Roque, SANTANA-JUÁREZ, Marcela Virginia and SERRANO-BARQUÌN, Rebeca Angélica.

Content

Article **ECORFAN-Ecuador Journal**
June 2016 Vol.3 No. 4 1-6

Feasibility Study Using Lemna Minor Treatment of Domestic Wastewater, from an Educational Institution

ORTEGA, Laura†* & MENDOZA, Rosendo

Intituto Tecnológico de Chihuahua II

Received January 14, 2016; Accepted May 26, 2016

Abstract

Conduct an investigation about wastewater domestic treatment processes, which are efficient and at the same time requiring low investment and maintenance cost, using aquatic flora present in the region. Were collected wastewater samples from our Institute in two different periods, in order to cover a full year and to make a more realistic characterization of the conditions of the effluent to be used. Lemna Minor or Duckweed was selected to carry out the removing contaminants process due of its availability and ease use. Basic analyses were established to carry out water characterization, and they were conducted sample analysis of untreated wastewater, and five days treated wastewater using Lemna Minor. The activated sludge treatment to removal BOD, COD and nutrients is very efficient and can be appropriate where high removal of organic pollution is required. Otherwise, activated sludge requires the continuous operation of oxygen blowers and sludge pumps, that involves mayor investments and high costs in maintenance and purchase of reagents, which are the main arguments supporting the choice of cheaper alternative treatments, as would the use of a biological process with native plants of the region. On the other hand, having a whole methodology for implementing the type of wastewater treatment being proposed, this can be implemented in residential colonies, where treated wastewater would be used for irrigation of green areas. An additional contribution is achieved when students are involved in a research work, so that provides training in the research process, developing their skills in science, critical, deductive and inductive thinking, thereby contributing to their professional growth.

Wastewater Domestic Treatment, Lemna Minor, Educational Institution, arid climates

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Introduction

Meeting the need to ensure an adequate water supply for Instituto Tecnológico de Chihuahua II green areas irrigation, this research project arises.

It seeks to design a treatment plant that uses sewage water discharge from the use of this resource in the facilities of our institution.

To carry out this work an exhaustive literature search about treatment processes was performed, looking for those that are appropriate to the waste effluent characteristics and at the same time requiring low investment and maintenance costs (Mahmood Q., et al., 2013).

The process suggested in principle, uses aquatic flora found in the region, for the degradation of organic matter, specifically the use of Lemna Minor or duckweed, probably in combination with Juncus as species associated with duckweed for the winter season.

It has been extensively researched the contamination cleaning potential and capacity of Lemna spp for the uptake and accumulation of mineral (Barba Ho, L. E., 2002), heavy metals (Shazia Iram et al., 2012), radionuclides as well as metalloids.

Additionally it demonstrated, cleaning capacity to remove ammonia and phosphorus from water. L. minor and L. gibba can metabolize phenol and a series of chlorinated phenols (Mkandawire M., Dudel E. G., 2007).

Considerable work has been done on the use of Lemna spp. as a means of treating wastewater of both agricultural and domestic origin (León M., Lucero A. M., 2009), (Arroyave M., 2004).

There is information that showing Lemna elimination capacity for organic material in terms of biological oxygen demand (BOD) and chemical oxygen demand (COD) (Valderrama et al.,), (Ramirez L., Sierra L., 2010), (Martínez P. et al., 2006), (Ozengin N. and Elmaci A., 2007).

It is noteworthy that have been considered various factors to reject the use of Lemna for wastewater treatment. Such factors include the need to remove Lemna excess due to its heavy growth presented in nutrient-rich environments (Canales A., 2010)

It has been found Lemna species have more environmental benefits than mere phytoremediation potential. Initially, a great deal of work has been done on the nutritional value of the species of the Lemnaceae in aquaculture (Zetina Córdoba et al., 2010) and livestock production (Rodriguez C. et al.).

Another point that is considered negative is the narrow temperature range at which Lemna spp. can survive and develop optimally (18-24 ° C). We evaluate the lower limit of temperature at which L. minor could survive in conditions typical of our region, finding that there was a growth decrease but not extinction at such low temperatures of 2 ° C.

A point in favor of our project is the water reduced evaporation in Lemna-covered wastewater treatment that is very important for weather and extreme aridity of our environment conditions.

It is noteworthy that there have been some projects in our community who have tried using Lemna species for the treatment of wastewater from educational institutions, but difficulties have arisen due to nutrient lack and system temperature monitoring.

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An important aspect to this type of research projects is the possibility of involving students who develop research skills, critical thinking and initiative but especially, sensitivity to environmental care through the development of simple and friendly technologies with nature.

Finally, it is considered likely that the development of a system of wastewater treatment, like the being investigated, it could be adopted by residential construction companies, which would benefit from the use of their own treated water for its green areas irrigation, stressing the growing shortage of the vital liquid that has suffered in recent years our state.

Methodology

Wastewater characterization

Samples of wastewater from our Institute were collected in two different periods: one at the end of the first half of the year (Table I), and two in the second half of 2013 (annexes), this in order to be able to make a more realistic characterization of the effluent conditions that will be used in the treatment plant as well as to obtain the corresponding capacity and to know the flow is to be handled. Analyses were performed by a particular company and the faculty of Zootecnia y Ecología at the Universidad Autónoma de Chihuahua, showing the most relevant results in Table I.

Determination of the temperature range

Samples of L. minor from the river and Chuvíscar dam were taken and placed on the outside of Chemistry Laboratory in a place where solar radiation occurs during the morning and exposed outdoors but closed to air currents, this to lessen the water temperature drop during the winter months .

The minimum air temperature was reduced to 2 °C without there being a severe impairment in Lemna fronds solely decreased growth.

The year 2013 proved to be particularly warm in our region with maximum air temperatures approximate 40 ° C during the summer, which does not affect in any way the samples of L. minor that remained in constant growth due to adequate supply of nutrients.

Parameter	Units	Method	Results	*MAL
Settleable solids	ml/l	NMX-AA-004-SCFI-2000	1.5	5
Fats and oils	mg/l	NMX-AA-005-SCF-2000	13.3	60
Total Nitrogen	mg/l	NMX-AA-026-SCF-2010	49	60
Detergents	mg/l	NMX-AA-039-SCF-2001	2.4	20
BOD	mg/l	NMX-AA-028-SCF-2001	152	200
QOD	mg/l	NMX-AA-030-SCF-2001	361	400
Total suspended solids	mg/l	NMX-AA-034-SCF-2001	76	300
pH			7.56-8.86	6.5-8.5
Water temperature	°C		22.8-26.1	40
Electric conductivity	µS/cm		741-1322	**dna

Table 1 Wastewater characterization of Instituto Tecnológico de Chihuahua II, May 2013

Conditioning L. minor

Samples of the Lemna Minor species extracted from the Chuviscar dam located south of Chihuahua City were subsequently adapted for use in experimentation.

Plants were washed with chlorine free tap water and transferred to a prepared solution with the nutrients described in Table II, for its conditioning (Worthington A., 1995), (Barba Ho, L. E., Edith L., 2002).

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It established the basic analysis to perform the characterization of water subjected to the treatment process with Lemna (APHA, 1992).

The basic analyzes were determining pH, electrical conductivity, settleable solids , Dissolved Oxygen , Chemical Oxygen Demand, Biochemical Oxygen Demand and Total Nitrogen .

Nutrient	Nutrient
KNO_3	$MnCl_2 \cdot 4H_2O$
$ZnSO_4 \cdot 7H_2O$	H_3BO_3
$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$	KH_2PO_4
$MgSO_4 \cdot 7H_2O$	$Ca(NO_3)_2 \cdot 4H_2O$
$FeCl_3 \cdot 6H_2O$	

Table 2 Nutrients necessary for the development of Lemna species (Worthington A., 1995)

Development of experimentation

To determine the ability of L. minor to degrade organics, wastewater composite samples from our Institute were taken and were handled four different concentrations: 100 %, 50 %, 25 % and 12.5 %, with three repetitions each.

Were used plastic containers of 500 ml and a 10.5 cm diameter (area = 0.008659 m^2). Wastewater samples with different concentrations and with an amount of 5 g of duckweed, slightly higher than reported in literature of 400 g / m^2 (Barba Ho L. E., Edith L., 2002) were placed.

It was allowed to act duckweed for a period of five days, and daily measurements of temperature and pH of the samples were made.

After five days reweighed Lemna samples and chemical analysis were made of samples of treated water.

Results

As shown in Table I and reports shown in the Annexes, the wastewater of our Institute are primarily domestic, with all parameters examined in the relevant standards , presenting loads of BOD , QOD and nitrogen within the proper range to be treated with Lemna species, with acceptable removal of such contaminants (Ozengin N., Elmaci A., 2007).

From the results obtained by analyzing the initial weight of samples Lemna before being used for the absorption of pollutants from wastewater (organic matter and nutrients) , see Table III , and then reweighing after standing 5 days in containers with different wastewater concentrations , can be seen an increase in weight of all samples. A very similar value of about 2.5 g appears in three of the four samples, but cannot observe any trend or correlation between increased weight of Lemna and the increase or decrease of wastewater concentrations, which suggest make another test run increasing the contact time (at different number of retention days).

Parameter	Samples a (100%)	Samples b (50%)	Samples c (25%)	Samples d (12.5%)
Initial average weight	5.234	5.283	5.296	5.301
Final average weight	7.818	6.084	7.709	8.003
Weight difference	2.584	0.801	2.413	2.702

Table 3 Wastewater samples at different concentrations treated with 5 grams of L. minor

Chemical analyzes of wastewater samples without dilution (100 %) , which were subjected to treatment with Lemna (Table IV) show a decrease of certain parameters.

ISSN: 1390-9959

The biochemical oxygen demand had a decrease of 12 %, the chemical oxygen demand 20.8 % while total nitrogen decreased 4.3 %

All these values are lower than those reported in the literature, which reaffirms the need for further experiments where different retention times are tested.

Parameter	Samples a (100%)	Untreated sewage, December 2013	% Removal
BOD	142	159	12
QOD	308	372	20.8
pH	7.76	8.2	
D. O.	7.16		
Fats and oils	9.97		
Total Nitrogen	47	49	4.3

Table 4 Analysis performed to residual water samples treated with lemna minor, December 2013

Annexes

Parameter	Units	Method	Results	*MAL
Settleable solids	ml/l	NMX-AA-004-SCFI-2000		5
Fats and oils	mg/l	NMX-AA-005-SCF-2000		60
Total Nitrogen	mg/l	NMX-AA-026-SCF-2010	43	60
Detergents	mg/l	NMX-AA-039-SCF-2001		20
BOD	mg/l	NMX-AA-028-SCF-2001	156	200
QOD	mg/l	NMX-AA-030-SCF-2001	359	400
Total suspended solids	mg/l	NMX-AA-034-SCF-2001		300
pH			7.72-8.21	6.5-8.5
Water temperature	°C		21.9-23.6	40
Electric conductivity	µS/cm		109-162	**dna

Table 5 Analysis performed to untreated sewage, November 2013

Parameter	Units	Method	Results	*MAL
Settleable solids	ml/l	NMX-AA-004-SCFI-2000		5
Fats and oils	mg/l	NMX-AA-005-SCF-2000		60
Total Nitrogen	mg/l	NMX-AA-026-SCF-2010	49	60
Detergents	mg/l	NMX-AA-039-SCF-2001		20
BOD	mg/l	NMX-AA-028-SCF-2001	159	200
QOD	mg/l	NMX-AA-030-SCF-2001	372	400
Total suspended solids	mg/l	NMX-AA-034-SCF-2001		300
pH			8.01-8.28	6.5-8.5
Water temperature	°C		19.8-22.1	40
Electric conductivity	µS/cm		103-174	**dna

Table 6 Analysis performed to untreated sewage, December 2013

We believe important to note that the development of experimentation would have been impossible to carry out without the reagents and materials which were provided with support PROMEP, having this resource for further testing. The Institute performed most of the analysis presented in Table III and IV except for the determination of total nitrogen, as the required equipment is damaged. For this reason, use was made of an agreement of academic cooperation established between our Institute and the Universidad Autónoma de Chihuahua, which gave us their support at this point and so we are extremely grateful.

Conclusions

It is need to perform additional tests to obtain similar results to those reported in the literature, where the percentages of removal are between 50-95%, while the results obtained in this study range from 4.3 to 20.8% (see Table IV).

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On the other hand several dams and canals were monitored near the metropolitan area of Chihuahua City, where Lemna was found in the period from October to June, noting that in the rainy season (July to September) despite having favorable temperature conditions, Lemna was swept by the currents generated by the increased level of dams.

Lemna remained dormant during the months of December to February in the established place outdoors, behind the chemistry lab. This latter finding confirms the possibility of survival of Lemna in the winter at low temperatures around 2 ° C.

With the above observations it is planned to have a kind of nursery to provide the necessary duckweed to the treatment plant during the year.

Finally, there is a need for a prototype, if in the future will have to carry out the project of building the treatment plant.

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Electrochemical Corrosion on Metals in Soil

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Abstract

Petroleos Mexicanos and the Federal Electricity Commission parastatals of Mexico, carry out activities of great diversity in metal infrastructure buried throughout the country. Therefore, it is considered important to evaluate the corrosion on the soil of the oil zone of Poza Rica, which is home to many piping systems to transport oil and high-voltage transmission towers. The electrochemical evaluation of corrosivity was made on carbon steel coupons, as well as on coupons made of copper, aluminum and zinc, with techniques of Polarization Resistance (RP), Potentiodynamic Polarization Curves (CP) and Electrochemical Impedance Spectroscopy (EIS). Grain size, moisture content, resistivity, chlorides, pH and redox potential was determined in order to characterize the electrolyte. Carbon steel has an increased corrosion rate due to the minor protection delivered by the corrosion coating formed. However, for materials such as Cu, Al, Zn, the corrosion products (identified by X-Ray Diffraction) form a very thin protective coating that achieve a seal protecting the substrate from surface soil aggressiveness.

Corrosivity, soil, electrochemical techniques

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Introduction

A large portion of the metal infrastructure (pipelines for water, gas or oil, metal cables for communications, tanks for fuel storage containers of toxic waste, concrete structures with steel reinforcement), is buried, where the aggressive environment is the ground with their physicochemical properties and other weather-related parameters [1, 8-9]. The study of corrosion in soils is important for the industry given the fact that most steel structures must rest on the ground or be buried, to fulfil mechanical, economic and security needs; these structures are then subject to a corrosion process where in some cases can be very complex [1-3]. This corrosion, in these structures, is very common and poses a problem for optimal fluid transport, for the generation of pitting and loss of mechanical properties that cause leaks and can even cause fatalities, millions in losses by waste of raw materials and pollution in areas where spills of the transported materials happens this way. Prevention of these failures can be done effectively if the corrosion mechanism involved is known, the way it is carried out and the evaluation of their electrochemical behavior [2, 9].

With variable moisture content, salt and decomposition organic matter, the soil is the most complex electrolyte of all that can be found; It is a heterogeneous environment where many variations occur in the corrosion rate of metals [1-4]. The presence of moisture in the soil makes possible the existence of an electrolyte film on the metal surface, whose aggressiveness depends on the soil type and degree of contamination (decomposition organic matter, bacterial flora).

Thus, the soil can form a more complex electrolyte on the metal surface with different degrees of aggressiveness -a necessary element for the development of the corrosion process and its electrochemical nature [9]. The diversity of soil types causes a considerable variation of their chemical and physical characteristics that influence the corrosive aggressiveness on metal structures. The land, with its heterogeneities, and the metal with its surface imperfections, originate on the metal surface anodic and cathodic areas. The soil in contact with the metallic material acts as electrolyte, due to moisture and soluble salts conteined. Associated to the electrochemical corrosion process, there is always an anodic metal oxidation reaction and a cathodic reaction comprising the reduction of O_2 in neutral or alkaline media, or reduction of protons (H^+) in an acid medium [10].

The soil corrosive activity is determined by its acidity, moisture, salts and oxygen, bacterial activity, texture and electrical resistance. The acidity is high in wet and marshy soils and low in dry and ventilated ones. Moisture influences positively on the corrosion of metals, but, when excessive, displaces oxygen and decreases aggression. Soluble salts may increase the aggressiveness of the soil, but when the amount (salt) is excessive, lowers acidity and reduces corrosion. The oxygen content is directly related to moisture and soil texture. If it is compact, very wet or with a higher amount of vegetation, oxygen decreases proportionally [13].

Soil corrosivity is usually estimated or inferred from measurements of resistivity, although this is not quantitative. To assess the aggressiveness of soil with quantitative chemical parameters and electrochemical methods is a critical matter for the prevention, control and evaluation of corrosion of buried structures.

