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Journal of Technology and Innovation

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Presentation of content

In the first article we present, *Removal of hexavalent chromium from graphene oxide supported on a cellulose acetate and polyacrylic acid membrane*, by SÁNCHEZ-MÁRQUEZ, Juan, FUENTES-RAMÍREZ, Rosalba and GAMIÑO-ARROYO, Zeferino, with adscription in the, Universidad de Guanajuato, in the next article we present, *Application of sub-segmentation enhancement in pore detection in soil CT images*, by ARREGUIN-JUÁREZ, Miguel, QUINTANILLA-DOMINGUEZ, Joel, OJEDA-MAGAÑA, Benjamín and TARQUIS-ALFONSO, Ana María, with adscription in the Universidad Politécnica de Juventino Rosas, Universidad de Guadalajara and Universidad Politécnica de Madrid, in the next article we present, *Cybersecurity dashboard*, by LEDESMA-URIBE, Norma Alejandra, JUÁREZ-SANTIAGO, Brenda, MENDOZA-HERNÁNDEZ, Guillermo and ALVARADO-MALDONADO, Ricardo, with adscription in the Universidad Tecnológica de San Juan del Río, in the next article we present, *Analysis of the relationship of the input parameters in an independent way and their effect on the efficiency of the treatment of wastewater with activated sludge technology*, by ALOR-RICALDI-TORREZ, Oscar, OLIVARES-RAMÍREZ, Juan Manuel, FERRIOL-SÁNCHEZ, Fermín and MARROQUÍN-DE JESÚS, Ángel, with adscription in the Universidad Internacional Iberoamericana and Universidad Tecnológica de San Juan del Río.

Content

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Removal of hexavalent chromium from graphene oxide supported on a cellulose acetate and polyacrylic acid membrane

Remoción de cromo hexavalente a partir óxido de grafeno soportado en una membrana de acetato de celulosa y ácido poliacrílico

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Abstract

This work focused on the study of the hexavalent chromium removal process from graphene oxide supported on a cross-linked cellulose acetate and polyacrylic acid polymeric membrane. The membranes were synthesized by the phase inversion method and Graphene oxide was added in proportions of 1% by weight to the polymeric material. Graphene oxide was obtained from crystalline graphite (Electron Microscope Science, No. 70230). The graphite was oxidized using the improved method of Hummers. The characterization of polymer and graphene oxide was made by Raman spectroscopy. The surface charge and point of zero charge of the materials were evaluated using a potentiometric titration method proposed by Loskutov and Kuzin. The removal of Cr (VI) was studied as a function of contact time and of initial concentration of Cr (VI). The removal of Cr (VI) (~90%) mainly occurs in a contact time from 32 to 64 h when the initial concentration of Cr (VI) is 1 mg/L.

Graphene oxide, Removal, Hexavalent chromium

Resumen

Este trabajo se enfocó al estudio del proceso de remoción de cromo hexavalente a partir de óxido de grafeno soportado sobre una membrana polimérica de acetato de celulosa y ácido poliacrílico entrecruzados. Las membranas fueron sintetizadas por el método de inversión de fases y el óxido de grafeno fue agregado en proporciones de 1% en peso al material polimérico. El óxido de grafeno fue obtenido a partir de grafito cristalino (Electron Microscope Science, No. 70230). El grafito fue oxidado usando el método de Hummers mejorado. La caracterización del polímero y de óxido de grafeno fue hecha a partir de Espectroscopia Raman. La carga Superficial y el punto de carga cero de los materiales fueron evaluados usando un método de titulación potenciométrica propuesto por Loskutov and Kuzin. La remoción de Cr (VI) fue estudiada como una función del tiempo de contacto y de la concentración inicial de Cr (VI). La remoción del Cr (VI) (~90%) ocurrió principalmente en un tiempo de contacto de 32 a 64h cuando la concentración inicial de Cr (VI) fue de 1 mg/L.

Óxido de Grafeno, Remoción, Cromo hexavalente

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Introduction

Many investigations have been focused on the development of new polymeric membranes for different applications (Wang 2004, 355). Nowadays these membranes are used for the recycling of metals, for the removal of toxic products or chemical species, and for obtaining high purity chemicals and clean wastes (Sivakumar 2006, 208). To reach these important applications, a great effort has been placed on the design of new membranes with high selectivity and chemical resistance. Furthermore, it is possible to impose to the membranes an additional requirement related to the possibility to control their selectivity or their properties by changing some external parameters (Rodríguez 2005, 1). The addition of fillers in polymers is an attractive method to obtain materials with novel properties. Nowadays graphene oxide is used as filler to produce new materials. However, when new applications graphene or graphene oxide are proposed, these materials need to be supported on other materials to obtain attractive composite structures with a better performance than the performance showed by pure initial components. The physicochemical characteristics of the membranes obtained from the polymer mixture can be changed if the membrane is prepared using different mixing ratios of the polymers (Sivakumar 1998, 311).

In this work, synthetic polymeric membranes made from polyacrylic acid, cellulose acetate and graphitic materials were prepared and characterized to evaluate their properties, stability, and their possible application in the chromium removal. The use of polymers provides support to graphene oxide and permits its use in continuous processes for the removal of ions. This idea is based on previous studies showing that these materials have great potential in the adsorption of heavy metals (Gadupudi 2007, 224), (Tuzen 2007, 219) and (Hu 2009, 1542).

Chromium is a heavy metal and has been identified as a contaminant of water and soil. Chromium pollution is produced from numerous industrial activities, such as the textile industry, the chemical industry and metallurgy (Kim 2002, 155), (Dönmez 2002, 751) and (Castiblanco 2021, 6).

The Cr (III) is poorly soluble and stable, is found primarily in food and is essential to maintain normal glucose metabolism in humans. On the other hand, the Cr (VI) is less stable and more soluble and is considered an environmental pollutant, is also toxic and carcinogenic to humans. Hexavalent chromium is harmful to health, relating to certain diseases of the liver, kidney, lungs, and different kinds of cancer (Todorovska 2007, 230).

Composites based on reduced graphene oxide and iron hydroxide have been used for removal of arsenic from aqueous solutions in different studies. Reports show that materials supported on either graphene oxide (GO) or reduced graphene oxide (RGO) have an increased binding capacity compared to free particles (Chandra 2010, 3979), (Hu 2010, 4317), (Ramírez 2021, 22) and (Zhang 2010, 162). Additionally, composites made from reduced graphene oxide and silver oxide have been tested for the removal of Hg (II) from water. The composites studied showed improvements in the ability of removal of Hg (II) compared to activated carbon-based materials. Besides, graphene oxide has been used in the detection of different trace metal ions such as Cu+2, Pb+2 y Cd+2, showing high sensitivity (Bin 2011, 31). Finally, it is important to point that the performance of nanomaterial in the polymer matrix must be evaluated from the study of conditions such as load, degree of oxidation, polymer features, synthesis conditions and carbon nanomaterial production and precursors. All these features play an important role in the final properties of membranes for chromium removal.

Methodology

Graphene oxide synthesis (OG)

The graphite (crystalline graphite of Electron Microscope Science, No. 70230). was oxidized using the improved method of Hummers (Bin 2011, 31). A mixture of graphite, sulfuric acid (Jalmek, purity: 95-98 %, MW: 98.08 g/mol) and potassium permanganate (JT Baker). The oxidation reaction was conducted at 35 °C, with a range of +/-3 °C, for 2 h, with a constant medium agitation. Then, the flask was removed from the heat and 92 mL of distilled water was slowly added to the flask. The solution was kept under magnetic stirring for 15 min.

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Next, a mixture of 270 mL of distilled water and 10 mL of hydrogen peroxide (J. T Baker, 30% weight) was added. The final solution was washed with distilled water and the material obtained was dried at 65 °C (+/-2 °C) for 12 h. Graphene oxide was obtained from a sample of graphite oxide. The sample of graphite oxide was mixed with distilled water. This mixture was placed in an ultrasonic bath (Branson, Model 1510R-MTH) for 3 h at a frequency of 50-60 Hz. After this time, the solution was filtered and dried for later use.

Synthesis of composite from cellulose acetate and polyacrylic acid

The composites were synthesized from cellulose acetate (Sigma Aldrich) with a molecular weight of 50,000 by Gel permeation chromatography (GPC) and a degree of acetylation of 39.7% weight and polyacrylic acid in aqueous solution (Sigma Aldrich) with a molecular weight of 30,000 g mol^{-1} and a percentage of 35% weight. All commercial reagents were used without any further purification step. Composite was prepared according to a procedure previously reported (Estrada 2010, 3). Initially, a solution was prepared dissolving 8 g of cellulose acetate in 100 mL of glacial acetic acid at room temperature. Then, when the cellulose acetate had been completely dissolved, 10 mL of polyacrylic acid was added slowly with a constant medium agitation; this solution was heated at 60 °C under agitation for 30 min, allowing the crosslinking reaction between the cellulose acetate and the polyacrylic acid to take place. The final solution was cooled down to room temperature and stored for 3 days before use. To obtain the composites, several samples were poured into flat glad molds of 10 cm in diameter, leaving the molds with the solution floating on iced water at 4 °C, allowing the solution to reach the same temperature of iced water. Thereafter, the mold with the polymer solution was completely immersed carefully into the cold water until the composites formed and subsequently permitted to rest for 15 min to allow the solidification of polymer solution. Once the composites were formed, they were withdrawn from the iced water and immediately placed into a bath of hot water at 60 °C. This procedure was applied to composites both with and without graphene oxide using concentrations of 1% by weight.

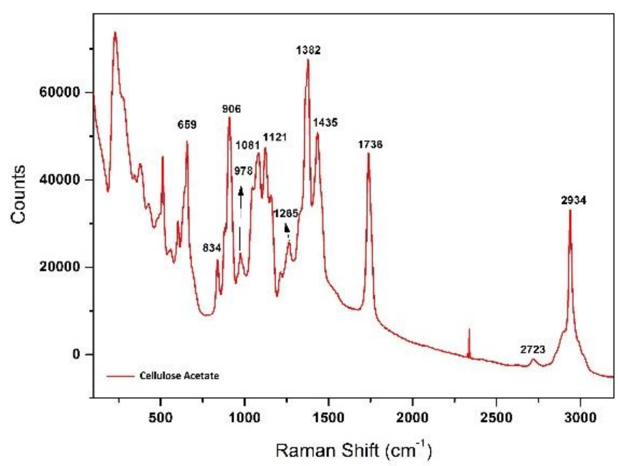
Surface characterization

The characterization of polymer and graphene oxide was made by Raman spectroscopy. The SEM images to the rest of materials were determined with an environmental scanning electron microscope (MEBA, PHILIPS: Model XL30) operated in the high vacuum mode too. The effective surface area and pore size distribution of the graphite materials were determined using N2-BET (ASAP 2010 V5.03).

Results

Raman spectra (crosslinked polymer)

The fundamental bands of cellulose acetate have been annotated on the Graphic 1. The characteristic Raman signals for cellulose were present at 2934 and 1121 cm^{-1}, which are attributed to C-H stretching and asymmetric stretching vibration of the C-O-C glycosidic linkage, respectively. In addition, we observed the pyranose ring signal at 1081 cm^{-1} and the band associated with the C-OH bonds present in the rings at 1265 cm^{-1}. The characteristic Raman signals for the acetyl group can be observed in 1736, 1435 and 1382 cm^{-1} corresponding to vibration of the carbonyl group (C=O) and asymmetric and symmetric vibrations of the C-H bond present in the acetyl groups. The signals observed at 978, 906,834 and 659 can be associated with C-O, C-H, and O-H and C-OH bonds, respectively.



Graphic 1 Raman spectra of cellulose Acetate

The spectrum for the polyacrylic acid is shown in graphic 2. The characteristic Raman signals can be observed at 3444 and 1678 cm^{-1} corresponding with the oxygen-hydrogen bond vibration and carbonyl group (C=O) vibration present in the carboxylic groups.

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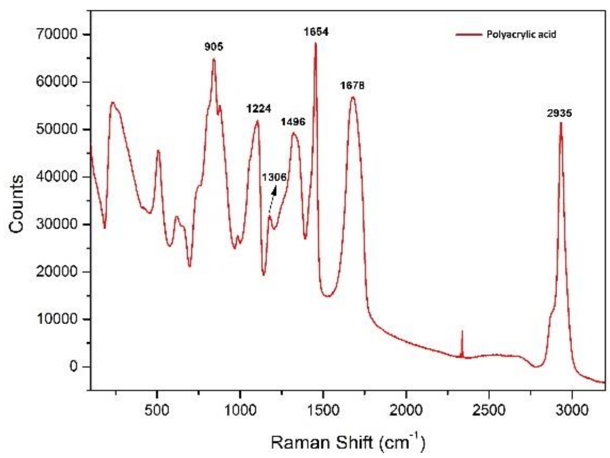
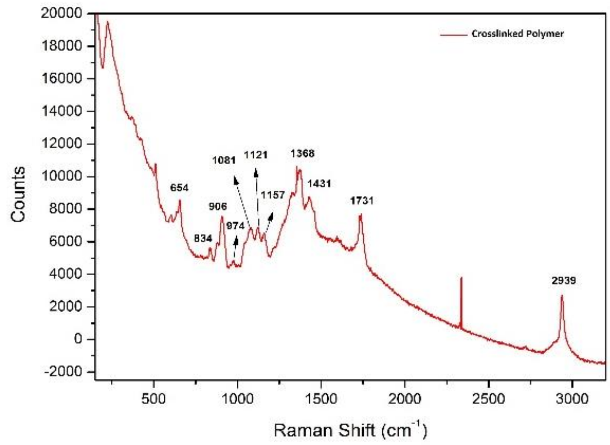
The stretching vibrations of the carbon-carbon double bond (C=C) appear at 1654 cm^{-1} while in-plane bending of the O-H bond can be placed at 1496 cm^{-1}. Finally, the bands at 1306, 1224 and 905 corresponding to C-O bond vibrations.