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In this research the aggressiveness of soil in the city of Poza Rica on carbon steel, copper, zinc and aluminum was analyzed using electrochemical techniques for evaluating the corrosion rate and the mechanisms that are carried out on metal surfaces.

Experimental methodology

Physical characterization

Based on the technique of mass loss (gravimetric), coupons Fe, Zn and Cu were installed during an exposure period of 40 days. For the morphological study of products of corrosion, an analysis of samples was performed by optical microscopy, and x-ray diffraction.

For soil classification by size, 1 kg sample was placed in a baking dish to let it dry in an oven at a temperature of 80°C for a minimum of 12 hours, then it was stored in a desiccator to cool down and finally passed through a set of sieves to separate particles according to their size. Resistivity measurements against moisture content were performed using the Wenner method. Redox potential measurements were made without changing the sample, an electrode (+) Pt indicator and another reference indicator (-) Cu/CuSO4, connected to a multimeter to record potential difference. This test is important to predict the risk of anaerobic corrosion (especially when the medium contains sulfates). A negative redox potential indicates that the sample is not aerated being very aggressive for the materials. For the determination of pH, 100 g of original sample were dissolved in 100 mL of distilled water and stirred for 5 minutes; the solution was allowed to settle for subsequent decanting and measuring with a potentiometer previously calibrated.

Also, with such solution, the amount of chlorides (Cl^-) present, according to Method 4500-Cl-B-18TH Standard Methods (1992) was determined.

Electrochemical characterization

Usually in Poza Rica, the metal infrastructure that is placed on the soil is at a depth of 40 cm and therefore the sample was collected at the same deep. Samples (working electrodes) carbon steel (Fe), galvanized steel (Zn), copper (Cu) and aluminum (Al), 1x1 in^2 were placed (with prior preparation and surface cleaning), to be evaluated by electrochemical methods 1, 6, 24 hours, with 7 and 17 days of exposure. A potentiostat Field Machine model ACM with 2 channels was used for electrochemical measurements, a cell with electrodes from Cu/CuSO4 as reference and graphite as a counter electrode.

Results and discussion

The results of the physicochemical characterization of soil studied, are shown in Table I, the percentage of moisture; in Table II, the size classification; in Table III, the pH values and chlorides and in Table IV, the measurements of mass loss metals evaluated in control.

According to bibliographic information, the percentage of moisture and characterization of particle size (Table I and II), the floor of the city of Poza Rica is classified as clay and slightly corrosive soils for its resistivity values (Raichev, 2008 Andrade, 1991). The redox potential indicates a trend very susceptible to the risk of anaerobic corrosion (Otero, 2001). The pH and the amount of chlorides present favors the process of corrosion (Table II).

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Initial mass (g)	Final mass (g)	Water content (g)	Moisture (%)
1000	839.32	160.68	16.068

Table 1 Percentage of moisture in the soil of Poza Rica.

Particle size (mm)	Mass (g)	Percentage (%)
> 2.38	706	84.11
2.38 a 0.59	85.56	10.20
0.59 a 0.279	10.94	1.30
0.279 a 0.149	5.52	0.66
< 0.149	31.3	3.73
Total	839.32	100

Table 2 Soil granulometry of Poza Rica

Resistivity (Ω/cm^2)	Potencial redox (V)	Cl^- (ppm)	pH
110,000	-0.131	78.658	6.8

Table 3 Number of chlorides, pH and redox potential.

Material	Mass		
	Initial (g)	Final (g)	Difference (g)
Cu	3.5412	3.5176	0.0236
Fe	4.8016	4.7254	0.0762
Zn	4.7371	4.7042	0.0329

Table 4 The measurements of mass loss metals evaluated in control

In Table V the results obtained from the electrochemical methods are shown. The current densities (proportional to the corrosion rate) obtained from the technique Resistance to Linear Polarization are high for carbon steel (in comparison with the other exposed metal), which implies a low resistance to the electron transfer. Aluminum, galvanized steel and copper, however, increase the resistance to charge transfer as time of exposure increases, this means the formation of corrosion products as cuprite for Cu and goethite for Fe.

Identified by X-ray diffraction (figure 6 and 7), forming porous layers on the metal substrate surface decreases corrosion.

	Time	E_{corr} (mV)	RP (Ω/cm^2)	I_{corr} (mA/cm^2)
Fe	1 h	-706.93	2400.8	1.08E-2
	6 h	-755.67	2405.9	1.08E-2
	24 h	-768.87	2084.3	1.25E-2
	7 d	-786.4	2593.6	1.01E-2
	17 d	-988.75	2141.2	1.22E-2
Zn	1 h	-1114.4	3715	7.02E-3
	6 h	-1012.8	7089.8	3.70E-3
	24 h	-1030.7	8715	3.04E-3
	7 d	-1018.4	2007	1.30E-03
	17 d	-1222.6	5633.8	4.60E-03
Al	1 h	-1279.8	4567	5.70E-04
	6 h	-699.7	1864	1.40E-04
	24 h	-673.76	6833	3.82E-05
	7 d	-757.53	6567	3.97E-05
	17 d	-832.11	3182.2	8.20E-03
Cu	1 h	-164.72	1086	2.40E-03
	6 h	-109.92	1728	1.51E-03
	24 h	-103.66	1728	1.51E-03
	17 d	-213.77	6417	4.06E-03
	17 d	-129.37	1120	2.33E-03

Table 5 Results electrochemical polarization resistance technique in soil of Poza Rica

In Figure 1a, potentiodynamic polarization curves present a mixed control and slow kinetics from the reactions of oxidation and reduction [6]. 1b shows diagrams EIS (Electrochemical Impedance Spectroscopy) in bode for carbon steel, it can be seen in the high frequency region (10^2-10^3 Hz) the formation of corrosion products that increases the resistance as exposure time increases (mainly 24 hours and 7 days of exposure), however, films formed of corrosion products (Fe_2O_3, 2a-2b) are porous by the presence of corrosion by activation in the medium frequency region (1 to 10^2 Hz) that allow diffusion of electroactive species in the visible low frequency region (1 to 10^{-2} Hz).

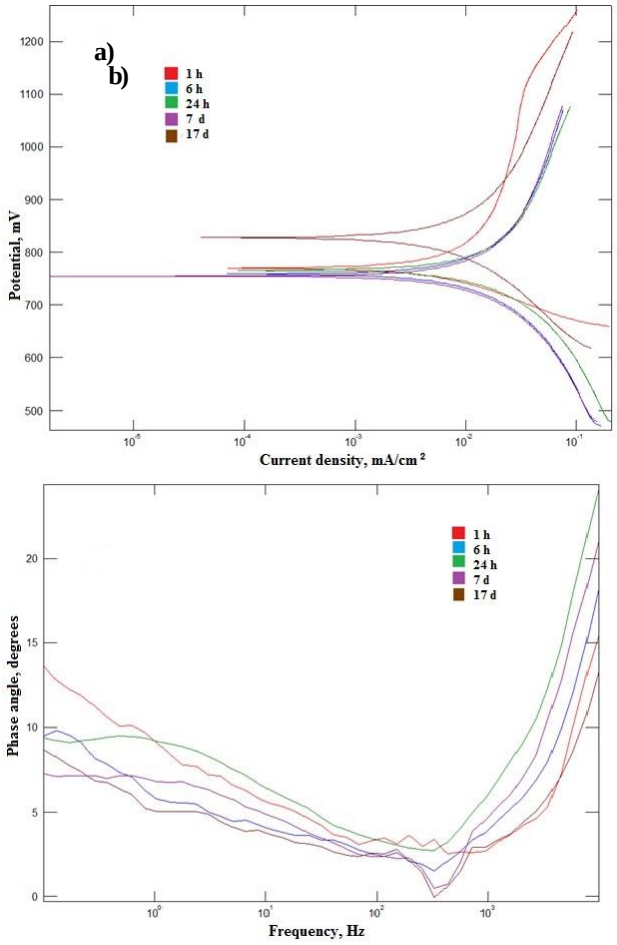

Figure 1 a) Polarization curves and b) impedance diagrams bode for carbon steel (Fe) on soil of Poza Rica at different times of exposure

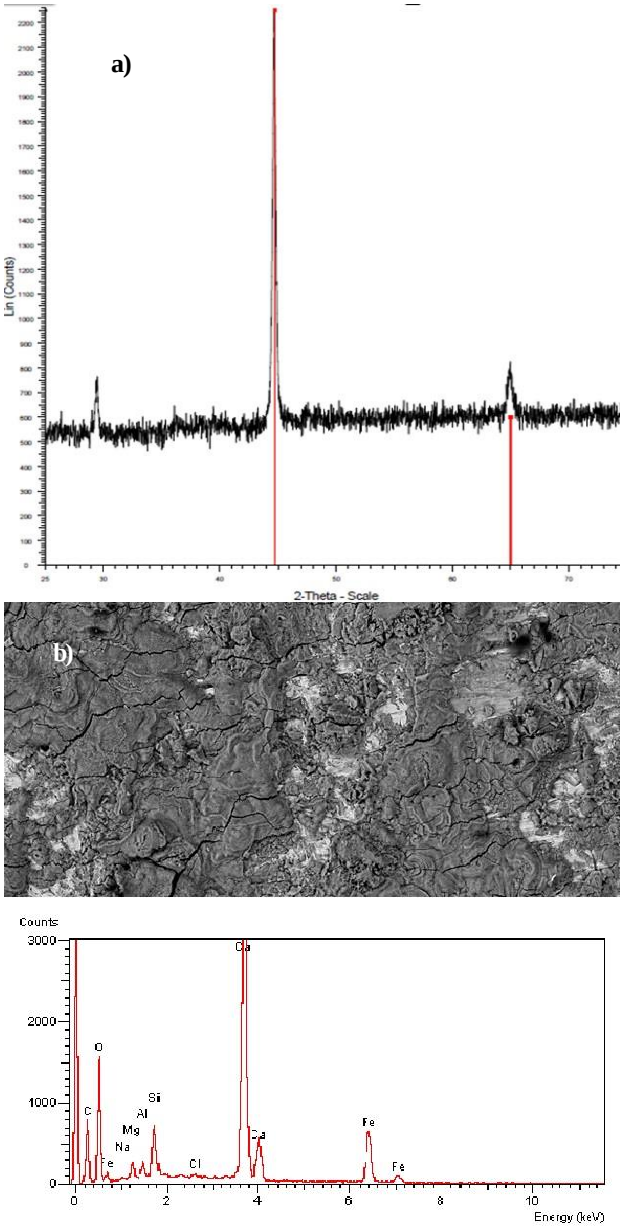

Figure 2 X-ray diffraction and SEM, showing the formation of corrosion products on the surface of Fe, 40 days of exposure on soil of Poza Rica

As shown in figure 3a, potentiodynamic polarization curves obtained for galvanized steel exposed to the aggressive soil in Poza Rica, which showed mixed control. In Figure 3b, EIS diagrams are presented in bode for galvanized steel.

The film of corrosion products (Figure 4a and b) formed by the aggressiveness of the soil (high frequency 10^2-10^3 Hz) increases the strength of the substrate as time of exposure increases (mainly 24 hours, 7 and 14 days of exposure), it being compact and slightly conductive given the RP values (table V). In the mid-frequency region (1 to 10^2 Hz) it can be observed the corrosion by activation in function of days of exposure and limited or semi-infinite diffusion (low frequency (1 to 10^{-2} Hz).

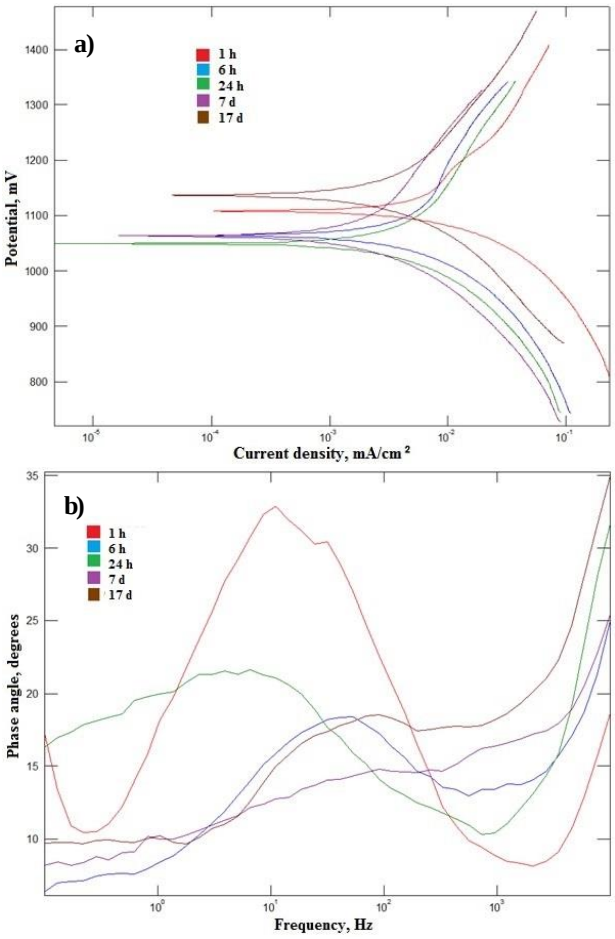

Figure 3 a) Polarization curves and b) impedance diagrams bode for galvanized steel (Zn) on soil of Poza Rica at different times of exposure

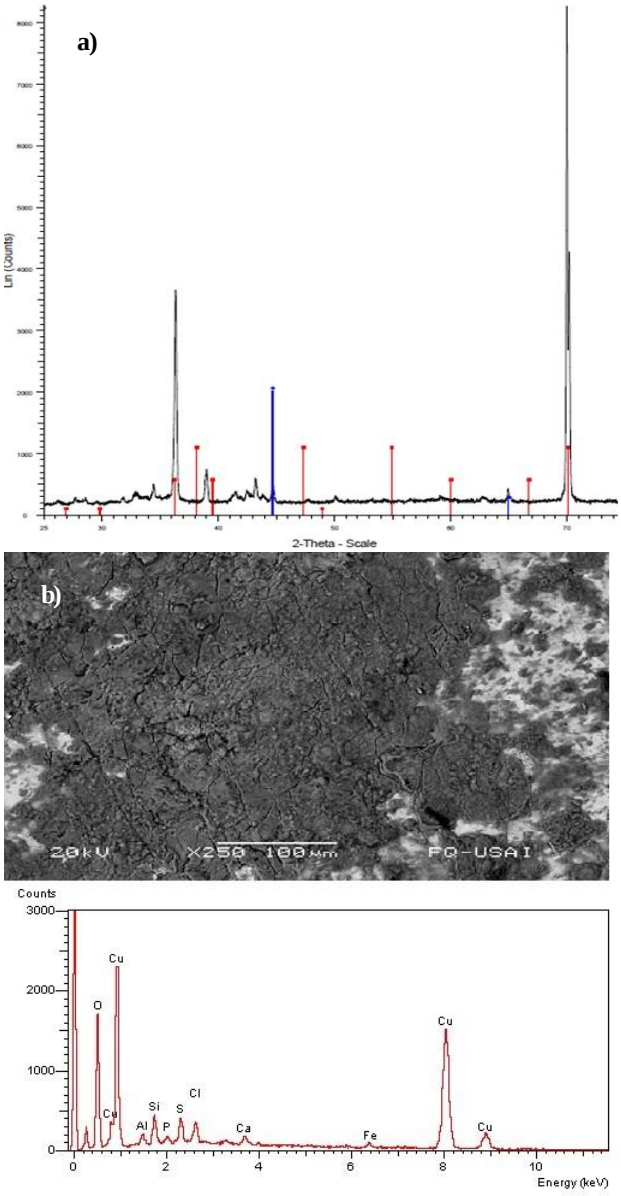

Figure 4 X-ray diffraction and SEM, showing the formation of corrosion products on the surface of Zn, 40 days of exposure on soil of Poza Rica

Potentiodynamic polarization curves obtained for aluminum (Figure 5a) show a mixed control and a decrease in the intensity of current at 24 hours and 7 days of exposure, but increased at 6 hours and 17 days; This can also be confirmed with the values obtained with the PR (Table V) technique.

In Figure 5b diagrams EIS shown in bode for aluminum at different times of exposure in the high frequency region (10^2-10^3 Hz) the formation of compact films of corrosion products increases their resistance the longer the exposure time and a high resistance given to the metal substrate according to strength values obtained with PR technique (table V). In the mid-frequency region (1 to 10^2 Hz) minimal influence of corrosion is observed by activation under 1, 6, 24 hours and 7 days; however, a domain of corrosion is observed by activation at 17 days, which means an increase in the corrosion rate and reduced resistance to electron transfer. In the region of low frequency (1 to 10^{-2} Hz), it is possible to observe a limited diffusion, however, after 24 hours of exposure the process is pure charge transfer and diffusional control known as Warburg impedance [8, 10, 12].