The peak at 1224 cm^{-1} had a contribution from C-C bonds presents.



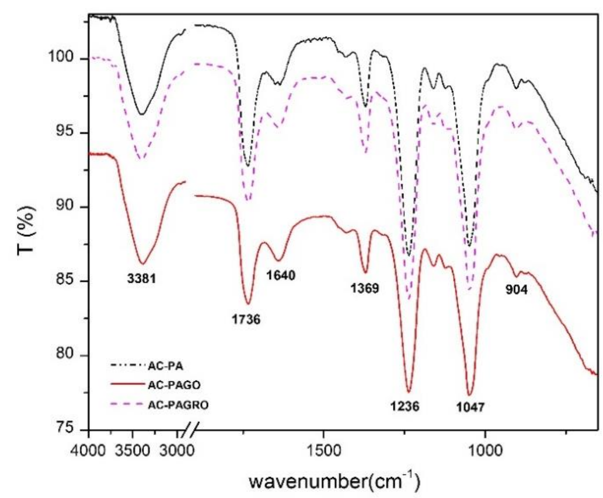
Graphic 2 Raman spectra of polyacrylic acid

When the crosslinking reaction takes place, the spectrum obtained shows primarily the characteristic Raman signals for the cellulose acetate while polyacrylic acid has remained undetected because their bands partially over-lapped those of cellulose acetate, as shown in Graphic 3. The characteristic Raman signals for crosslinked polymer were present at 2939 and 1121 cm^{-1}, which are attributed to C-H stretching and asymmetric stretching vibration of the C-O-C glycosidic linkage, respectively. In addition, we observed the pyranose ring signal at 1081 cm^{-1} and the characteristic Raman signals for the acetyl group in 1731, 1431 and 1368 cm^{-1} corresponding to vibration of the carbonyl group (C=O) and asymmetric and symmetric vibrations of the C-H bond present in the acetyl groups, respectively. Finally, the signals observed at 978, 906, 834 and 659 can be associated with C-O, C-H, and O-H and C-OH bonds, respectively. For crosslinked polymer we cannot observed the band associated with the C-OH bonds present in the glycosidic rings at 1265 cm^{-1} and we cannot see the characteristic Raman signals at 3444 and 1678 cm^{-1} corresponding with the oxygen-hydrogen bond vibration and carbonyl group (C=O) vibration present in the polyacrylic acid neither.



Graphic 3 Raman spectra of crosslinked polymer

The IR spectra of polymer with materials made from graphite are shown in Graphic 4. These spectra show the characteristic peaks of the polymer crosslinked. In addition, it is not possible to observe interactions between the polymer and graphite materials from IR spectra.



Graphic 4 Infrared spectra of the crosslinked polymer (AC-PA) and the crosslinked polymer with graphite oxide (AC-PAGO) and graphene oxide (AC-PAGRO)

Scanning electron microscopy

The images obtained from electron microscopy are shown in Graphic 5.

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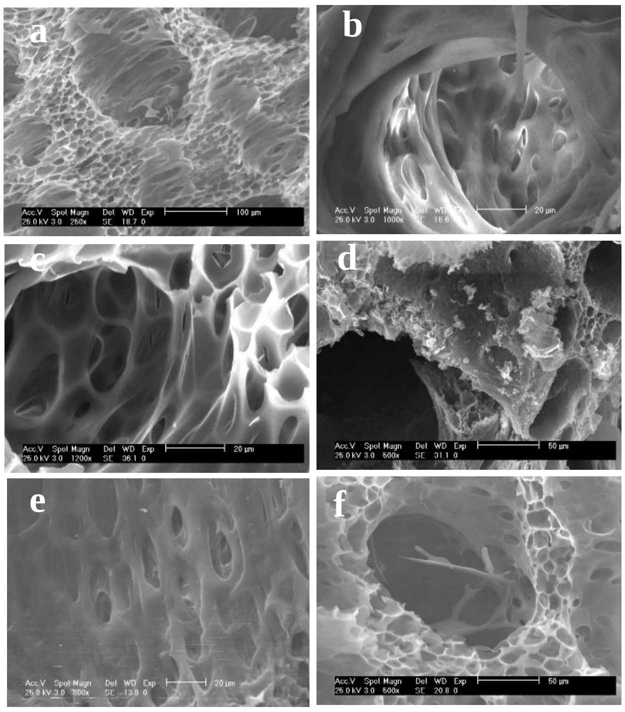


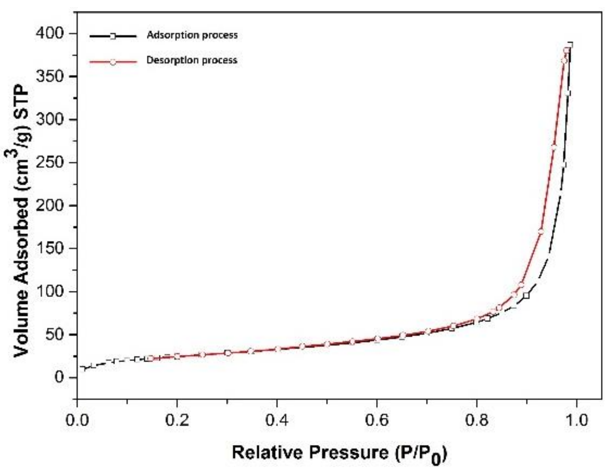
Graphic 5 Sequence of scanning electron microscope images for different polymeric materials. (a), (b) and (d) Graphite oxide, (c), (e) and (f) Graphene oxide.

The figures correspond to the different kind of membranes synthetized. In accordance with the results obtained from the microscopic characterization, we can say that the polymeric membranes have pores of variable size. In some membranes, the pores are formed in layers, giving the effect of forming a deep network, Graphic 5a, 5c and 5e. For the materials obtained from graphite we can observed that the graphitic material is deposited on the walls of the pores within the polymer structure, Graphic 5d and 5f, respectively. Both graphite oxide as graphene oxide cover the walls of the material and they improve the structure polymer.

Determination of the surface area and pore size distribution in the graphene oxide

The BET analysis was applied to graphene oxide to determine the effective surface area and the pore size distribution of the material. The effective surface area of graphite (7.73 m^2/g), graphite oxide (2.85 m^2/g) and graphene oxide (20.86 m^2/g) were calculated with the same method. The average pore size for samples of graphite (9.4 nm), graphite oxide (8.9 nm) and graphene oxide (10 nm) showed small variations.

In the case of graphene oxide, the adsorption-desorption isotherms obtained by BET analysis, Graphic 6, showed a characteristic behaviour of the isotherm of type 3 proposed by Brunauer, which shows that the adsorption occurs by a physical mechanism. From adsorption-desorption isotherms obtained we can see that the analysed samples have a hexagonal tubular capillary.