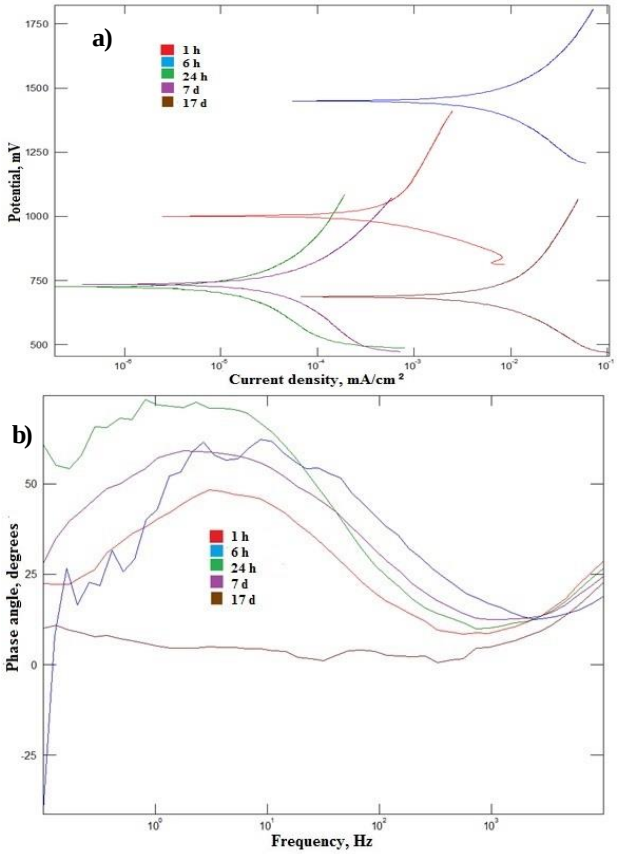

Figure 5 a) Polarization curves and b) impedance diagrams bode for aluminum (Al) on soil of Poza Rica at different times of exposure

The polarization curves (figure 6) show minimum densities of current for the anodic reaction. In figure 6b, behavior of copper shown at different periods of exposure in the high frequency region (10^2-10^3 Hz), the films of products of corrosion formed (Cu_2O identified by XRD, fig.7) increases the resistance substrate by increasing the exposure time. However, in the mid-frequency region (1 to 10^2 Hz) it can be observed an increase in the corrosion process by activation 7 to 17 days with limited diffusion at low frequency. The storm activity, moisture and the oxygen in soil, can influenciate an increased corrosion rate, however, depending on the exposure time, copper forms passive films that can protect from aggressive soil [3, 5, 7 and 11].

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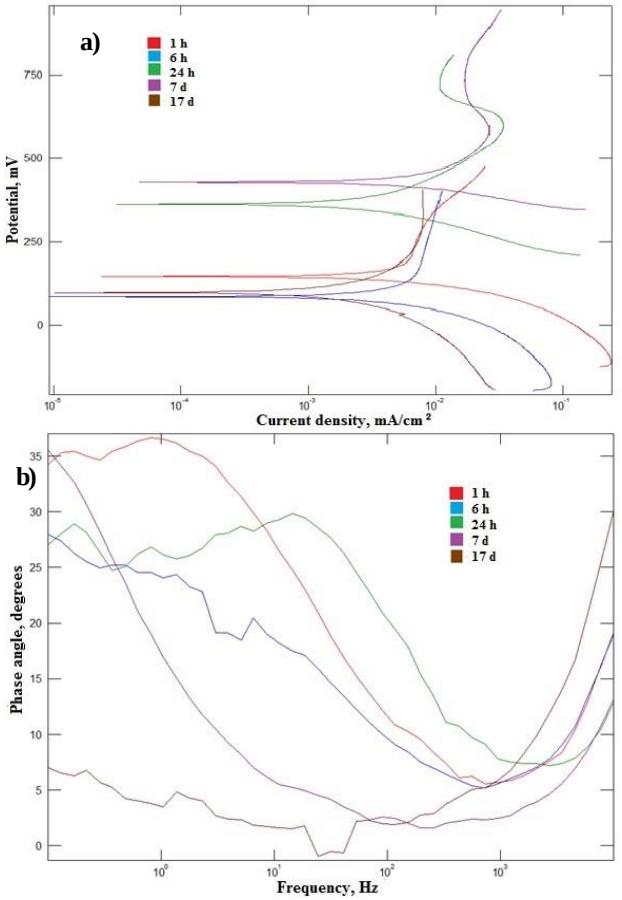
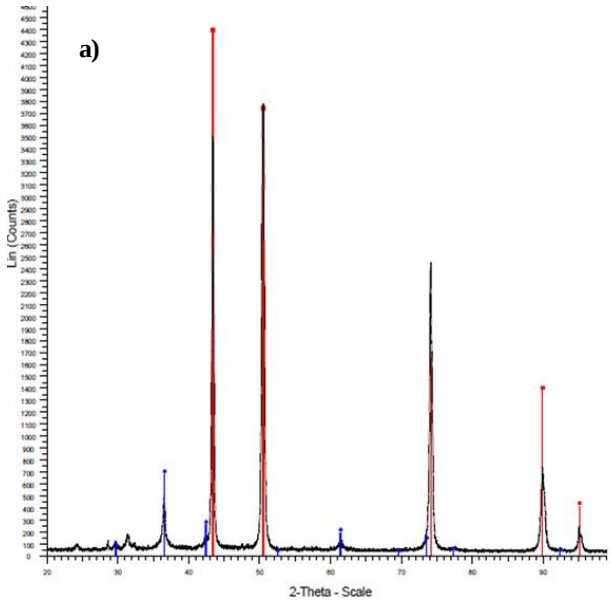


Figure 6 a) Polarization curves and b) impedance diagrams bode for copper (Cu) on soil of Poza Rica at different times of exposure



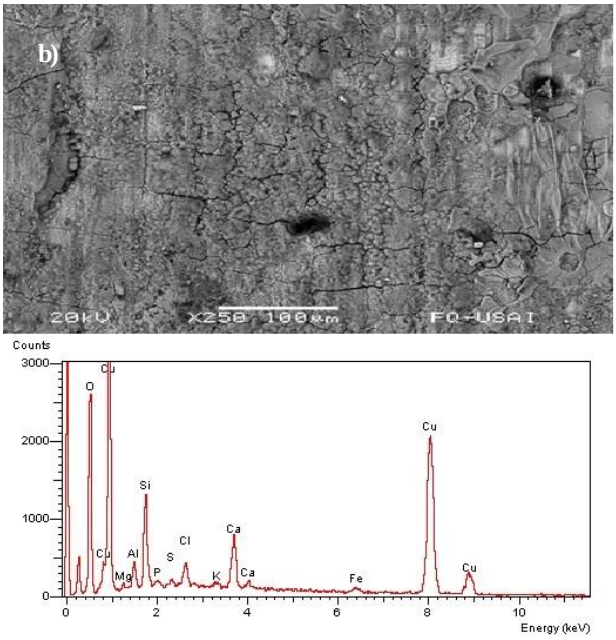


Figure 7 X-ray diffraction and SEM, showing the formation of corrosion products on the surface of Cu, 40 days of exposure on soil of Poza Rica

Conclusions

The presence of ions in the studied soil increases its conductivity and decreases its resistivity favoring the corrosive behaviour by the formation of differential aeration cells.

Copper and galvanized steel are metals that showed an improved corrosion resistance because of the minimum amount of missing mass.

According to the results obtained with electrochemical techniques form the carbon steel corrosion products which form a porous film incapable of reducing the corrotion by activation due to environmental conditions and characteristic of the material.

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However, for materials such as Cu, Al, and galvanized steel (Zn) corrosion products (identified by XRD) are very compact protective films, such as patina or alumina, manage to seal the surface of the substrate by decreasing the corrosion rate as time of exposure increases.

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Development of a process configuration using a new design anaerobic reactor at low rates of dissolved oxygen, for biodegradation of phenol in an industrial effluent

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Abstract

The wastewater from the chemical, pharmaceutical, paper, etc., present typical phenol concentrations between 35 and 400 mg/L, however, there are extreme cases as some Mexican refineries, which produce on average 14 m^3/d of wastewater with phenol concentrations of about 30,000 mg/L. Their presence in industrial effluents has adverse effects on health and aquatic life in the short and long term, when they receive no prior treatment are discharged into natural bodies of water (rivers, lakes and seas). Among the methods commonly studied for disposal and/or recovery are; the use of hot gas, steam distillation, adsorption, ion exchange, solvent extraction, oxidation, phase transfer catalysis, photo-decomposition, volatilization, biological methods, polymerization, electrocoagulation, advanced oxidation and ion exchange. Its high concentration in industrial effluents makes impractical the use of biological processes for treatment because there is inhibition of microorganisms. In this research, the biodegradation of phenol of an industrial effluent was evaluated in a new configuration process using an anaerobic reactor design at low rate of dissolved oxygen and hydraulic retention time (HRT). 2 tested organic loads: 3.2 and 13.9 kg COD/m^3·d, HRT of 0.5 days, dissolved oxygen rate of 0.78±0.18 mg/L and 30±0.5ºC controlled temperature. The results showed low load, removal efficiency of phenol and COD of the order of 74 and 64%, while at higher load, both the phenol removal efficiency as COD, decreased by 54 and 60% respectively. Based on the results obtained in this investigation, it is demonstrated that the new reactor configuration employed, it was possible to phenol biodegrade industrial effluent.

UASB, dissolved oxygen rate, biodegradation, phenol, Industrial effluent

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Introduction

The presence of phenols in the environment is a result of both natural and anthropogenic actions contribution mainly agricultural and industrial character. The production processes of industries; pharmaceutical, perfumery, explosives, phenolic resins, plastics, textiles, oil, dyes, leather, paper, coking plants, distilleries tar and pesticides, among others, expelled about 26.3% of phenols air, 73.3% in their wastewater discharges (ATSDR 2016), and about 0.4% in soil and aquatic sediments (Mohan et al, 2004). Discharges of wastewater from the chemical, pharmaceutical, paper, foundry, etc., provide concentrations between 35 and 400 mg/L of phenol (Chen et al, 1997). Those from petrochemical, reach values of the order of 30,000 to 50,000 mg/L (Olguín et al, 2003). In chemical structure, the phenol has a benzene ring, and a hydroxyl ($^{-}$OH) group instead of one of the hydrogen atoms own benzene (C_6H_6).

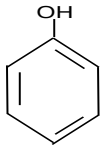

Figure 1 Chemical structure of phenol

The Environmental Protection Agency under section 313 of Title III (EPA, 2008) EPA, for its acronym in English, classified as highly toxic substance and determined as limit, less than 1 part per billion (ppb) in surface water, unchlorinated water 0.1 mg/L (100 ppb), and in chlorinated water in order from 0.001 to 0.002 mg/L (1-2 ppb).

Acute exposure to phenol causes adverse effects; skin irritation, headache, bitter mouth, diarrhea, vision problems, dark urine excretion, because it is easily absorbed by the skin and mucosa.

It affects the nervous system, causes severe damage; kidneys, liver, lungs, heart, and has a lethal effect in blood of 150 mg/100 mL (Wang et al, 2011), also inhibits DNA synthesis and replication in cells. A study revealed that phenol stopped DNA synthesis in human diploid fibroblasts (Michalowicz and Duda, 2007). Toxic levels usually range at concentrations of 1024 mg/L for humans, from 9-25 mg/L for fish (Ahmed et al, 2012), affects both flora and fauna of the environment (Lika and Papadakis, 2009). Therefore, industrial effluents should be pretreated for the download at any receiving body, present a final concentration of less phenol than 0.5 mg/L and thus be safe to the environment (Veereshet al, 2005). Moreover, their presence in natural waters can lead to the formation of substituted compounds during the disinfection and oxidation processes (Rappoport, 2003).

Many technologies have been studied for the treatment of industrial effluents with phenol, but only a few have proven to be really efficient. These technologies are classified into three groups; 1) Recovery technologies that addresses all processes or unit operations that attempt to separate and/or recover the phenol wastewater for reuse. Within these conventional recovery technologies are; Distillation, extraction, absorption, adsorption (activated carbon, zeolites, clays, bio-adsorbents), 2) Technology degradation (oxidation or mineralization), which contemplates; biological processes through a biochemical mechanism, the microorganisms used to phenol as a carbon source to transform it into less hazardous products. But, due to its high toxicity (200 mg/L), it is not possible to reduce the total organic carbon (TOC) of the wastewater to harmless levels for the environment and/or their environment (Abu-Hamed et al, 2004).

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Processes or Advanced Oxidation Technologies (AOP or AOT) based on physicochemical processes capable of producing changes in the chemical structure of the contaminants. Involve the generation and use of oxidants transient species mainly hydroxyl radical ($^{-}$OH). Which can be generated by photochemical means (sunlight) or other sources of energy, and possesses highly effective for the oxidation of organic matter. Some AOP resort to chemical inducers (electron donors) which allow transfers toxic contaminants little susceptible to oxidation, such as metal ions or halogen compounds. Within the AOP, they are not photochemical technologies (chlorination, ozonation, ozone/H_2O_2, Fenton's reagent, Electrochemical oxidation, oxidation in water), and photochemical Technologies (photolysis of water in the vacuum ultraviolet (UV), UV/H_2O_2, UV/Ozone, photo-Fenton, heterogeneous catalysis-Photo) that do not involve the use of light for pollutant degradation. And 3) new technologies or hybrid processes that include; the per-evaporation, solvent extraction using membranes and membrane systems for the recovery of aromatic (Ten et al, 2000). The study of biological processes for biodegradation of phenol in waste water has been very disappointing, at concentrations of about 10 mg/L, causes inhibition of microorganisms, and therefore low efficiency of removal. Because its toxicity, is the factor preventing or delaying the metabolic reactions, which depends on the type of microorganisms and toxic concentration of this specific compound. Why, these processes are limited by the concentration of phenol present in industrial effluents as required dilutions of the contaminant, using large volumes of water to degrade and avoid inhibiting the growth of microorganisms (Luo et al, 2009). The use of mixed cultures, allows to take place faster degradation of phenol with a pure culture (Gerrard et al, 2006).

However, there is evidence showing that degradation of phenolic compounds can be carried out by prokaryotic and eukaryotic organisms. Under aerobic respiration, oxygen used as the electron acceptor and carbon molecules to produce CO_2, H_2O and energy as ATP. Biodegradation studies phenolics this way, they have shown that there is a common metabolic pathway for this type of compound and even for those not so close family of phenolic compounds, such as biphenyls (Autenrieth et al, 1991). During aerobic respiration, oxygen is consumed, and by action of the enzyme phenol monooxygenase, $^{-}$OH the resulting phenolic ring group is added, the formation of catechol be broken in two ways, and therefore two possible routes biodegradation, the *ortho* and *meta* route path (Shalaby, 2003). In the *ortho*-break, 1-2 catechol bond is broken to produce the muconic acid. While ring opening by the target route occurs between carbons 2-3, to result in the formation of 2-semialdehyde hidroximuconico and is very common in the metabolism of bacteria, fungi and microalgae of different types (Heesche-Wagner et al, 1999). These conditions (aerobic way), are distributed in various bacteria, yeasts and fungi (Harwood and Parales, 1996). Despite its wide taxonomic distribution, it has only been identified him soil microorganisms, particularly in groups of bacteria associated with plants and specifically, taking place in bacteria that have the goal via encoded in plasmids (Ramirez, 2005).

Under anoxic conditions respiration (anaerobic digestion), different electron acceptors are used as: nitrate, sulfate, metal ions or carbon dioxide in order to produce compounds reduced nitrogen, sulfur, methane and carbon dioxide (Lovley and Lonergan, 1990).

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In this way, the biodegradation of phenol is carried out, when the rate of oxygen consumption by the microorganisms exceeds its diffusion rate in the medium or when it is zero. The fermentation and anaerobic respiration are the two basic mechanisms of anaerobic catabolism of organic compounds. In this context, the metabolism of aromatic rings can be carried out in anaerobiosis allowing the break ring in the absence of oxygen. Although the benzene ring is a very stable chemical structure, can be reduced by hydrogenation and hydroxylated complete dehydration for subsequently broken by action of a non-oxidative enzymatic process (Borraccino, 1997). Catechol, muconate *cis-cis*, *β*-ketoadipate, succinate and acetate, are some of the intermediates in the biodegradation of phenol (Rodriguez, 2003).