Graphic 6 Adsorption-desorption isotherm of graphene oxide

Concentration of acidic sites and basic sites

Both, acidic and basic sites were calculated in graphene oxide and polymeric materials using a method proposed by Böehm based in an acid-base titration. For the graphite oxide and graphene oxide, concentration values for only the acid sites were obtained. The graphene oxide (2.28 meq/g) showed a higher concentration of acid sites than graphite oxide (1.45 meq/g). Both, acidic and basic sites on the membranes without graphitic material were calculated using the method proposed by Böehm. The concentration of acidic sites in the polymeric material (4.9 meq/g) is 1.25 times higher than the concentration of base sites (3.9 meq/g). The basic sites in the polymeric material may be associated with unreacted sites on the cellulose; while the acid sites can be ascribed to sites vacated in the polyacrylic acid during the synthesis process of the copolymer. For the membranes with graphitic materials, significant changes in the concentration values of the sites were not observed.

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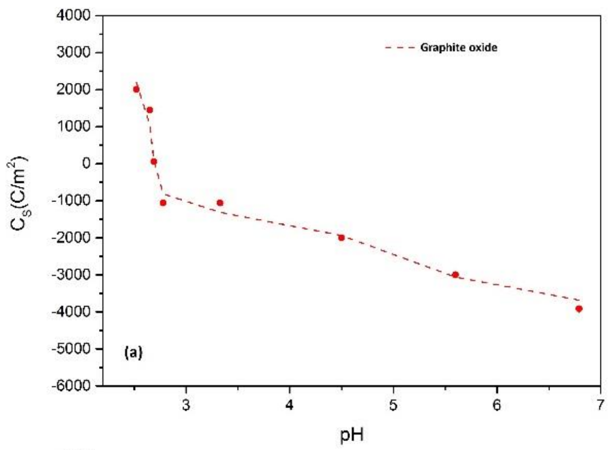
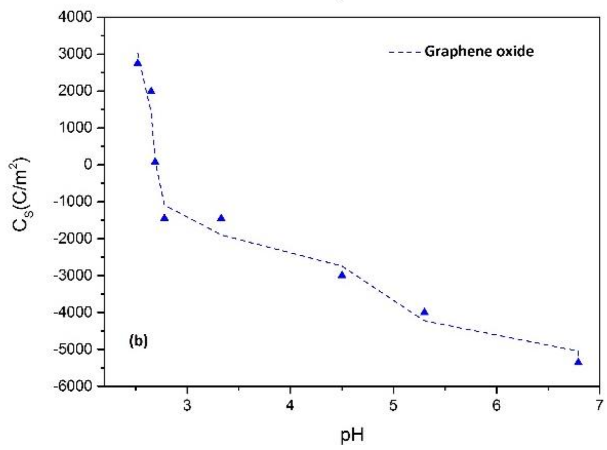
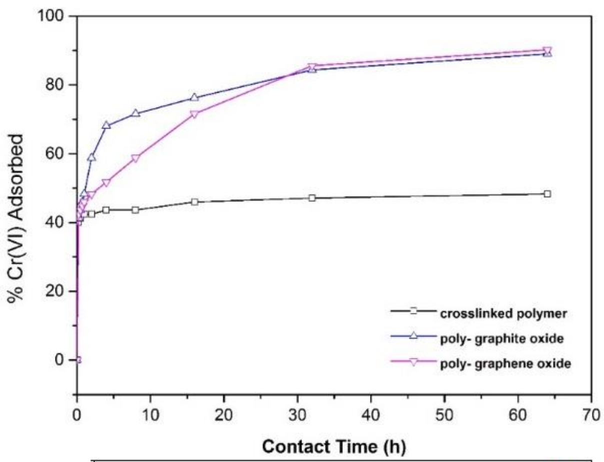
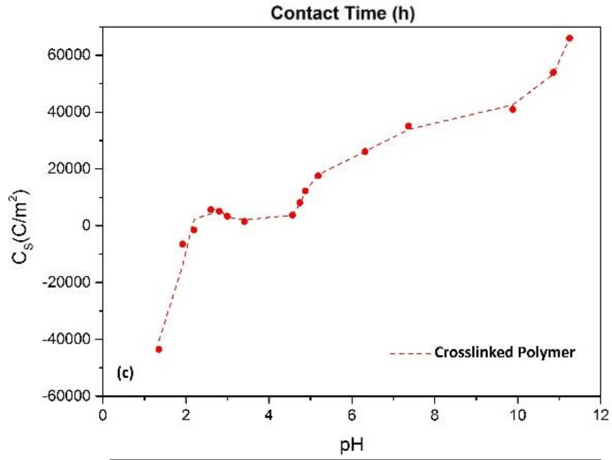
Surface charge and zero-point load

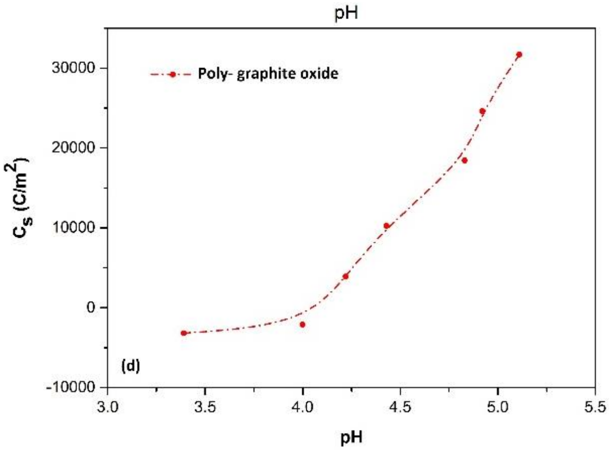
The surface charge of the graphene oxide and reinforced membranes was placed using a method proposed by Loskutov Kuzin based in a potentiometric titration. The zero-point load for the graphite oxide and graphene oxide was determined in a pH value of 2.8 and 2.7, respectively. Thus, the materials are positively charged at pH values lower than load point zero and negatively at pH values higher than load point zero, Graphic 7a-7b. For the polymeric membranes, the zero-point load was placed in a pH value of 2.2, Graphic 7c. The surface of polymeric membranes is positively charged at pH values higher than the zero-point load and negatively charged at pH values lower than the zero-point load. The behaviour of the surface charge of the membranes is opposite to the behaviour shown by graphite materials. The membranes with graphitic material showed a zero-point load placed at pH values higher than those shown for the membranes without graphitic material, Graphic 7d-7e. The surface of polymeric membranes with graphitic material is positively charged at pH values higher than the zero-point load and negatively charged at pH values lower than the zero-point load.







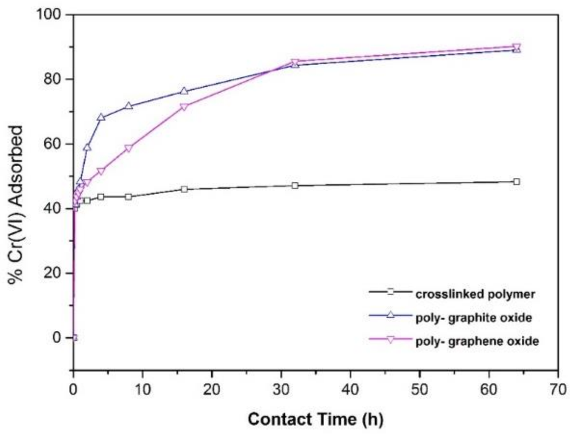




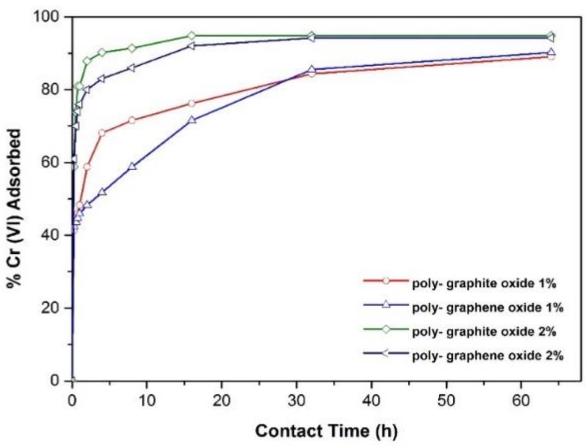
Graphic 7 Distribution of the surface charge in the different materials: a-b) Graphite and graphene oxide, c) Crosslinked polymer and d-e) Crosslinked polymer with graphite and graphene oxide

Effect of contact time

The removal of Cr (VI) from aqueous solutions using polymeric materials made from cellulose acetate and polyacrylic acid with graphite materials was studied as a function of contact time at a pH value of 2.2. From the adsorption kinetics obtained the removal of C r(VI) increases when the contact time increases, Graphic 8. The removal of Cr (VI) mainly occurs in a contact time from 32 to 64 h when the initial concentration of Cr (VI) is 1 mg/L and the charge of graphitic material in the membranes is 1% by weight, Graphic 9.



Graphic 8 Chromium adsorption kinetics for polymeric membranes with graphite and graphene oxide (pH 2.2)



Graphic 9 Chromium adsorption kinetics for polymeric membranes with graphite

Effect of initial concentration of Cr (VI)

The effect of initial concentration of Cr (VI) on removal of metal was studied using polymeric materials with graphitic materials. The data were obtained at a pH value of 2.2 and different temperatures. For the materials studied, the removal percentage of Cr (VI) decreases with the increase of the initial concentration of chromium. When the dose of the graphitic material is constant, the availability of surface adsorption sites also remains fixed; in this way, the removal percentage decrease is due to electrostatic repulsion between ions. When the concentration increases, the competition between ions also increases, thus increasing the electrostatic repulsion. The data of the amount of Cr (VI) adsorbed on the polymer graphitic materials (q, mg/g) and the concentration of Cr (VI) remaining in solution (Ce, mg/L) are described in a better way by the model Langmuir for the temperatures studied, Table 1.

Adsorbent	T (°C)	Model Langmuir q_{max} (mg/g)	K_L (L/mg)	r^2	Freundlich Model N	K_F (mg/g)	r^2
Crosslinked Polymer	25	0.340	0.570	0.9606	1.613	1.707	0.9128
	35	0.211	0.851	0.9795	1.850	1.391	0.9006
Poly- graphite oxide	25	0.894	15.132	0.9988	4.085	1.455	0.8041
	35	0.829	12.901	0.9996	3.400	1.656	0.8897
Poly- graphene oxide	25	0.823	15.632	0.9987	3.998	1.578	0.8225
	35	0.923	5.473	0.9981	2.858	1.687	0.8220

Table 1 Parameters langmuir model and freundlich model

Conclusions

The results obtained show that it is possible to design polymers with graphitic materials whose pores are formed in layers, giving the effect of depth forming a network. The graphitic material is deposited on the outside of the polymeric material. The adsorption-desorption isotherms obtained by BET analysis showed that the adsorption occurs by a physical mechanism and that the analysed samples have a hexagonal tubular capillary. Besides, the isotherms of adsorption / desorption obtained for graphite, graphite oxide and graphene oxide showed characteristics like the carbon nanotubes. For the graphite, graphite oxide and graphene oxide, concentration values for only the acid sites were obtained. These acid sites can be associated with the presence of carboxylic groups inserted during oxidation of the graphitic materials. The basic sites in the polymeric material may be associated with unreacted sites on the cellulose; while the acid sites can be ascribed to sites vacated in the polyacrylic acid during the synthesis process of the copolymer. For the membranes with graphitic materials, no significant changes were observed in the concentration values of the sites.

The graphitic materials are positively charged at pH values lower than load point zero and negatively at pH values higher than load point zero. While the surface of polymeric membranes is positively charged at pH values higher than the zero-point load and negatively charged at pH values lower than the zero-point load. Thus, the behaviour of the surface charge of the membranes is opposite to the behaviour shown by graphite materials. From these studies of removal of Cr (VI) on the membranes we can establish the following conclusions:

- The removal of Cr (VI) using polymeric membranes with and without graphite and graphene oxide is strongly dependent of the pH values. Besides, the adsorption of Cr (VI) decreases with the increase of pH value.

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- The adsorption of Cr (VI) using polymeric membranes with and without graphite and graphene oxide is fast in the beginning of the process and then becomes slow with increased contact time.

- The removal of Cr (VI) takes a considerable time when using polymeric membranes with and without graphite and graphene oxide as adsorbents.

- The kinetics of absorption of Cr (VI) can be represented by models of pseudo second order and pseudo first order.

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Application of sub-segmentation enhancement in pore detection in soil CT images

Aplicación de la mejora de la sub-segmentación en la detección de poros en imágenes de CT de suelo

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Abstract

Computed Tomography imaging is a non-invasive alternative to observe soil structures, mainly the pore space. The porous space corresponds in the image of the soil to an empty or free space in the sense that there is no material present but only fluids and the transport of these depends on the porous spaces in the soil, for this reason it is important to identify the regions that correspond to the pore areas. Due to this, this article presents a methodology based on digital image processing techniques with the objective of segmenting porous spaces in soil images. The methodology consists mainly of two stages. The first is an image contrast enhancement through a nonlinear adaptive transformation function and the second is an image segmentation through a technique known as sub-segmentation enhancement which is based on the Fuzzy Possibilist C clustering algorithm. -Medias (Possibilistic Fuzzy C-Means, PFCM). The results obtained in the segmentation stage are compared with the technique known as sub-segmentation or conventional sub-segmentation, which is also based on the PFCM hybrid algorithm. In this article it is shown that both segmentation techniques are robust, but nevertheless the area of opportunity of the classic sub-segmentation and the improvement process that results in the new sub-segmentation or improvement of the sub-segmentation are also shown. segmentation.