Among the most studied for the degradation of phenol microorganisms are; Bacteria of the genera *Bacillus spp*., *Micrococcus spp*. and *Pseudomonas spp*. that tolerate concentrations of 10 to 25 g/L of phenol and yeast *Candida tropicalis* using the phenol under aerobic conditions as sole source of carbon and energy with a potential degradation of this compound up to 1700 mg/L (Fialova, 2004;. Yang, 2005). Other microorganisms studied are; *Phanerochaete Chrysosporium*, *Bacillus pumilus* and *Asomopergillus terreus* (Gallego, 2003). For the case of *Pseudomona putida* has a phenol degradation capacity of 500 to 600 mg/L in 48 hours of incubation. The use of isolated bacteria can lead to a considerable decrease of treatment time and improve the rate of elimination of phenol (Tziotzios, 2005). Biodegradation involves many factors (Wheat, 2009). Among them; temperature, pH, oxygen content and concentration of substrate (Nair, 2008; Agarry, 2008).

Extreme pH values of wastewater (less than 3 or greater than 9) may be inhibitory to the growth of microorganisms. In sequential batch reactors (SBR) mixed cultures of activated sludge, it has been reported that concentrations greater than 1200 mg/L phenol, occurs a strong inhibitory effect on microorganisms. In the case of a peak concentration of 1850 mg of phenol/L, biomass is inhibited and requires a cycle over 300 h to degrade the inhibitory compound. Yoong (2000) found a similar behavior, they found that at concentrations greater than 1300 mg/L of phenol in activated sludge treatment, resulted in complete inhibition of the system. Under this scenario, phenol can be degraded both aerobic and anaerobic conditions. In general, laboratory studies on the biodegradation of phenol are carried out at pH values close to neutral (pH=7.0). Each microorganism has a specific temperature range for growth. *Bacillus stearothermophiles* is capable of efficiently degrading phenol 50ºC (Naas, 2009). Studied exposure to temperatures above 35ºC has a detrimental effect on bacterial enzymes that are responsible for the breakdown of the benzene ring. While exposure to temperatures below 30ºC, decreases the bacterial activity. Bevilaqua (2002) studied a conventional aerobic system coupled batch to an enzymatic treatment using tyrosinase as enzyme, and observed a degradation efficiency of 75% with a remainder of 420 mg/L of phenol in a reaction time of 4 hours with 46 Um/L tyrosinase and 50 mg/L of chitosan (as coagulant). Silva (2002) used a SBR type reactor, reaching a phenol biodegradation of the order of 99%. Hossein (2006) in a bioreactor packed bubble for treatment of phenolic residues, 100% found deletion at a load rate of 33120 $mg/m^2 \cdot hr$. Marrot (2006) studied the biodegradation of high concentration of phenol by activated sludge membrane bioreactor.

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For his part, Bajaj (2008) in a reactor with a cycle of 360 minutes operation (260 minutes under aerobic and 100 minutes under anoxic conditions conditions), they found a removal of 50% phenol present in synthetic waste water with an initial concentration of 5.17 g/L phenol. Donoso-Bravo (2009) in a study with phenol synthetic water at a concentration of 5 gCOD/L and content; 10, 25 and 40% phenol as a carbon source from a concentration of 400 mg/L of phenol, in ASBR reactors, biodegradation found an efficiency of about 30%. For his part, Almasi (2012) using an anaerobic lagoon dimensions; 1.2×0.6×0.55 m, HRT of 10 days, hydraulic load rate of 43.5 L/d and organic load rate of 150 kg/h·d with initial phenol concentrations in the influent: 0-28, 3080, 90-130 and 150-200 mg/L respectively under conditions of warm temperatures and: 100-140 and 200-260 mg/L under cold temperature conditions, reported a phenol removal efficiency of 71.8% at warm temperatures and 14.66% to cold temperatures.

In this research process new configuration using a design of anaerobic reactor UASB type at low rate of dissolved oxygen and hydraulic retention time (HRT), to biodegrade the phenol present in an industrial effluent, varying the volumetric organic load we were assessed (Bv) two different ratios; 2 and 10% (v/v), in order to achieve maximum removal.

Materials and methods

Sampling. Was counted with a batch of 10 L of phenolic wastewater from a resin industry. The method used for sampling is described in the standard (NMX-AA-003-1980). Analytical techniques. For the evaluation of the main parameters in the industrial effluent phenol feed (influent) of processed water (effluent) and control system studied, the following analytical techniques were used:

The pH was evaluated by a potentiometer (Conductronic PC18). Dissolved oxygen was measured using a portable YSI model. COD, total solids (TS), total suspended solids (TSS), volatile solids (VS) and volatile suspended solids (VSS) were determined according to standard method (APHA, 2005). The determination of phenol, was performed by the colorimetric method of the 4-aminoantipyrine according to the Mexican standard NMX-AA-050-SCFI-2001 using a UV-VIS Spectrometer Perkin Elmer Lambda XLS model computer. Measuring biogas, it was effected by means of an inverted column in a container with saline (pH=2). The volume of the displaced solution corresponds to the volume of biogas produced. The analysis of volatile fatty acids (VFA), was determined by gas chromatography using a gas chromatograph (Hewlett Packard Model 5890 series II) equipped with FID detector and capillary column Superox FA, AT 1000 under the following operating conditions; column temperature of 120ºC to 140ºC, with a increase of 10ºC/minute, 130ºC injector temperature, 150°C detector temperature and N_2 as carrier gas at 3 mL/min.

Experimental design. In this research, an anaerobic UASB reactor was used for its acronym in English Upflow Anaerobic Sludge Blanket) at low rate of dissolved oxygen with a volume of 1.21L design, useful volume of 1.04L, internal diameter of 4.5 cm, height 53 cm, operated at a temperature of 30±0.5°C, without pH control, agitation or recirculation.

Inoculum. The biomass used as inoculum was collected of a UASB reactor of the Autonomous Metropolitan University of Iztapalapa unit that treats wastewater from the academic unit, with a concentration of 67.9 g/L of TSS, 35.7 g/L of VSS and methanogenic activity specified (MAE) of 0.11 LCH_4/gVSS·d.

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During the starting period and stabilization, it was used RAMM mineral medium (Shelton and Tiedje, 1984), with sodium acetate as carbon source for developing the inoculum methanogenic conditions.

Feed preparation (influent). From equation $C_1V_1 = C_2V_2$ it was calculated the volume of the sample taking phenolic wastewater previously characterized phenolic wastewater, making a series of dilutions according to the proportion of 2 and 10% to test in the reactor of new configuration.

Operating conditions of the reactor. Table 1 shows the operating conditions of the reactor in the various stages in the experiment was conducted.

Stage	I	II
Proportion of Phenolic Wastewater	2 %	10%
Bv ($kgCOD/m^3 \cdot d$)	3.2	13.9
HRT (days)	0.5	0.5
Dissolved oxygen (mg/L)	0.78±0.18	0.78±0.18

Table 1 Conditions of reactor operation

Results and discussion

Characteristics phenolic wastewater. Before addressing the analysis of the results in Table 2 an estimate of the average of the main parameters (pH, turbidity, electrical conductivity, total solids, total suspended solids, volatile solids and volatile suspended solids), the chemical oxygen demand (COD) and total phenol, evaluated through calibration curves.

Parameters	Units	value
pH		6.5±0.15
Turbidity		142
Electric conductivity	/L	128
Total solids (TS)		3.25±0.02
Total suspended solids (TSS)		3.04±0.01
Volatile solids (VS)	/L	3.21±0.04
Volatile suspended solids (VSS)	/L	3.18±0.32
COD	/L	71.8±0.51
Phenol	/L	13.07±0.023

Table 2 General characteristics of industrial effluent phenol

Table 3 shows the characteristics of feeding two dilution rates (2 and 10%) from the original sample (Table 2) that the UASB reactor was fed.

Parameter / Stage	I	II
Proportion (V/V)	2%	10%
Bv ($kgCOD/m^3 \cdot d$)	3.2	13.9
HRT (d)	0.5	0.5
pH	7.04±0.1	7.0±0.13
TS (g/L)	0.12±0.07	0.11±0.11
VS (g/L)	0.03±0.01	0.04±0.03
COD (g/L)	1.43±0.05	7.3±0.13
Phenol (g/L)	0.48±0.025	1.49±0.04

Table 3 General characteristics of the influent (UASB reactor feed)

ISSN:1390-9959

Biological degradation of phenol in a reactor UASB new configuration

During the experiment continuously for biodegradation peak concentration of phenol and COD according to the rate corresponding dilution influent biological reactor based on the characteristics of phenolic wastewater they are presented in Table 2, from 0.48±0.025 g/L of phenol and COD of 1.43±0.05 g/L corresponding to a dilution rate of 2% over 36 days (stage I) and 1.49±0.04 g/L of phenol with COD of 7.3±0.13 g/L from day 37 until day 71 of operation, corresponding to a dilution rate of 10% (stage II), the reactor showed a stable pH during the course of the experiment (figure 2), with a in influent pH 7±0.1 and a pH in the effluent of 7.2±0.13. Triangles represent the influent pH and dark rhombs the effluent pH. It reported in the literature that extreme pH values (less than 3 or greater than 9) may be inhibitory to the growth of microorganisms involved in the biodegradation of phenol (Naas, 2009). However, given the behavior of pH in the reactor throughout the experiment, biomass reactor presented no inhibitory effect, which allowed the biodegradation process of phenol was carried out properly under the operating conditions tested in the study.

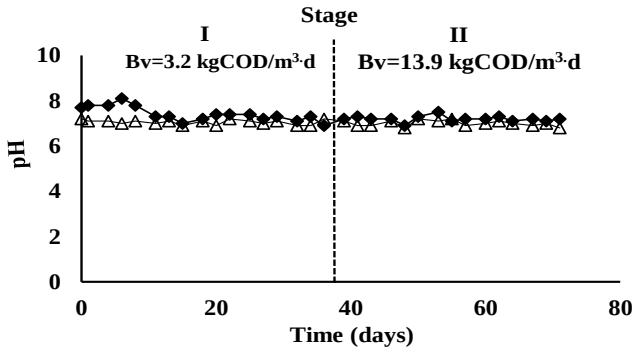

Figure 1 Performance of pH in the reactor: Influent ( ) and effluent ( )

The figure 3 shows the volatile solids (VS) in the reactor effluent (stage I and II). The triangles represent the SV in the influent and the dark rhombus, the SV in the effluent. And it is seen that during the acclimatization phase biomass reactor at a concentration of phenol 0.48±0.025 g/L (stage I) over 36 days to loss of biomass is results (0.24±0.1 g/L of VS) in effluent. Similar behavior to that reported by (Buitrón, 2005) SBR reactors with biomass losses at concentrations of phenol of 7000 mg/L and reported by Tziotzios (2005) in sequential batch reactors (SBR) at concentrations of 1200 mg/L of phenol. However, it is noted that once the biomass is acclimated to the presence of phenol as sole carbon source at a concentration of Phenol of 1.49±0.04 g/L and 13.9 Bv kgCOD/m^3·d (stage II), results in a decrease of volatile solids (VS) in the reactor effluent, 50%. In the literature mentioned that to carry out biodegradation involves many factors (Trigo, 2009). Among them; temperature, pH, oxygen content and concentration of substrate (Nair, 2008; Agarry, 2008). Each of these factors needs to be optimized for maximum degradation. In this vein, optimizing the concentration of phenol as a substrate for biodegradation by microorganisms, it may be inhibitory, especially at very high concentrations causing toxicity and death of microorganisms resulting in a loss of biomass and solids in the reactor outlet stream (Luo, 2009).

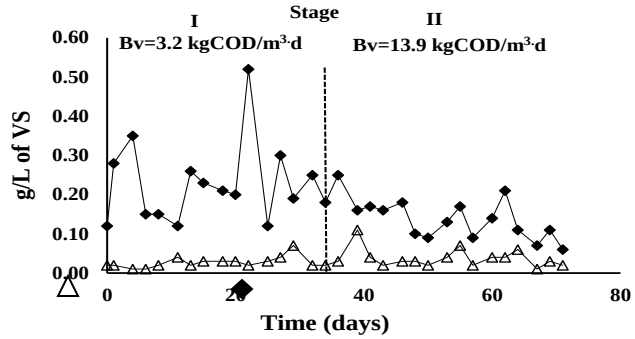

Figure 2 Performance of the volatile solids in the reactor: Influent ( ) and effluent ( )

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In the figure 4, the efficiency of COD removal is shown, the dark rhombus represent the COD present in the influent (2%) based on the COD of the phenolic Industrial effluent (Table 2) and triangles represent the COD remaining in the reactor effluent. This figure shows that by increasing the volumetric organic load of 3.2 and 13.9 kgCOD/m^3·d, the COD removal efficiency decreases moving from a 64 to 60%, due to the toxic nature of phenol, which causes inhibition biomass reactor and consequently, low efficiency of removal to prevent or retard the metabolic reactions of microorganisms for biodegradation (Abu-Hamed, 2004;. Luo, 2009). However, despite a decrease in the efficiency of COD removal the results achieved under the operating conditions tested, are better based on what is reported in the literature on biological processes for the biodegradation of phenol (Use of synthetic water, low concentrations of phenol, use of co-substrates, support means, HRT long, dissolved oxygen concentrations greater than 1 mg/L and independent systems).

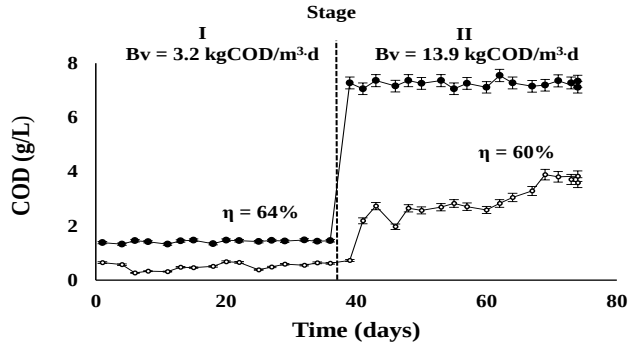

Figure 3 Elimination of COD: Influent ( ) and effluent ( )

For his part, Figure 5 shows the behavior of the reactor on the degradation of phenol, dark diamonds represent the phenol concentration in the influent and triangles, the phenol remaining in the reactor effluent.

And it is seen that, to the extent that their concentration increases of 0.48±0.025 g/L (stage I) to 1.49±0.04 g/L (stage II) in feed (influent) of the studied system, the different organic loading rates (3.2 y 13.9 Kg/m^3·d) respectively, the degradation efficiency of phenol decreases moving from 74% to 54%. Similar behavior to that shown by the reactor on the COD removal. This probably be attributed to the rate of dissolved oxygen for limiting oxidation of the phenol molecule factor, aerobically, reducing the possibility of contributing fully to the anaerobic consortium phenol degradation and consequently inhibition and involvement of both the activity of cellular metabolism of the microbial consortium. In the literature it is reported that a phenol concentrations greater than 1300 mg / L, inhibition of biomass and including total loss of activity of the microorganisms in biological processes (Yoong, 2000) is raised. However, despite the results, the new configuration of anaerobic reactor UASB type used in research, showed biodegradability of such toxic compound, which is an excellent sustainable alternative treatment of industrial effluents with phenol.

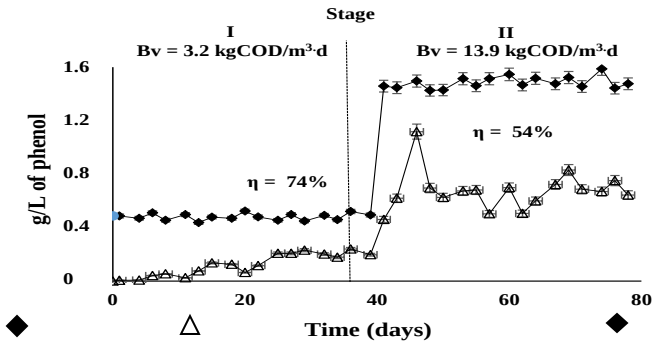

Figure 4 Biodegradation of phenol: Influent ( ) and effluent ( )

From the figures 2, 3, 4 y 5 is constructed the table 4, what represents the average days of operation when the reactor reached stationary phase in each stage.

Parameter	Stage		
	I		
	II		
Operation period (d)	0-36		37-
pH	7.39±0.33	71	
TS (g/L)	0.59±0.21		
VS (g/L)	0.24±0.1	7.2±0.13	
COD (g/L)	0.51±0.13		
η_{COD} (%)	64	0.26±0.15	
Phenol (g/L)	0.12±0.08		
η_{Phenol} (%)	74	0.13±0.04	
Acetate (g/L)	0.048±0.07		
Propionate (g/L)	0.017±0.04	2.9±0.79	
Butirate (g/L)	0.014±0.03		60
VFA (g/L)	0.026±0.05		
Biogás$_{STP}$ (L/L_{R}·d)	0.06±0.2	0.68±0.15	
			54
		0.075±0.08	
		0.06±0.05	
		0.04±0.02	
		0.058±0.05	
		3.1±0.9	

STP: standard temperature and pressure; COD: chemical oxygen demand, VFA: volatile fatty acids, η_{COD}: COD removal efficiency, η_{Phenol}: phenol removal efficiency, $L/L_{R\text{-}d}$: liters of biogas by liter of reactor per day.