Digital image processing, contrast enhancement, segmentation, clustering algorithms

Resumen

La imagen por tomografía computarizada es una alternativa no invasiva para observar las estructuras del suelo, principalmente el espacio poroso. El espacio poroso corresponde en la imagen del suelo a un espacio vacío o libre en el sentido de que no hay material presente sino sólo fluidos y el transporte de éstos depende de los espacios porosos en el suelo, por esta razón es importante identificar las regiones que corresponden a las zonas de poros. Debido a esto, en este artículo se presenta una metodología basada en técnicas de procesamiento digital de imágenes con el objetivo de segmentar espacios porosos en imágenes de suelo. La metodología se compone principalmente de dos etapas. La primera es una mejora de contraste de imagen mediante una función de transformación adaptativa no lineal y la segunda en una segmentación de imagen por medio de una técnica conocida como mejora de la sub-segmentación la cual se basada en el algoritmo de agrupamiento Posibilista Difuso C-Medias (Possibilistic Fuzzy C-Means, PFCM). Los resultados obtenidos en la etapa de segmentación son comparados con la técnica conocida como sub-segmentación o sub-segmentación convencional, la cual también está basada en el algoritmo hibrido PFCM. En el presente artículo se muestra que ambas técnicas de segmentación son robustas, sin embargo, también se muestran el área de oportunidad de la sub-segmentación clásica y el proceso de mejora que da como resultado la nueva sub-segmentación o mejora de la sub-segmentación.

Procesamiento digital de imágenes, mejora de contraste, segmentación, algoritmos de agrupamiento

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Introduction

The study and analysis of soil samples is of utmost importance for the identification of the pore structure of a soil segment, this provides information on the mechanics of the soil and displays information of interest. Another importance of soil analysis is the study of exploring the influence of the soil structure, that is, the spatial arrangement of the soil pores.

Soil analysis focuses on performing different tasks, such as segmentation, classification, and interpretation. In some cases it is also necessary to carry out a preprocessing which improves or prepares the image so that it can be processed in such a way that for the segmentation and interpretation algorithms it facilitates the labeling of pixels and the processing of the data. According to (Vogel, 1996) segmentation implies the identification of objects in images. For the segmentation of images, a data grouping process is used which searches for pixels with similar intensities of gray in order to assign them into homogeneous groups. Subsequently, the similarity between pixels is evaluated according to a measure of distance between each pixel and a prototype that represents each object or region, according to the above, each pixel is assigned to the group with the closest prototype or that has something in particular, normally it is expects the distance between patterns in the same clustering to be significantly smaller than the distance between different clustering patterns. For the grouping process, we have a set of vectors {x_1,…, x_n}, which represent the objects and from this we want to obtain the set of groups {1,…, n} that encompasses them. The problem is that a priori it is not known how the vectors are distributed in the classes, or even how many classes there will be, therefore, from the given set of vectors of characteristics, we try to group these vectors into groups, according to with the similarities that have been found (Moreiro, 2002). All groups have a centroid, which represents the objects of the group to which it belongs. The similarity to the objects in the cluster with respect to their centroid is measured by the similarity function, for example, the Euclidean distance. For the partition grouping the objective is to obtain a partition of the objects into groups in such a way that all the objects belong to one of the k possible groups and that on the other hand the groups are disjoint.

Partitional algorithms that focus on partitioning data are classified as: hard or strict, fuzzy, and possible. The main characteristic of a strict partition is that it is based on a Bayesian classification, that is, the algorithm strictly decides (according to certain properties and characteristics) whether or not the data of a certain analysis belongs to a certain data group. In accordance with the above, taking into account the logical values [1,0], the following could be assumed: 1 the data belongs and 0 does not belong to a certain group (discrete data). In the case of fuzzy partitioning, a piece of data is capable of belonging to more than one group, with a fuzzy degree of membership between the values [0,1] where the sum of the membership values is equal to 1 (Continuous data). Finally, in the possibilistic partition, its main characteristic is that it alleviates the restriction of the sum of the membership values in the fuzzy partition that is equal to 1, in addition to that, in each data, it obtains a possible value or degree of membership to the which is also known as a typical value for each of the groups that is independent of the other groups, this algorithm can have a degree of membership of the data between the values [0,> 1].

For the segmentation of images by means of clustering algorithms, different techniques have been used that are based on the family of K-Means algorithms (MacQueen, 1967), which is one of the unsupervised strict partition learning algorithms that It is used to solve the data grouping problem, this means that the algorithm performs the grouping of the data based on a criterion of minimum distance between them and the center of the group. Another highly relevant algorithm for data grouping is the Fuzzy C-Means or Fuzzy C-Means (FCM) which was proposed by (Dunn, 1973). Later (Bezdek, 1981) generalized this algorithm and explained that the Boolean logic on which the K-Means algorithm is based is known as the most accurate and that despite its accuracy advantages, it has a disadvantage, which is not being able to reproduce the patterns of human thought, while the fuzzy logic on which the FCM algorithm is based is designed to react to continuous changes in the variable to be controlled and is not restricted to only two values of 0 and 1 This which indicates that it is a fuzzy or soft partition algorithm. An important characteristic of FCM is that its foundations are based on the theory of fuzzy sets that was proposed by (Zadeh, 1965).

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To solve the proposal of this research, it is not pertinent to use the K-Means clustering algorithm, however, a hybrid algorithm that focuses on the characteristics of the FCM and PCM algorithms will be used, which is called Fuzzy Posibilist C-Means. (Possibilistic Fuzzy C-Means, PFCM) (Pal, 2005) which verify that the algorithm is robust through a set of standard data. After the execution of the algorithm, a method is used which is called sub-segmentation, it is based on the concept of typical values or typicality, that is, it allows finding the most typical or atypical data within a group. The present research work builds on previous research studies that focus on efficient segmentation techniques based on clustering algorithms. As a first study in (Cortina-Januchs, 2011) a solution to the problem of detecting pore spaces in computed tomography (CT) images with the help of image processing is shown, extracting the entities from the images, in addition to using three methodologies for the detection of porous spaces (segmentation), which were (K-Medias algorithm, FCM and SOM neural network). Later he focused on the investigation of (Ojeda-Magaña BQ-D.-B., 2014) in which an alternative method is proposed to detect pore spaces, image processing is also used, data grouping with the help of the PFCM algorithm which segments the images into two groups or regions, one for pore spaces and the other for solid regions. Subsequently, each of these regions is divided into two groups, which are identified as typical and atypical subregions, resulting in four subregions (two typical and two atypical) which constitute the original image, for this approach there is a drawback which is the subjective tuning of the threshold α and the sensitivity of the results to this parameter. To obtain quantitative results of the results of the proposed method, the value of the non-uniformity measure (NU) was used, which is of great help to represent an estimate of the quality of the sub-segmentation results, through the variance of the pores with respect to the variance of the whole image. Through the analysis of several applications, it was found that one of the main drawbacks of the segmentation method arises from the fact that two types of atypical pixels of each group were mixed for the representation of the typical object.