Table 4 General characteristics of UASB reactor effluent

Conclusions

The low rate of dissolved oxygen in the reactor type applied UASB new configuration favored the oxidation of phenol (Aerobic way) contributing in mineralization to CH_4 and CO_2 (anaerobic way), allowing achieve removal efficiencies phenol and COD present in the wastewater of the order of 74 y 64% an organic load 3.2 kgCOD/m^3·d and of the 54 y 60% respectively, to a load of 13.9 kgCOD/m^3·d under the operating conditions described above. The results obtained with this new configuration unconventional reactor, showed their biodegradability, based on those reported in the literature, besides being novel, it turns out to be an excellent alternative biological treatment of phenolic wastewater. Contributing to this research, the generation of new scientific knowledge, have 2 types of consortia microbial (anaerobic-aerobic) in a single biological reactor upflow UASB, without variants pH destabilizing development, which in addition to solution a real problem of environmental pollution, proves to be robust and friendly to the environment.

Despite having a major drawback in the study, the use of large volumes of water for conducting respective dilutions (2 y 10%), to avoid involvement and inhibition of biomass biological reactor for phenol degradation of industrial effluent. However, this disadvantage in a wastewater treatment plant at the industrial level, resolved, with the volume fraction of exchange that is returned to power processing system, which significantly reduces the volume of water to be used for biodegradation, and therefore , generating good quality treated water for reuse.

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Economic and Ecological Zoning Proposal for La Roqueta Island, Mexico

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Abstract

The territory of Mexico is prodigal since it bears exceptional natural landscapes, biological diversity, varied landforms that, we planned from the tourist point of view, are a useful tool for the human in the sustainable regional development. Hence, the central aim is to propose the Economic and Ecological Zoning (EEZ) of La Roqueta Island. The methodology used was founded in office work that included the analytical review of printed and digital materials about Acapulco Bay, EEZ, tourism, local development and heritage; this work was enriched with ten field research. Among the results, we could obtain *i)* some information synthesized the municipal, political, conservation and management issues of the island; *ii)* one map were produced at small scale; *iii)* the physical location of the island, and *iv)* the current local use of the island terrain. The conclusions were *a)* scientific interest in the geomorphologic aspects of the island has facilitated a strong ecological environmental policy, *b)* planning for ecotourism accompanied by only rudimentary environmental management has resulted in minimal preservation of the island and the local economy and *c)* the Island provides the visitors with a place to recuperate physically, mentally and spiritually.

Environmental Management Unit (EMU), Economical and Ecological Zoning (EEZ), Roqueta, Acapulco, Guerrero

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Introduction

Sustainable management requires the analysis of ethical, social, economic and ecological factors, and these are now under discussion by various Governments throughout the world including that of Mexico, since the existing economic model of development ignores environmental aspects. An interdisciplinary approach in scientific research can inform the process of zoning in any part of the world (Murillo & Orozco, 2006).

In Mexico, there is a huge diversity of landscape therefore in this essay, we can defend the fact that the territory on Guerrero is prodigal. So, it aims to integrate the debate in the sense that the geoforms are heterogeneous but are useful tool for the human in the sustainable regional development. In the study case, in 1981 the Official Journal of the Federation (Diario Oficial de la Federación, DOF) published a decree that placed La Roqueta Island in Acapulco Bay, Guerrero, Mexico under the management of the Naval Secretariat as of 6 November 1981. The Ministry for Tourism would collaborate in planning tourist activities to be integrated with national plans for tourism on the island.

The purpose of the essay is to increment the interest in the geomorphologic aspects of the island has facilitated a strong ecological environmental policy, whose powers were increased in 1999 by the Environmental Management Unit (Unidad de Manejo Ambiental, UMA). It is important the planning for ecotourism accompanied for better environmental management has resulted in maximal preservation of the island and to get the ecological equilibrium. This act increase the esthetic of the nature reserve and the environmental educational potential, the cultural knowledge and human welfare of La Roqueta Island's recreational area.

The island provides the visitors with a place to recuperate physically, mentally and spiritually.

A question relevant was Which is the zoning model to be engaged to economy and ecology of La Roqueta?

There are six sections that integrate this essay, these sections are: objective, methodology, results, gratitude, conclusions and references.

Objective

To propose of economic and ecological zoning for the island Roqueta.

Methodology

Firstly, an office work was carried out through consultation of digital and printed literature of topics as economic and ecological zoning of Sabatini, Verdiell, Rodríguez & Vidal (2003); competitiveness (Sepúlveda, 2008); nature tourism (Chávez de la Peña, 2005); sustentability (López, 2008); ecogeographic method of Melo (1987) y Melo & Niño (2003); ecotourism (Báez, 2003); touristic space planning (Boullón, 2001 y Pérez de las Heras, 2004) and ecological business (Delgadillo & Alburquerque, 2010). Too, printed and digital records of La Roqueta Island were analyzed. These included the digital cartography of the "Instituto Nacional de Estadística, Geografía e Informática" (INEGI) on Acapulco (2013) the orthophotograph of Acapulco Bay (INEGI, 2011) aerial photography (INEGI, 2014) and the topographical Charter of Acapulco (Secretaría de Programación y Presupuesto, SPP, 1981). Others documents as the terrestrial ecology of Otero & Radilla (2001); the marine part of La Roqueta of Palacios (2002); touristic-environmental management of the island Niño (2010a y 2010b).

Was elaborated a base map at 1: 5 000 scale was enriched with field work. A hypsometric map presented the reveals anthropogenic factors (human settlements, land routes, air tracks, etc.) and this was followed by cartographic representation of each of the elements of nature in order to interact with who represent the various economic activities. This would be useful to authorities, entrepreneurs and citizens in decision-making regarding optimum use of the natural resources offered by the terrestrial ladscape. Secondly, a work of field was carried out for the achievement of the objective raised in such way that some face-to-face surveys were also carried out in the island, during the period between December 2015 and July 2016 to national tourism (650) and foreigners (350) in larges weekend, Winter, Holy Week and Summer enriched with participant observation, direct observation and study case (Babbie, 1996).

Finaly, involved the processing of socio-economic information from resident population and from the tourists, in order to determine the origin and reason for interest in the following beaches: La Fantasía, Palao, Palmitas and La Marina. This required information such as tourists' favorite areas for then active and intensive recreation and was achieved by questionnaire (Babbie, 2000). The matrix zoning and the corresponding map were developed in order to clarify the distribution of vegetation.

Results

Ecological and economical zoning: this is defined as the process of dividing a complex geographical space, areas which are relatively homogeneous and characterized according to physical, biological and socio-economic and evaluated factors with regard to their potential for sustainable use and environmental restrictions.

It is a useful tool for planning the rational occupancy, redirecting human activities not compatible with the environmental offer in the field we refer to. Its results are applicable in the territorial planning of natural protected areas; development of sustainable agriculture, determination of the suitability of soils for default uses and ecological and territorial use plants (Sabatini, Verdiell, Rodríguez & Vidal, 2003). The objectives of the EEZ are: Identifying the areas where certain specific uses may be induced through the development of programs, services, financial incentives, etc; identifying the areas with special needs or problems, as well as the ones needing protection or conservation; and providing the basis for the development of infrastructure.

The greatest virtues of the zoning methodology can be applied at all geographical scales and in soils with any type and intensity of uses, but is more widely used to subdivide basins and physiographical regions that hold important concentration of human population. Implementing zoning implies a dynamic process which can be adjusted at any time a socio-economical change appears; this could happen in the studied space or in its area of influence which has to do with national and global trade.

Zoning has the virtue that considers a wide range of land uses that can meet the needs of various users. The objectives of each zone can be compatible or incompatible with certain land uses, but they can also change with the passage of time. The use of multiple objectives and the subsequent optimization allow a periodic reorientation of goals to select the best use of a certain sector.

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The island is located southeast of Santa Lucia bay. The geographical coordinates are 16º 49' 30'' to 16º 49' 02'' North Latitude and 99º 54' 03'' to 99º 55' 07'' West Longitude. The total area is 190 acres or 75 hectares (INEGI; 2015, Figure 1).

Local management of La Roqueta was iniciated by the local concessions in 1958. It outlined the tourist attractions, they are as follows, the island's landscape, the rock cliffs, the beaches of Caleta, Caletilla, Palao, Larga and Palmitas, as well as the restaurant Palao. It included the channels Boca Grande and Boca Chica, Acapulco Bay, the well known buildings and the historical lighthouse were documented in the article Niño (2010b). The La Roqueta Island area is exceptional attractive international market place frequented daily by aproximantally 600 visitors of which there are 500 are mexicans citizens 60 local people and 40 people from other nations. This number multiplies during the 5 vacations periods of the year (Christmas, easter, long holiday weekends, new years and summer vacations). The visitors relax enjoying the calm crystal clear ocean waters white sands and the colorful tropical fish.

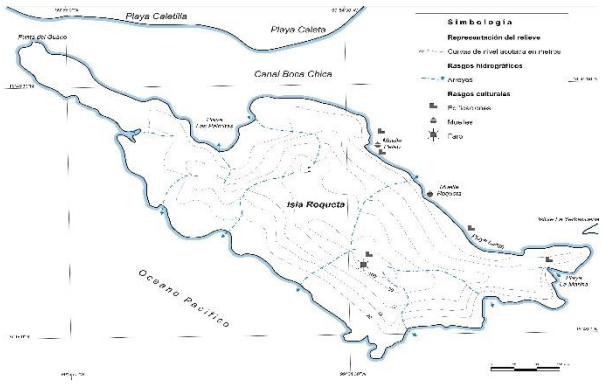

Figure 1 Study area. Source: Niño, 2012

During the last fifty three years the local concessions preserved and managed by the Pro Defense Association of Roqueta Island A. C. (Asociación Pro Defensa de la Isla La Roqueta A. C.) and the Green Guerreros (Guerreros Verdes) additionally, the citizens of Acapulco have collaborated with the municipal authorities to protect and preserve the island's landscape by not constructing tourist hotels or other building on the island. These structures would permanently modify the island's ecological equilibrium and natural landscape.

The propose of zoning La Roqueta Island should consider the following elements: preservation of the magnificient island landscape, continuation of ecotourism on the island with minimal impact to the areas flora, fauna and landscape, as well as continuing with recreational and sports activities on and around the island (Figure 2).

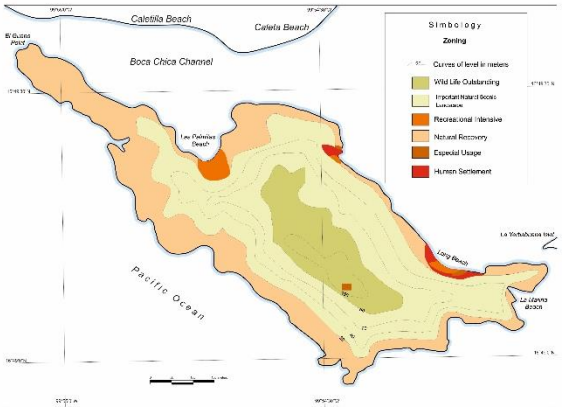

Figure 2 Zoning. Source: Own elaboration

The internal zoning of the island presented in the document created by the Environmental Management Unit (UMA) sets future guidelines for preserving the objectives presented by the conservationists and the economic development on the island. It presents guidelines preserving the variety of activities on island and limiting the new construction near and on the island. Additionally, it presents guidelines for the limitation of the tourist population visiting the island daily. The document (Melo & Niño, 2006) proposes a zoning outline for ecotourism, refining the geological landscapes, identifying the possible negative impact to the environment in the future, and the proposed future activities to avoid the negative impact of the activities on the landscapes. It provides for optimistic outlook for the future island usage if these guidelines are enacted (Table 1).

Zone	**Flo**	**Important**	**Intensi**	**Natural**	**Special**	**Human**
s	**una**	**scenic**	**reational**	**usage**		**nt**
Char	Nat	Controlled	Attracti	Area of	Area to	Explanation
	ources	cess	ape areas.	on of flora	zed for	e "Federal
tics	y	Preservatio	Ideal	resulting in	ative	Terrestre
			center	o Aca-		he restaurants
						and "Fantasia"
Man	Con	Preservatio	Implem	Limit	Remode	Correlation
s	of	naturals	creational	ental impact	touristic	conservational
	e and	istic for		nt	cture	with the future
	s	l public				nomic
						s
Actio	Lim	Facilities	To	Strict	Restorat	Remodelatio
	of	organized	usage of	ent of	ourist rest	estaurant areas
	ary	tures in order	present	l protection		itchen and
		t the island's		nd		areas)
						To reduce
						gical impact to
Cons		Restoratio	Remod	Study and	Tourist	Sign an
		existing vista	f tourist	proposed	buildings	l and tourist
			reas for	restoration	ration and	nt with public
			film		orm	al universities
Reco	Prot	Environme	Active	Tourist	Module	Established
l	ra and	ation	passive	tions	ofessional	reas
sage	Areas		al		ents	

Table 1 Proposal zoning. Source: own elaboration.

The island was divided into six zones to be protected and reserved. They are as follows, wildlife, magnificent scenic landscapes, a recreational area which is well used, natural restoration, a special usage area for agriculture, and physical structures.

A name and additional information has been designated with the headings for each zone, a) name, b) management objectives, c) description, d) construction, e) conservation programs and f) recommended soil usage. All of the fundamentally significant fragile ecological aspects of the islands are categorized as, the fragile flora and fauna, and the scenic vistas. Facilities or limitations on the installation of public services, construction, conservation of natural phenomenon (i.e. waterfalls, etc.) and pathways the analytical studies of La Roqueta island reflect the possibility of the realization of ecotourism and recreational usages on the island. The most important ecotouristics activities are defined as, educational, investigative, conservational and observing the diverse flora and fauna.

Flora and fauna, integrates the natural resources of the island minimizing the socioeconomic impact to the natural heritage and promote activities such as bird watching, and hiking among others. They are fragile geosystems. This zone will help maintain, preserve and conserve the landscape as well as the natural resources and promote the development of scientific activities which will to prevent negative environmental consequences to the island´s ecosystems. The suggested usage of the terrain is to preserve the island as a nature preserve with its current landscape highlighting the geoformations of the island and wildlife. The preservation of natural resources with minimal socioecological activities is essential.

Important natural scenic landscape, nature vistas, identifies steep inclines of more than 25°. The specific objective of the island management is to safeguard the islands natural characteristics. The recommended activities for this zone are to open rustic pathways (paved pathways) that will reduce the deterioration of the terrain and facilitate visitors or group access. Registration will be necessary and deployment security agents to guarantee both the safety of visitor and the environment. It is also recommended that environmental educational classes be given by a guide.

Intensive recreational usage, provides for the integration of the island's lower levels. The natural characteristics of this zone are the gentle slope of the hill, to the almost virgin beaches, and a warm climate. The minimum slope of the terrain allows for intensive recreational usage. Recreational usage of the shoreline as a whole is a tourist attraction. These areas are heavily populated by tourist. The objective of area management is to provide the tourist with a spiritually peaceful place to adventure, relax, observe the natural surroundings and harmonize with magnificent scenary of the island (Figure 2).

(Niño, 2010), presents the consequences to the island's landscape if the administrative philosophies presented are enacted to preserve the natural resources and recreational activities appointed to each zone.

The idea is to allow the admission of groups of visitors in controlled numbers with the goal of educating the groups along the lines of active and passive ecotourism. It will be important to specify areas to be reserved for camping, "palapa", area and local commercial tourist businesses which sell film, souvenirs, etcétera.

The map displays the spatial distribution of the Mexican Environmental Management and Protective Policy for the island. The protected area is dark green the conservation area is Light green, the restoration area is purple and the area designated for improvement is red. These policies also include five areas to be improved.

The natural recovery usage, include the vegetation areas that have reversible and regenerative potentials. The eco-destruction continues annually. Also, it includes the wildlife zones to be managed with the objective of zonal preservation, and improvement.

Special usage, this area is indispensable for the administration of the island. The principle objective is to maintaine and safeguard the administrative areas as well as the existing structures of the island. These are to include all administrative services (security, protection, restoration and optimal land conservation) which are of importance to local employees and visitors. The specific proposal is the remodelation of existing structures insuring protection of the island's natural landscape. The actions to be undertaken are to maintain the functions of the areas that are for tourist usage and limiting the access to the administrative areas. The buildings to be included are the tourist registration building, reception center, which will be a visitors courtesy area, (i.e. bathrooms, auditorium, rest area, exhibits, movie that replay automatically, and a panoramic vista area which will include a five arts section. These administrative structures are to centralize the administration of the island and promote ecotourism (Niño, 2009).

Human settlement, is for strategic security of the island's light house as well as the restaurant area, Palao and La Fantasía. These strategic areas currently dedicated to the island's and restaurant's security, are impossible to relocate.

The objective is to inspire and awaken the interest of the population's awareness to the preservation of the island's natural resources.

The principal ideas are, to have more qualified personal, remodel the administrative buildings and construction of a visitor's center, environmental awareness information will be to promote preservation of the island as a nature preserve.

The costal zone known as "Zona Federal Marítimo Terrestre" (Zofemat) is from sea level to 20 meters above sea level on the island in Law number 137 which is concerned with tourism in the state of Guerrero. The regulations describe the touristic development of the island, its natural ecological and beauty, located near the main land of Acapulco. The idea is to increase the touristic development of La Roqueta island in the future.

This planning should be participatory, "beyond the implementation of Rationalist Court planning models", whose contents are usually defined in the political centers to apply, but without assessing the role of local actors, or their expectations and needs (Molina, 2007).

Planning is first and foremost an inter and multidisciplinary process considering that the problems of the use of resources may not be raised or resolved by a single discipline and to achieve their complete understanding is desirable to optimize communication between scientists capable of addressing the study of natural and social areas; planning the environment implies the holistic view of resources within the area in question, to be recourse to the technical aptitude and knowledge of the geographer, ecologist, forest or biologist, architects, engineers, environmentalists, sociologists, etc.

Each will contribute in this process so that the global environment and the relationship between their parties are recognized and considered within a Natural Protected Area's management plan.

Where the indicators of sustainability are interrelated in its various aspects such as the physical component which includes the slope of the ground, plant development, agrological capacity (depth, fertility, development and stoniness), gathered from coverage and water erosion; biotic component, presence or absence of vegetation (deforestation) and anthropic component, such as the total population, economically active population, economically inactive population, wages, occupation, production, consumption, index of marginalization (housing, services, access roads, transportation, food supply center).

The strategy is an adjustable process whose aim lies in "meeting the set of rules to ensure a better decision in every moment". The challenge here is to make the right decisions at the right time since carrying out a developmental option rarely relies on clearly distinguishable and instantaneous events (Oñate, Pereira, Suárez, Rodríguez & Cachón, 2002).

Natural resources include the "geology and lithologic substrate", the morphology of the land and soil; the fluvial network; vegetable formations and its floristic wealth; Wildlife; "weather conditions and specific ecological traits" which should be basis of constant consultation for the development projects making and promotion of some natural appeal in particular (Boullón, 2001).

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The public use of the resource, "refers to protected natural areas in operation", it seeks to know the interrelation between visitors, facilities and services, as well as the impact that public use exerts on the environment in order to detect the type of most frequent activities, the number of participating users and favorites sites for their performance (Melo & López, 1994).

The determination of the limits will be congruent to the management objectives so that the location for employees, visitors and owners of adjacent land are easy to set. Then, we have to settle the optional uses for management based on the value of the resource, use and current property, ability and limitation of the land to the environmental impact of physical development and socio-economical and political aspects of the region.

Once limits are settled, we have to assess and classify lands by separating the entire protected natural areas of management, indicating where they can or cannot locate physical works. This zoning map occurs on the preliminary sketch of the plan.

Latin America uses the following system of the land classification which considers nine independent management zones: Wild Life Outstanding, Natural Recovery, Natural Scenic Landscape Recreational, Special Use, Recreational and Intensive Use and finally Human Settlement (Niño, 2008).

Once the management zones and formulated appropriate uses are established, the different programs have to be made.

The zonal proposal for La Roqueta island show potentials benefits of being implemented, among them we can mention:

a) To avoid the capricious use of the island which can lead to social conflicts and irreversible damage to the quality of natural resources as it happened with the "ExAca-Extremo" project.
b) To accurately understand the objectives, priorities and requirements of licensees of the island, the municipal authorities, owners of the seven restaurants, national and foreign tourists. In order to reconcile interests in the implementation of land-use plans.
c) Technical advice and planning territorial on behalf of human resources' planners of natural protected areas and sustainable tourism specialists attached to State institutions.
d) The proposal for the island zoning includes a range of time between two and five years to be set up in the insular territory where the beneficiaries are multiple as well as monitoring the elements of nature: water, soil and vegetation in order to avoid environmental impacts with a vision of intergenerational social equity through a participatory approach and combination of multiple State and municipal public policies.

As "La Roqueta" has its well-defined limits, we propose the zoning where they can or cannot locate physical works. Latin America uses the following system of classification of lands which consider seven independent management areas: intangible, primitive, extensive and intensive use, historical and cultural, natural recovery and special use (Linberg & Hawkins, 1993).

On the island, the territorial strategy emphasizes the local resources in order to make sustainable tourism that is currently carried out on the island itself and the providers' competences in established restaurants to offer a quality product as it is the walk from the Continent's harbor to the island.

The comprehensive goals of the tourist phenomenon consist of reconciling the protection of the environment with economic and social interests of the local population, the tourists' acceptance and the satisfaction of their needs. "Protection and valuation of natural spaces by local, public and private economic actors, and by other contributors to the tourist community, as hoteliers, restaurateurs, etc., are directed to maintain the quality of the environment and to provide them with special attention" (Ramírez, 2006).

The territory seen as a holistic entity where its components "involved, rather than independent and isolated from others, but integrated through a dense and complex network of strong and close relationship ties, including a situation of mutual dependence, where participation and alteration of each of the components have an impact on the content", the structure and the functioning of the others and, of course, of the whole territory. This is shown as a real, complex, complete and inseparable entity defined by content, dynamics and states that result from processes subordinated to the functioning of all and each of the fundamental elements.

The recreational activity which is highly recommended is the field visit, due to the proximity to the area of the city and the port of Acapulco, tourists have excellent routes of shipping communication in motorized boats.

It is recommended carrying out formal and informal talks on the outdoor stage and they should be about topics that guide and promote sustainable tourism as a strategy of sustainable development, the conservation of the landscape, sound management of natural resources, importance of the local natural area; existing publications and by edit, will focus on the various items of "La Roqueta".

The recommended administrative actions revolve around the organization of protection, rehabilitation (cleaning), educational programs and cultural diffusion, agreement signing, tourism promotion and research, and training of community cooperation in the work committees to undertake.

Gratitude

At National Council for Science and Technology (CONACYT, Mexico) for to finance this research with number of project 117791.

Conclusions

The enactment of environmental policies for conservation, restructuring tourism and land use of La Roqueta Island will promote as well as preserve the island's future as a natural protected area as defined in the UMA.

Zoning is useful to ensure the success of activities connected with the resulting exploitation of the natural resources of the island landscape. Within the framework of the sustainability of the landscape, we must avoid any recreational activity that adversely affects our natural resources.

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Synthesis of biopolymer from chitosan/xanthan

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Abstract

It was synthesized a hydrogel based on chitosan and xanthan biopolymers, by varying the amounts of both polymers in the network. The polymer chitosan/xanthan (Q/X) ratios analyzed in this work were 75/25, 67/33 and 50/50 respectively. With the aim to improve chitosan properties in acid medium, it was performed crosslinking reactions in the hydrogels by employing glutaraldehyde (GA) as crosslinking agent and hydrochloric acid (HCl) as catalyst, by changing the concentration of each one at 0.5, 1 y 5% w/w over the total sample. Crosslinking reaction was allowed to proceed at 70° C for 3 hours at inert atmosphere. Water fraction determination results showed high values between 0.98 and 0.99, which made them high hydration materials. On the other hand hydrogels exhibit resistance to dissolve at pH 2 and 7, and the relationship of polymers 75/25 showed the lower weight lost in neutral media. Infrared spectroscopy analysis exhibit characteristic groups of both biopolymers in the network, and also appear N-H bonds or available sites that can suggest a good perform in adsorption processes. SEM analysis show homogeneous surfaces with some particles of xanthan gum without react, except to the Q/X ratio of 75/25, where it can be notice a denser surface, probable due to a good crosslinking of both polymers. It could not be possible to establish the glass transition of the xerogel, however by determining and comparing fusion heats in thermograms of materials, it was feasible to explain some possible changes in the structure hydrogel during due to crosslinking reactions.

Biopolymer, hydrogel, chitosan, xanthan, crosslinking

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Introduction

Water pollution caused by discharges from industries of their wastewater, particularly those that contain heavy metals, is a difficult and serious problem for ecology and health, as these are considered dangerous because of its biodegradability, toxicity even at low concentrations and their ability to get accumulate in the body. The growing concern for environmental care, and compliance with strict legislation on the discharge of these products that contain heavy metals, has produced the need of the development of new technologies for the removal of these contaminants. Currently, there are various treatments for its removal, such as chemical precipitation, ion exchange, separation by membrane electrolysis, among others *(Baroni et al., 2008)*, however they present the drawback of being expensive or ineffective in removing trace metal ion in dilute solutions. Adsorption is recognized to be an effective, efficient and economical method for achieving this end, whereby the search and development of new adsorbent materials has been necessary, based on natural polymers such as polysaccharides and their derivatives.

Hydrogels are cross-linked structures in a network having good physicochemical characteristics, such as its ability to absorb large amounts of water, and its responsiveness to stimuli, which has made have applications in several areas, including the removal of metals, particularly those based on chitosan.

Chitosan is one of the most used materials, because presents good physicochemical properties such as high reactivity and excellent selectivity to aromatic compounds and metals, due to the presence of hydroxyl and amino groups in the polymer chains.

It has been found that hydrogels based on chitosan, improve the ion adsorption capacity, however one of the major limitations of poor resistance to it acidic conditions, and mechanical strength (Bailey et al., 1999). It has been discovered that through the crosslinking reaction, and on the other hand, by combining or mixture of polymers, these properties are improved, making it possible to obtain materials with desired properties. In this research synthesis based on chitosan and xanthan gum, chemically cross-linked by using glutaraldehyde as crosslinking agent, studying the effect of three relationships hydrogel polymers developed, and three concentrations of crosslinking agent and catalyst (HCl) in the material, for further characterization, by determining the water fraction, solubility tests in various media, swelling tests, and analysis by Fourier Transform Infrared Spectroscopy (FTIR).

Methodology

Hydrogels were obtained based on the proposed method by Li and Bai, in 2005, adapted for the synthesis of the biopolymer chitosan-xanthan. For the crosslinking reaction it was necessary to prepare a solution of glutaraldehyde [$2.5*10^{-3}$ M], and a solution of hydrochloric acid [$1*10^{-2}$ M], according to the method described by Park et al. (2000). 1500 mg total sample was used to prepare biopolymers Q/X. For the synthesis of hydrogels, solutions of each polymer with a final concentration of 0.65% by weight, and solvent for the chitosan powder was a solution of acetic acid [0.4 M] were used, while for xanthan, water was used deionised . It was stirred at 200 rpm, at a temperature of 35 ° C for 2 h until completely dissolved.

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The solution was injected xanthan dropwise in chitosan, with the help of an insulin syringe (in order to keep the size of the formed sphere constant) all with slow stirring for 2 h. Both polymers were allowed to interact, for 2 h after complete addition of the xanthan to chitosan solution, to complete formation of the physical hydrogel. To make the crosslinking reaction, the temperature was raised to 70 ° C and stable once rose, glutaraldehyde solutions (GA) and catalyst HCl (0.5, 1.0 and 5% by weight) were added, and allowed to react for a period 3 h, while maintaining an inert atmosphere and constant stirring. After this time, we proceeded to filtering hydrogels and washed with deionized water until a neutral pH. The spheres were placed in a petri plastic box, which took a stove at 40 ° C for 48 h, for drying. A hydrogel spheres obtained, were performed to determine the water content, known as water fraction (by weight). Once obtained films of chitosan-xanthan biopolymer, tests were performed at pH solubility, acidic, basic and neutral, to study their physical endurance, in different media. Furthermore, tests prior to testing solubility, swelling in deionized water were made. Properties were also evaluated, and characteristics of the materials obtained using the technique Fourier transform infrared spectroscopy (FTIR).

Results

Synthesis of hydrogels

The synthesis was performed using hydrogels proposed by Li and Bai in 2005, with some modifications to the addition of xanthan gum method.

The ratio of chitosan-Xanthan polymers, taken as a starting point for the development of materials, was to 67/33, selected as reference previous work done by Martinez in 2007, varying this relationship with the addition of more and lower content of chitosan in 75 and 50%, considering a maximum content of xanthan gum 50%, since at higher concentrations not the complete dissolution thereof was achieved because forming very viscous solutions, hindering adding to the solution as drops chitosan.

After the crosslinking reaction, spheres of smaller size were obtained, approximately 1 mm in diameter, which after performing corresponding washing with deionized water to remove residual acetic acid, increased its size considerably to about 3 mm diameter , due to the expansion of the chains within the formed network, allowing the entry of water, swelling. The hydrogel showed uniform appearance and was soft to the touch; physical appearance can be seen in Figure 1 (a), which shows the hydrogel with 50/50 ratio and a concentration of 5% GA.

Once in xerogel form, after drying for 48 h at 40 ° C, the surface showed a nonuniform formed, thin and somewhat brittle, rough appearance due to air bubbles formed during drying. Its physical appearance is presented in Figure 1 (b). The appearance and characteristics presented were the same for other synthetic materials, regardless of the ratio Q / X used. Only for relations with higher content of xanthan gum was obtained.

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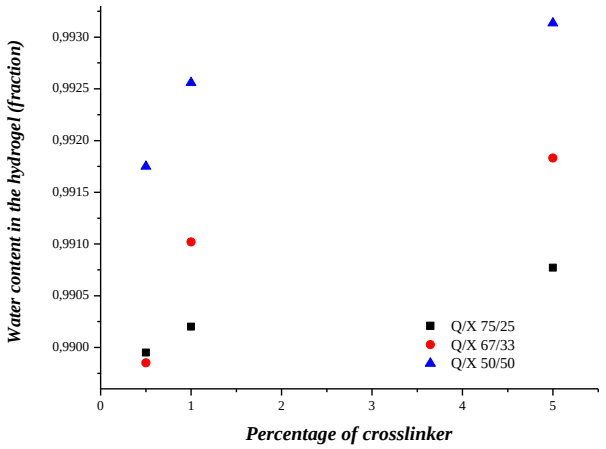
(a) (b)

Figure 1 Biopolymer Q/X, 50/50 and 5% crosslinker (a) hydrogel and (b) xerogel

Determining the percent water (by weight)

The water content in the gel is one of its main features, providing versatility, to a wide number of applications, being the holding capacity, a function of the structure of the materials that compose it, being higher for materials with lot of hydrophilic groups. The graphic 1 show the values of the fraction of water in hydrogels obtained for each of the relations Q/X used in the synthesis as well as the effect of crosslinking agent concentration on these values.



Graphic 1 Effect of percent crosslinking agent on the values of the water fraction by weight of Q/X hydrogels, the three relationships polymers studied: 75/25, 67/33 and 50/50

It can be seen that the ratio of polymers showed the highest values in water content was corresponding to 50/50 followed by 67/33 and 75/25 of. For each ratio Q/X is observed that larger fractions are obtained the highest concentration of crosslinking agent, means, those with 5% GA. This may contradict those reported in the literature for crosslinked materials in which at higher concentrations of crosslinking agent, the absorption capacity of water decreases due to the increase in the density of nodes in the network, hindering liquid inlet.

However, this phenomenon can be explained considering the helical structure of xanthan, assuming that during the crosslinking reaction and the effect of high temperature, this structure is destroyed and therefore a part of the hydroxyl groups which stabilize this helical structure by hydrogen bonding take part in the reaction and another part was available to interact with the water during the swelling process. Thus a network that the initial, less compact is created with spaces in the larger network, which allow increased water absorption. The values of the determinations of water fractions are high and range between 98 and 99% in water content, having some significant changes, these percentages between the studied relations of both polymers in the network.

Swelling tests

In the swelling of the hydrogel is carried out the diffusion of water into the polymer matrix, this process involves the migration of water with preexisting spaces formed between the polymer chains. The swelling of the hydrogel involves a large movement of the segments of the polymer as it is the result of increased spacing between the chains of the hydrogel (Crini, 2005).