This area of opportunity was improved in (B. Ojeda-Magaña, 2018) in which they already differentiate between the two types of atypical pixels, calling the new technique improvement of sub-segmentation, in which the objects of interest are identified better in precision and quantity in addition to improving the ease of selection of the threshold parameter and the robustness against its changes.

Solution model

This article focuses on the detection of porous spaces in 2D images that have been acquired by means of X-rays or computed tomography. The proposed methodology focuses on digital image processing and data grouping techniques. The images used for pore detection were captured by means of an EVS MS-MicroCT scanner. The images that are generated by the scanner already have the application of a Gaussian filter (retouch filter) which focuses on reducing the noise of the images, but even so there is a problem with the ground images they still contain a bit of Noise and contrast between solid soil and pores is very limited. The first stage focuses on receiving the images of soils with low contrast, the second stage focuses on performing a preprocessing through an image enhancement technique using the adaptive nonlinear transform which improves the contrast between pore spaces and ground. The third stage consists of image segmentation, it focuses on the PFCM hybrid clustering algorithm to find the typical or atypical data within the clusters by means of a resulting matrix of data (Matrix T). The fourth and last stage focuses on sub-segmentation which, once the PFCM algorithm is used, the matrix T is used that segments the pore and soil space regions (2 regions), using a threshold value these regions are divided into subregions, the atypical data of each region are identified, improving homogeneity by reducing the threshold value until the atypical region becomes more homogeneous, where finally the regions of interest are detected, in Figure 1, the diagram is shown. solution model blocks.

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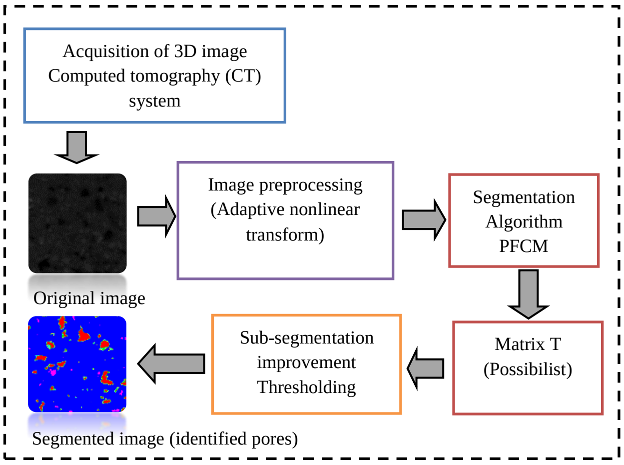
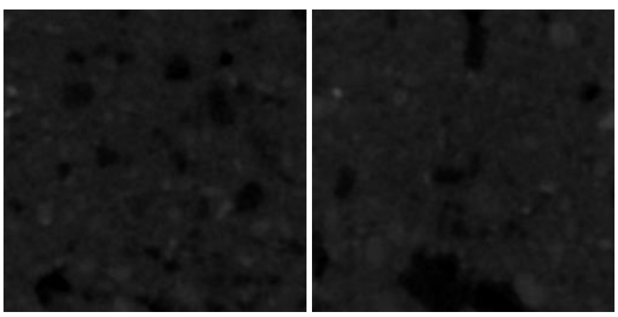


Figure 1 Block diagram for the application of the improvement of subsegmentation in the detection of pores in CT images

Preprocessing (Contrast Enhancement)

CT soil images contain noise due to the nature of the acquisition process, it is usually characterized by the small differences in the gray intensity values of the pixels (low contrast) that exist between the pores and soil space, it is possible observe it visually, Figure 2.



a) b)

Figure 2 Low contrast 2D images acquired by CT computed tomography, a) image 112, b) image 343, with a resolution of 256 x 256 pixels

To improve the contrast, a pre-processing stage is pertinent, which reduces the noise and simultaneously increases the values of the pixels that represent the objects of interest. For this process, the adaptive nonlinear transformation is implemented so that the gray values of the pixels are modified and these are closer to the extreme values. The advantage of this technique is that it is able to emphasize the important characteristics of the image while also reducing noise.

This technique has been used in different applications, for example, for the improvement of mammography images (Andrew F. Laine, 1994), the improvement of natural images (Jevtic, 2009) and in ROI images of mammography (Vega-Corona, 2003) in which they use this technique to attenuate the gray levels of the pixels with a small amplitude value. To perform the contrast enhancement, which allows the contrast and threshold to be controlled adaptively, the expression defined in equation (1) is proposed.

$$I_T(x,y) = T\big(I(x,y)\big) = \qquad (1)$$

$$A\ [sigm(k\big(I(x,y-\beta)\big) - sigm\big(-k(I(x,y)+\beta)\big)]$$

Where I (x, y) is the gray level of a pixel of the input image I, I_T is the image resulting from the transformation, T (.) represents the transformation function that acts on I (x, y). A is defined as:

$$A = \frac{1}{sigm(k(1-\beta) - sigm(-k(1+\beta))} \qquad (2)$$

$$0 < \beta < 1$$

and the sigmoidal function is defined with the following equation:

$$sigm(x) = \frac{1}{1+e^{-x}} \qquad (3)$$

Where $\beta \in R$ and $k \in Z$ which control the threshold and contrast control in the image respectively. For an input image I, with a maximum gray level L_max, it is necessary to map the image in the range of [$-L_{max}$, L_{max}] to an image in the range of [-1,1], therefore the value of L_{max} can be used as a normalization factor. According to the above, the non-linear transformation function equation (1) is represented in graphic 1.

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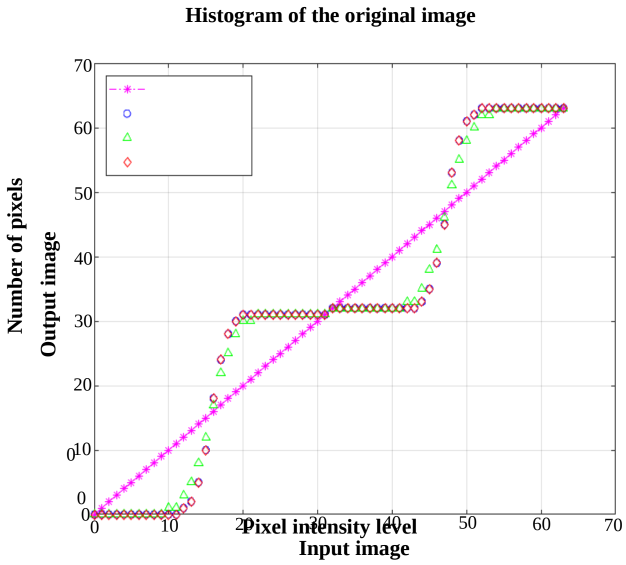
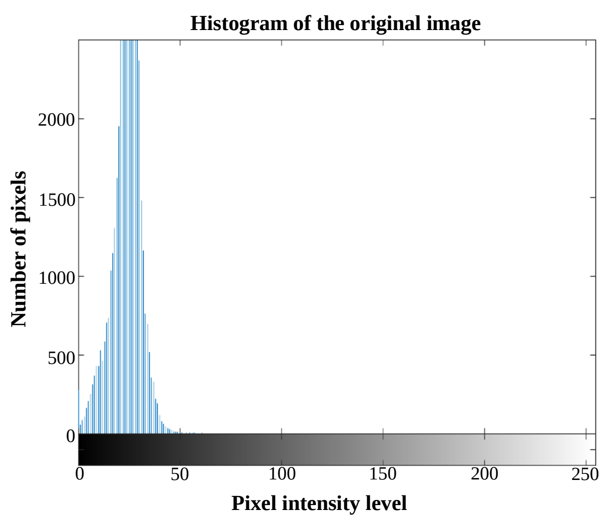


Graphic 1 Nonlinear adaptive transformation function I_T for contrast enhancement of CT images. This technique was applied in a) image 112, and b) image 343, with parameters β = 0.5, k = 10,20,30.