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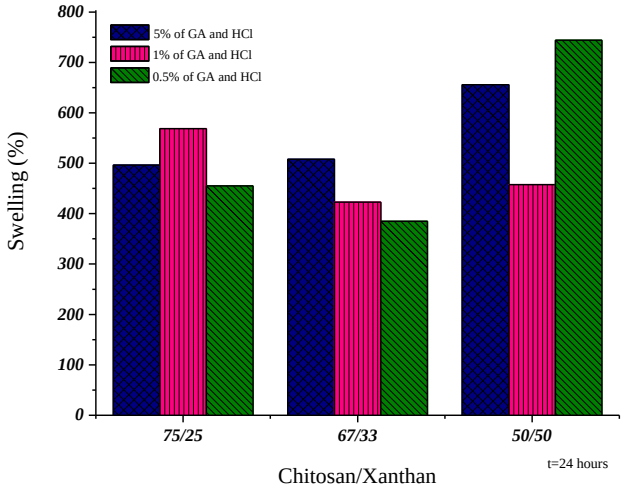
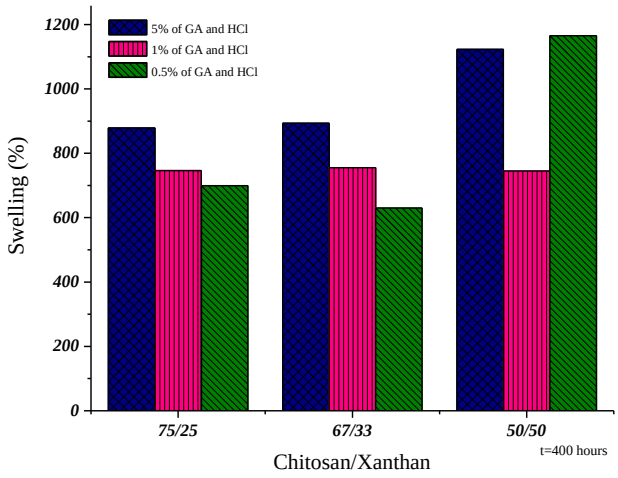
Graphic 2 shows the percentages of swelling obtained after 24 h of starting the dive, materials in deionized water. Inside it there are the three relationships chitosan/xanthan studied, each of the concentrations of glutaraldehyde added to the materials. For the ratio of Q / X of 67/33, A trend is visible towards a higher percentage of swelling for the hydrogel with a concentration of 5% GA, reaching a percent swelling of 508%, followed by 1 and 0.5%.



Graphic 2 Percentage of swelling at 24 h of hydrogels three relationships biopolymer Chitodan/Xanthan and three concentrations of glutaraldehyde employed

In the case of hydrogel 75/25 with 1% crosslinking agent, showed the highest value of water absorption with 496%, and finally the 50/50 ratio, was the one that threw the highest percentages water content, for hydrogels with 5 and 0.5% GA, with 655 and 744% respectively. In the graphic 3 the percentages of swelling of hydrogels are observed in a time of 400 h for each ratio Q/X, at concentrations of GA studied. For the 67/33 ratio remains the trend observed in the previous graph, the largest percentage of swelling hydrogel for 5% to 893% of fluid retention, followed by crosslinked materials with 1 and 0.5%.

In the case of hydrogel to the ratio 75/25, a new trend is observed in a similar ratio 67/33, the material with 5% GA which the highest percentage of swelling, having increased 382 presents % compared to the previous value at 24 h. Similarly this trend is followed by the hydrogels with 1 and 0.5% crosslinking agent. The highest percentages of swelling values of all materials Q / X were for the relationship with higher content of xanthan gum, 5 and 0.5% respectively, there being a significant difference between these values.



Graphic 3 Percentage of swelling to 400 h of hydrogels three relationships biopolymer Chitosan/Xanthan and three concentrations of glutaraldehyde employed

This behavior, somewhat variable, presented in hydrogels, may be that in the course of time, there is a rearrangement of the chains into the hydrogel, allowing greater water retention. That is, it is possible that the large number of ionizable groups present in xanthan, suffer repulsions, for example between COO- groups, increasing the spaces in the hydrogel network, leading to increased swelling.

A behavior very similar to that observed in this research project was found, by Rubio in 2009, which made the synthesis of materials based on natural sources, including xanthan gum, karaya gum and hydroxyethylcellulose.

ISSN: 1390-9959

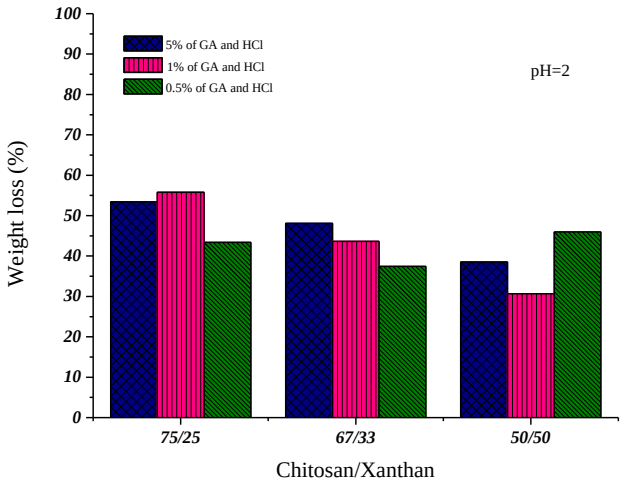
He used equally GA, as crosslinking agent, finding that in general, materials with the highest concentration of it, throwing the highest values in the percent swell, reaching a peak of 10211%, attributing the author this behavior to nature own materials (in this case xanthan gum) and the large number of loads present in the system.

Solubility tests

A xerogels obtained was subjected to tests solubility in different media: basic and neutral acid, to evaluate their behavior and physical endurance in different pH ranges. To do this, it was necessary first films swell to its maximum capacity of water retention, to further suspend the material in buffer solutions of pH 2, 7 and 10, with constant agitation of 120 rpm for a period of 24 hours. The results obtained during tests solubility subsequent swelling of hydrogels are presented.

Graphic 4 shows the percentage weight loss hydrogels, after 24 h of being in contact with the solution of pH = 2, showing that high values of weight loss in the material is obtained, having higher values of chitosan content higher, reaching up to 55% loss ratio 75/25.

However there was no gels solubility in such media, since it reached to record each of the weights without the total loss of the materials. The loss of material is greater in the hydrogels in contact with this medium, and the ionic strength there is increased, leading to an interaction of the counterions of the medium, therefore the hydrogel loses ionizable groups to form ionic bonds with polyvalent ions of the medium (Katime, 2003).



Graphic 4 Percentage of weight loss hydrogels pH=2

Graphic 5 presents the percentages of weight loss in the hydrogels after 24 h of being in contact with the solution of pH = 7. It can be seen as the percentages are much lower compared to thrown to pH = 2. The hydrogel which present the highest value was the highest content of Xanthan i.e. 50/50, with 22% loss of material.

Hydrogels had the lowest values were those with ratios of 75/25 and 67/33, with the lowest percentage of crosslinking agent, with values of 1.88 and 2.13% respectively. This behavior is due to low ionic strength exists in the middle, and the ionized functional groups attached to the chain hydrogel attraction or repulsion suffers with said medium.

A basic pH was not possible to record the weights for the material after 24 hours in contact with the solution pH 10, as they lost their properties and resistance, mostly solubilized. This can be attributed to that between, basic those corresponding to xanthan, carboxylic groups pass carboxylate groups, and because of repulsion between them and the environment, the hydrogel network relaxes completely, allowing more liquid inlet until solubilizase completely.

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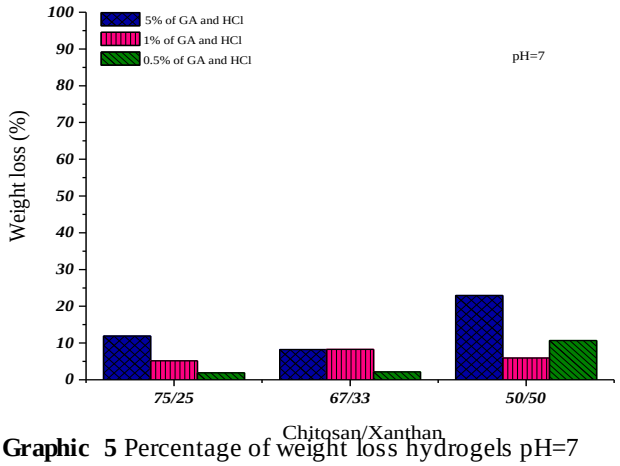


Graphic 5 Percentage of weight loss hydrogels pH=7

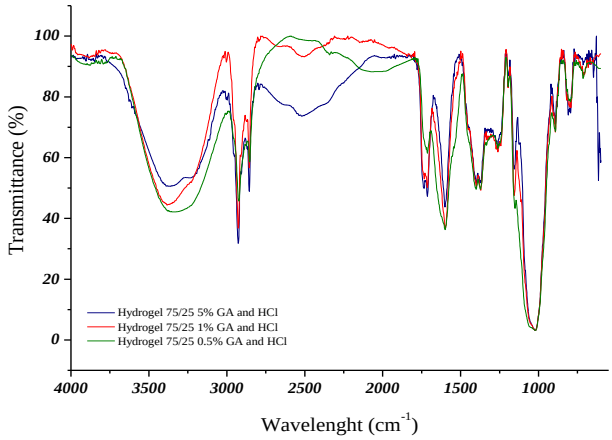
Infrared Spectroscopy Fourier Transform (FTIR).

After the synthesis of chitosan-xanthan biopolymer, and having the same shaped xerogel, we proceeded to carry out the characterization by FTIR hydrogel Q/X, in order to identify key functional groups present in each ratio Q/X.

In this work the FTIR spectrum for the hydrogel Q/X ratio 75/25 at three different concentrations of HCl and studied crosslinking agent (0.5, 1 and 5%) is presented. In the three spectra (see graphic 6) a broad band between 3600 and 300 cm^{-1}, corresponding to stretching vibration characteristics of the O-H and N-H groups present in both polysaccharides are presented.

There is evidence of bands characteristic related to free aldehyde group around 1740 cm^{-1}, which may be due to not react with the amino groups of chitosan, as Baroni mentioned in 2008, in this type of crosslinks, the molecules of bifunctional glutaraldehyde not necessarily have both aldehyde groups bound or linked to the chitosan molecule and therefore functions the same group may remain unreacted, remaining available in the matrix crosslinked end.

The peaks present at 2918 and 2855 cm^{-1} are due to vibrations of symmetric and asymmetric stretching of C-H bonds, while the signals present at 2500 cm^{-1}, may correspond to stretching vibrations of bonds N-H. The peaks located at 1370 cm^{-1} and 1259 cm^{-1}, attributable to deformation vibrations of the OH groups and the peak at 1406 cm^{-1} located deformation vibration of C-H bonds. The weaker signals present at 793 cm^{-1} and 713 cm^{-1}, due to vibrations shake N-H bonds and C-H respectively.



Graphic 6 FTIR spectra of the hydrogel 75/25 to different concentrations of crosslinking agent and catalyst: 5%, 1% and 0.5%

The signal located at 1630 cm^{-1} may be attributed to stretching vibration of C=N, corresponding to the formation of the imino groups during the crosslinking reaction. Baroni in 2008 reports this signal around 1655 cm^{-1} in its work on chitosan membranes crosslinked with glutaraldehyde, used for adsorption of chromium ions. The signal located between 1100 cm^{-1} and 1000 cm^{-1} corresponds to vibrations of symmetrical and asymmetrical stretching of the bonds C-O-C.

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Conclusions

Biopolymer synthesis chitosan-xanthan was performed, in which thin, flexible, transparent films were obtained, regardless of the ratio of Q/X used. Determining the water content in the material, as a fraction of water, high values between 0.98 and 0.99 was obtained, which classifies it as a hydrogel high hydration, wherein the maximum value more content ratio of xanthan (50/50) and the highest percentage of glutaraldehyde (5%).

Swelling tests showed the highest percentages for the 50/50 ratio with 5% and 0.5% glutaraldehyde, reaching values of 1123 and 1165% respectively, which may favor when used on adsorption of metal ions facilitating the diffusion process in the hydrogel.

The solubility tests performed show that all materials have good properties, when their physical resistance to pH 2 and the neutral, since no solubilized, not so for the pH 10, as loss of material was. A suitable range for the use of materials in serious adsorption tests 4 to 8, still more favorably pH 7, using the relative 75/25 hydrogel with 5% crosslinker because it presented the least loss of material, l during testing in a neutral context, with a value of 1.88%.

By characterization by FTIR, the major groups present on both polymers were determined in the network, such as absorptions present of OH, C=O, NH, N=H, CH_2 and CO groups in which a greater intensity in the corresponding peaks in the region of the carbonyl group and CH bonds, as the concentration of crosslinking agent is increased, which can be attributed to the aldehyde group and the signal around 1630 cm^{-1}, may correspond to a imino bond, reaction product of chitosan with glutaraldehyde.

Spectra is equally materials containing functional groups still present N atoms, which means sites still available to take place a good adsorption process with metal ions.

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Participatory cartography, as a support for decision-making in public health, case: Metropolitan Area of Toluca

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Abstract

The work aims to revalidate environments participatory mapping, know the origin this practice, and the epistemological basis. Since this type of research can create links for reflection and action, between social perception and stakeholders focused on promoting social development and investigative actions. It articulate collective knowledge by the researcher becomes a challenge, involving a group of people in research and methodological schemes without losing objectivity cohesive give opinions, criticisms. From this idea analysis methodologies of the IAP, Geography of perception and participatory mapping was performed, and how they can help uncover the major public health problems currently facing the metropolitan area of Toluca because diagnoses by the Institute of health of the State of Mexico that identifies two focuses: environmental pollution, and chronic degenerative diseases (ISEM, 2015).

Participatory mapping, IAP, public health

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Health geography as antecedent

The attention to Public Health in the Metropolitan Area of Toluca is based on the development plan of the State of Mexico, whose approach is to meet a series of objectives, in an integral way, which seeks to solve three main issues: infectious diseases, environmental problems And chronic degenerative diseases.

The beginning of health studies from a geographical perspective begins in (5th century BC) with a medical book that established the characteristics that could be applied to geographical situations on different diseases in Asia and Europe (Somolinos, G. 1966). In the twentieth century began, theoretical innovations and methodologies related to technological progress.

For that same time, there was an answer to quantitative geography, it was the interest for social problems as social welfare, which led to the geography to incorporate studies of the quality of life through subjective indicators and objectives of the necessary conditions for the Reproduction of men "(Méndez, L. 1995).

The birth of the named Health Geography arose in France in 1843. The distinctive features of the studies of that time were based on a "hygienist" perspective under the name of "medical topography" or "medical paleography" included as those medical characteristics of a Geographical space (Olivera, P. 1986). Investigations of this period were made by doctors during the nineteenth century.

It is evident that the studies required to describe the geographical space that occupied and its pattern of behavior to explain the possible causes of what suffered the regions what besides knowing.

The movements, expansion and surface in relation to eg density of population, mode Of life and physical features.

In public health different perspectives are used to understand, explain and locate the topologies that are manifested in society that is why Geography plays an important role in the contextualization and explanation of these phenomena, through Human Geography as an approach General and particularly the Geography of Health (ISEM, 2015).

Public health environment in the Metropolitan Area of Toluca

There is a difference between the traditional medical approach and the concept of public health. On the one hand the population health strategies that address a wide range of determinants (social, environmental and epidemiological). And on the other hand should be looked for ways to manage social actions to reduce threats, since the work of government institutions in addition to pointing out the focus of attention is to implement the strategies designed.

Figure 1 shows the study area is the Metropolitan Area of Toluca (ZMT) consists of 15 municipalities and a population Approximately 1 900, 000 inhabitants (INEGI, 2010), where there is a growing accumulation of evidence on most Of health problems, this can be attributed to the social conditions in which people live or work, they are called "social determinants of health" which (Evans et al, 1994) sets out as goals to determine a profile of Health in a certain space.

ISSN: 1390-9959

At national level (ISEM, 2016) indicates that the main health problems, ie nine chronic-degenerative diseases: Diabetes mellitus, obesity, hypertension, cervical cancer, human papilloma breast cancer, tuberculosis, influenza and dengue.

Information from the "Instituto de Salud del Estado de México" (ISEM 2016) indicates that one of the main concerns in the entity is the cause of deaths since they consider this an indicator to measure the health care, although it is of Indirect form since knowing when, how and from what the individuals die, it is possible to deduce, approximately, the lifestyle of the members in a community.

A more concrete antecedent was an investigation directed by (Santana V. et al 2014) in which a diagnostic work was carried out based on the perception of environmental and health problems, an important element in the territorial planning for the construction of Cities of the Metropolitan Area of Toluca (ZMT).

Figure 2 shows the results that the mentioned author found as pockets of risk derived from social perception, such as: lack of surveillance, excess of non-domestic animals, lack of recreation areas, increase of litter, lack of lighting Pollution in the air.

Derived from the above (Santana V. et al 2014) indicates which municipalities are the ones that have greater recurrence of problems besides the type of problem perceived. And Lerma Zinacantepec and Toluca are those that demonstrate that status.

The role of Geography in the face of social perception

The Geography of Perception, also known as Geography of the subjectivity, has its roots in works on the posture of the economic man, since it maintains a critical cut on the normative models of economist roots prevailing in the Quantitative Geography, in which the location Of activities is based on the perfect economic rationality of man's behavior (Millán E. 2004).

The complexity of this concept hinders the consensus on more general and common definitions in different areas of study. Based on the above the present work makes reference to studies of the abstraction of the population, that is to say the geography of the perception constituting a paradigm of the Human Geography. This position in the sixties sought to refute the deterministic and a priori principles that quantitative geography had elicited in its quest for scientificity.

Derrey (Perreyra C. 2012) argues that the fundamental basis of this approach is to recognize the existence of two types of space: on the one hand an absolute one that is reflected in official cartography and statistical data; On the other hand, the subjective space, which starts from the words (opinion, preferences, valuation, description) and the actions and behaviors of citizens, who live daily in the same space.

The space that has relation with the subject of this form the perception of the second about the first is hierarchized according to the places lived; The richness of this approach is that the object-space, when transformed by the subject, is linked to the symbolic, the affective, the lived and the subjective, which is called perceived space (Sotelo L. et al., 2003).

ISSN: 1390-9959

In this case, the object of study is to identify the challenges of documenting the perception of those who inhabit the Metropolitan Area of Toluca (ZMT).

The purpose is to develop studies and reports on appropriate healthy development measures, so it is necessary to consider within a geographic study, some cognitive representation of the autochthonous urban spaces. In such a way to the authentic thinking of the person who manifests his evaluation, to apply studies of descriptive analysis of data and spatial.

In summary, this line of research is based on the combination of many points of view to understand territorial ideologies, space conflicts, as well as their symbolic connotations at the individual and social levels, drawing on the individual's own vision of deficiencies represented through Participatory mapping and methods of Research and Participatory Action.

Research and Participatory Action (RPA)

In order to tackle issues related to participatory mapping, it is important to know from which approach the technique is born and what its epistemological beginnings are. In 1946 Kurt Lewuin used for the first time the term "action research" derived from observations in communities and groups that sought to solve problems and meet needs, Lewin's method started from psychosocial theory and proposed combining it with practice in action research through An analysis of the categorization of priorities and evaluation. It described a form of research that could link the experimental approach of social science to programs of community action that responded to the major social problems of the time.

Durston Jhon & Miranda (2002) point out that in the sixties in Latin America the framework of so-called social modernization emerged and was inserted in the process of social and educational planning. They affirm that during the 1970s it acquired specific strength to be linked from the Social Sciences as an expression of the insertion and commitment of intellectuals with the popular movements, in the eighties it took importance in processes of democratization that consolidated styles of development concentrating and excluding.

At the moment it is occupied like a technique that through the participation, it foments the social integration and facilitates processes of development where they break traditional research schemes since it combines a series of elements to strengthen the execution of projects and decision making. Then, based on a large literature on the subject, we could propose as an objective of the IAP To promote the collective production of knowledge by breaking the monopoly of knowledge and information, allowing both to become the heritage of the postponed groups. Encourage collective analysis in the ordering of information and in the use of which it can be done.

Increase critical reflection using ordered and classified information in order to determine the roots and causes of problems, and ways of solving them. Finally establish relations between individual and collective, functional and structural problems, as part of the search for collective solutions to the problems faced.

From the qualitative point of view, the IAP is structured in four stages according to (Villegas R. 2000). The first is thematic selection that begins with a plan focused on improvements and development, which at the same time is beneficial to the population, then a plan to implement it.

ISSN: 1390-9959

Management as a next step is part of the action of the researcher in shaping and observing the results of which is being worked. Finally an analysis of the results obtained to what the author calls "self-reflection and spiral intervention"

Collective cartography

Cartography, whose origin lies in the human need to be located in the space in which it develops its life through its graphic representation, can be defined as the science, technique and art in charge of "the realization and the study of maps, In all its aspects "(Robinson et al., 1987, p.3).

It is important to emphasize that in any field of human activity and in any field of knowledge, since its practical use and application is not limited to the field of geography and sciences, but extends to any other branch, such as Humanities, social sciences or technology.

Authors especially highlight the graphic value of this discipline, for the ability to represent and expose "ideas, forms and relationships that take place in a bi or three-dimensional space" (Robinson, Sale, Morrison & Muehrcke, 1987, p.3). And refer to the importance of cartography for a few years, motivated by the "progressive general awareness of the strategic value of space" and the need for "useful tools for the control and planning of the territory"

However, there is a tool that enables the use of these methods of data structures such as the appearance of web 2.0 as it is commonly associated with a social phenomenon, based on the interaction that is achieved from different applications on the web.

That facilitate information sharing, interoperability, user-centered design, or DCU And collaboration on the World Wide Web.

Examples of Web 2.0 are web communities, web services, web applications, social networking services, video hosting services, wikis, blogs, mashups and folksonomies. A Web 2.0 site allows its users to interact with other users or to change website content, in contrast to non-interactive web sites where users are limited to the passive display of information provided to them (IM, 2015).

Supported by this scheme, the process of obtaining data on social participation has its origin in methods of rural evaluation, which underwent a great development during the decade of the eighties and that had as a starting point the inclusion of all the members of the community in any activity related to development initiatives or to community decision-making processes? In this context, participatory mapping became a "method for incorporating oral information into a map, with the aim of integrating secondary voices into a tangible and visible medium" (IFAD, 2010, p.7)

Contributing in this way to citizen and community empowerment, through the georeferencing of their space through these online map applications. (Subires M. 2011), points out that applications that in addition to becoming channels for the transmission of ideas, projects and proposals for improvement, have the added value of the multimedia nature of the network enriching it in this way.

He mentions that participatory maps often constitute a socially or culturally distinct way of understanding the landscape and contain information that is excluded from the usual maps, which normally represent the views of the dominant sectors of society.

ISSN: 1390-9959

And they can, in turn, propose alternatives to the stories and images of existing power structures and become a means of empowerment by allowing local communities to spatially represent themselves.

They encourage greater community cohesion, encourage the participation of its members in land-based decision-making, and raise awareness of the most pressing problems that threaten it. This leads, finally, to the fact that this method can contribute, as already mentioned, to "the empowerment of local communities and their members" (IFAD, 2010, p.4).

Instruments of participatory mapping

According to the Popayan Association of Community Projects cited by (Iratxe, B 20012), the methodology of participatory mapping has conceptual foundations in IPA which are based on the territory as the main factor of the methodological scheme, Table 2.

There are a number of tools that can record and document the happenings and challenges of the settlers as mentioned (Ardón M 1998). They provide graphical information to participants and enrich the perception of how the relationships between real-world changes and the consequences that can be viewed as an opportunity or a threat are shaped.

Community mapping becomes an instrument of support as spatially projected routes, workshops, discussions, and contributions so that as far as subjective knowledge is concerned, it is necessary to find a coherence and spatial association between what is being registered and the Territory, in addition to contextualizing in social, urban and environmental environment.

Interviews, It is important to emphasize that an interview is reciprocal, where the interviewee uses a collection technique through a structured interrogation or a totally free conversation; In both cases a form or scheme is used with questions or questions to focus the talk that serve as a guide.

Participatory Observation That is why we must talk about qualitative research, provide researchers with methods to revise non-verbal expressions of feelings, determine who interacts with who, understand how participants communicate with each other, and verify how long they are Spending on certain activities

Open interviews, in them of favors the communication leaving to speak freely and making the participant feel the researcher asks few questions and it is dedicated to redirect the subjects of which it is spoken. It is used when interested in information regarding subjectivity or, in its absence, personality.

Perception surveys It is linked to the open interview, however it is the main stage within the method of participatory mapping, it puts in commitment to objectively document information that may not be structured or depends on the type of variable that needs to be documented

Participatory cartography challenges in the ZMT

Investigations similar to those of (Alberich, T. 2000) indicate that the field work itself has as its main purpose to obtain the information required by applying the techniques and procedures indicated above. It means that it will expand the knowledge of the reality about which it will act. At this stage of the process there are two main types of tasks:

ISSN: 1390-9959

Compilation of field data (primary data), identification and collection of data already available (secondary data) for later use, depending on the study to be performed.

For the fieldwork, the operations plan entails making decisions on the following issues: in what place or sectors will the different techniques be applied; At which point the data collection will be carried out (in particular the dates of initiation); Duration of the field work (expected time for this phase of the work); How many people will be required for each activity; Distribution of tasks and responsibilities; How and when will be trained the people who will perform the field work; What elements of support must be provided (transport, previous contacts, search for addresses and completion of interviews, authorizations, preparation of forms, etc.).

After the data collection stage, a certain amount of information is available. This is the moment when it is necessary to sort and classify it according to certain criteria of systematization. It is an orderly presentation of the collected data.

They can be tabulation tasks (counting and recording the totals obtained for each value when it comes to quantitative data). In other cases, it will be a simple ordering of the material, so that everything that deals with the same subject is in the same place (usually, in folders classified according to the issues that have been studied).

In this phase of the work, in some cases will have to amalgamate various data to obtain more synthetic information. This will be done by enumeration, description, comparison, distinction, classification or definition. What matters, in this phase, is to reveal uniformities, similarities and differences within the set of facts and phenomena studied.

Once ordered, grouped, arranged and related the data according to the objectives of the research, it is already in a position to elaborate the information in the sense of analyzing and interpreting it. That is why if it is necessary to approach a specific group of people, it is necessary to know the type of conditions that the population can access and thus determine the universe of study based on this indicator (Jiménez P. 2001).

Finally, at the end of the previous stage, the dissemination of results can be done in several ways: verbal communication in the form of a talk or seminar; in presentation to a large group: assembly of settlers; Mural posters, popular newspaper, flyers, leaflets or folding, or in a web viewer.

In this new context, that of the digital age, in which Communication and Information Technologies are present digital inclusion becomes a basic element, and the development of applications and improvements in web interaction a primary objective. In spite of the enormous importance that the Internet has acquired in recent years, the gap between countries, regions and sectors of the population remains, preventing access on an equal footing in a society where the use of technology .

On the other hand there are advantages to society and have virtually eliminated the barrier of time and space itself that is not only economic, but also generational, between people of different ages. In this sense, (Habergger S. 2006). Reflecting on the concept of digital citizen states that there are three basic requirements that must comply: "Internet access, digital skills and perception of the utility of technologies."

ISSN: 1390-9959

In order to carry out social inclusion in this case, it is necessary to think about Internet users and in Mexico, D.F. Last year, 44.4 percent of Mexico's population aged six or more declared themselves to be Internet users, or 47.4 million people, according to the National Institute of Statistics and Geography (INEGI 2015).

On May 17, the institute noted that the Mexican population that uses the services offered by the Internet shows an annual growth rate of 12.5 percent in the period from 2006 to 2014. Based on the Module on Availability and Use of Technologies Of Information in Homes 2014 (MODUTIH 2014), pointed out that 74.2 percent of Mexican netizens are under 35.

Esto significa que los usuarios potenciales pertenecen a un rango de edad y en la ZMT la población hasta el 2010 de personas entre 15 y 44 años es de 960, 814 habitantes es decir el 49% de la población (INEGI 2015). Esto quiere decir que se tiene mayor posibilidad encontrar interesados en contribuir con el estudio.

Discussion

There is a need to create instruments that conform to the new forms of social interaction, which at the same time are based on methodologies that facilitate the modeling of reality. Collaborative mapping is an alternative method that works to enrich the global knowledge of a specific territory and requires a social culture that encourages the action or participation of the population oriented to different age groups and with different socioeconomic characteristics.

The task of mapping is a process of management and articulation between research and new ideas, that is to say, it must have a comprehensive overview that allows to favor within the results as many social groups as possible and thus to include different sectors since the idea Main is to attend to the demands or complaints that are being registered.

New instruments are now required because of the complexity of the trends and the volume of data that can be generated in different media. These tools, such as database managers, web platforms and tools previously mentioned, may have a The way in which a community is organized socially and facilitating or promoting this process by granting joint power and sovereignty in decision-making or public policies.

Among the main challenges are three points on the one hand the human part, the scientific part and finally the tools that support implementation: On the one hand educate the population not only to manifest their concerns and experiences in terms of health problems, If it is part of the solution and knows how it can eradicate the problems encountered, methodologically there is a discussion about the way in which the model of the scientific method contrasts with the IAP method, however from the point of view Geographical is Valid qualitative analysis.

Finally, the use of web tools, social networks and the media nowadays become means of distraction rather than empowerment of knowledge which indicates a certain vulnerability to the investigative use of such means. However, the promotion of mobile applications and web platforms focused on this type of studies is fundamental to generate information and structured data useful for describing and exploring hidden data.

ISSN: 1390-9959

Figura 1 Location of the study area, Source: Own elaboration with INEGI 2015 data

Factor	Characteristics
Socioeconomic stability.	Its importance is significant when studying the behavior of a group as the state of health improves as it rises on the income scale.
Support and social integrity	The support of families, friends and the social fabric which in turn is related to recreational and productive activities.
Education	Increases income opportunities, safety at work, factors that influence the quality of life.
Employment and laboral conditions.	Income level and employment characteristics are associated with security, concern, stress and income level, a situation that influences social and family development
Enviroment	Physical and geographic variables such as air, water and soil quality are influences on health. Urban infrastructure, housing, workplaces, roads and services must have a sustainable and environmentally friendly design.
Life styles.	Personal habits allow and support choices and healthy lifestyles, as well as skills, intentions, and adaptive skills to cope with life in a healthy way.
Health services.	Factors to promote, maintain and restore health, is called healthy culture whose main objective is the prevention of diseases, the development of healthy population is included as a determining factor in urban policies.

Table 1 Determinants, Source: Evans et al, 1994

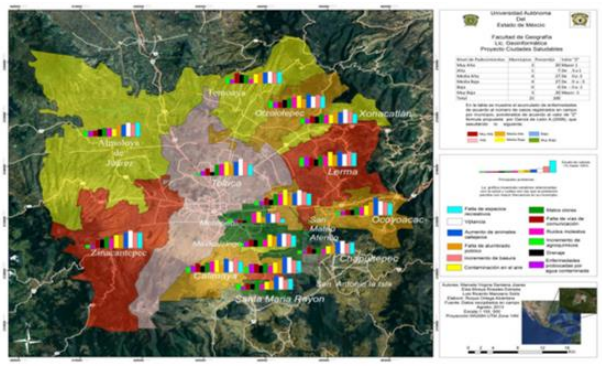

Figure 2 Percepción social de problemas de salud en la ZMT Fuente: Santana V. et al 2014

Etapa	Insumos	Descripción
Investigation	Objective, universe of study, social actors	Stage that allows to dimension the knowledge and practices to make sustainable the objective raised
Action	Data, opinions and documentation	Validation process regarding the objectives that are sought with each research topic is to say what type of information will be stored and how.
Participation	Community Databases	Framework for dialogue and investigative expression consists of consistently carrying out individual or joint reflections, of course social integration is sought
Systematization	Support tools Web maps and reports	It consists of moving from theory to practice as it is the main element to be able to replicate the process that at one time was disorganized and without structure, due to the diversity in obtaining collaborative data.

Table 2 Metodología de la Cartografía participativa Fuente: Elaboración propia con base en (Iratxe, B 20012)

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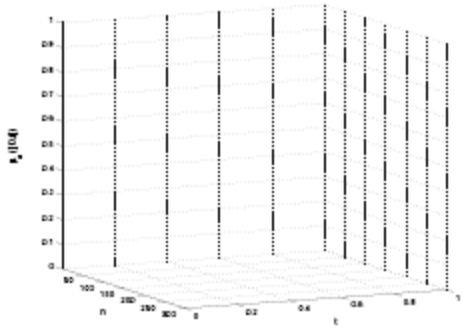

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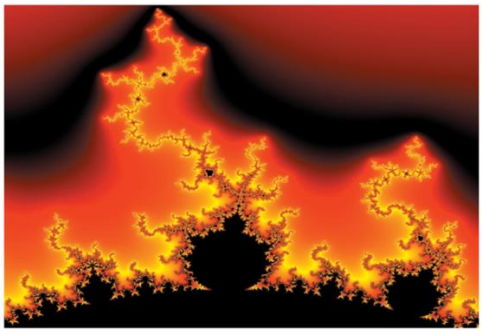

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