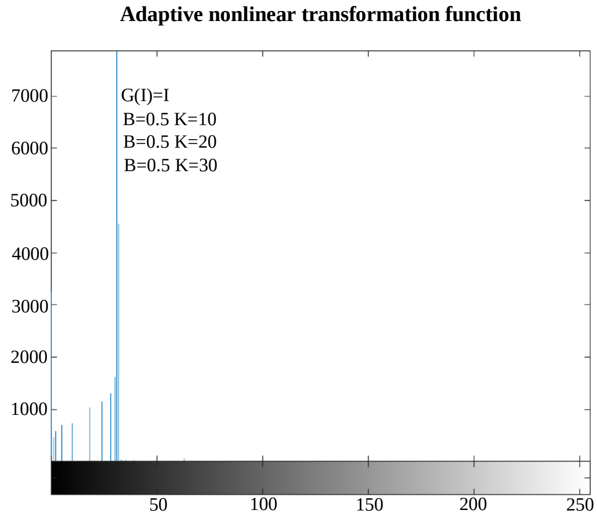
It is important to mention that values of β and k can be used regardless of the dynamic range of the image, as long as the following restriction is met:

$$\beta k > 2 \tag{4}$$

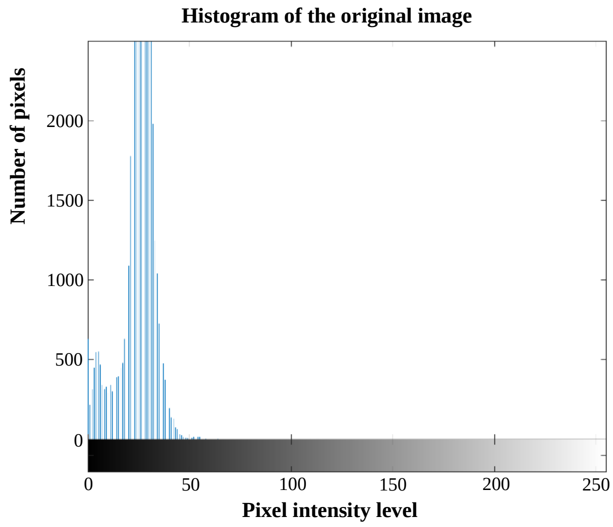
It is important to mention that values of β and k can be used regardless of the dynamic range of the image, as long as the following restriction is met.



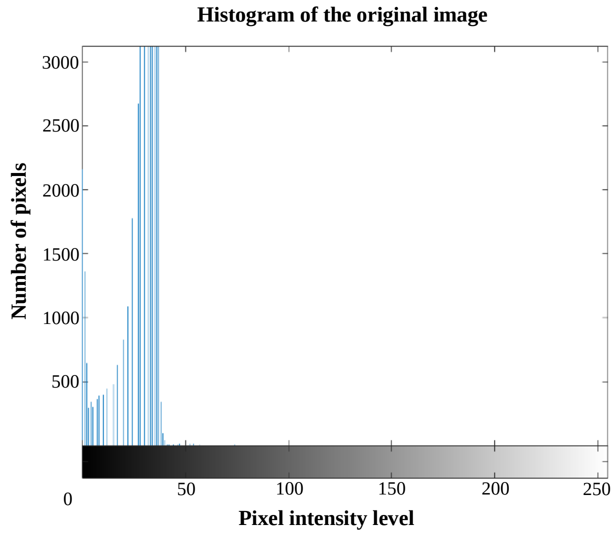
Graphic 2 Histogram where the intensity levels of the pixels of the original image are observed a) Image 112, it is observed that there are pixels with different levels of gray intensity



Graphic 3 Histogram where the intensity levels of the pixels of the transformed image a) image 112 are observed, it is observed that the pixels have been grouped and emphasized the important characteristics, the values used are β = 0.5, k = 30



Graphic 4 Histogram where the intensity levels of the pixels of the original image are observed a) Image 343, it is observed that there are pixels with different levels of gray intensity



Graphic 5 Histogram where the intensity levels of the pixels of the transformed image a) image 343 are observed, it is observed that the pixels have been grouped and emphasized the important characteristics, the values used are β = 0.5, k = 0

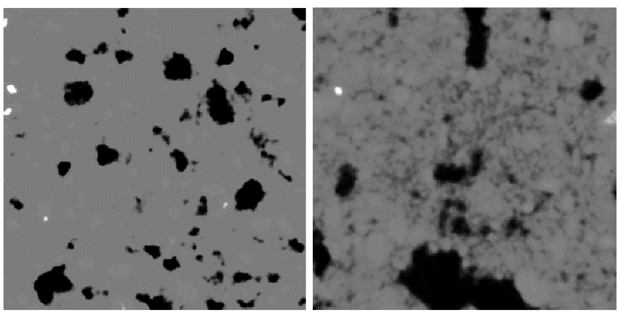


Figure 3 Results of the application of image enhancement, a) image 112 (β = 0.5, k = 30), b) image 343 (β = 0.5, k = 10)

Image segmentation using the PFCM algorithm

The clustering algorithm that has been proposed as a solution to the problems of the FCM and PCM algorithms is the PFCM hybrid algorithm, which has been demonstrated in different experiments by means of a standard data set that is a robust algorithm and that the results are satisfactory. The PFCM algorithm has four adjustment parameters which are: a, b, η and m. The values of a and b represent the relative importance of membership and similarity in the calculation of prototypes. Therefore, if a> b the prototypes are more strongly influenced by the membership values, otherwise if b> a the typicality values have more influence and it is expected that the prototypes will be less affected by noise. In (Ojeda-Magaña B. Q.-D., 2014) they propose a value of a smaller than b to produce a better identification of the pores.

As for the parameter m it has the same function as the FCM algorithm, and the parameter η has the same function as the PCM algorithm. Current literature recommends that these values be small and less than or equal to two. It is important to mention that when the images are segmented, only two objects will be shown, which are the pore space and the floor space.

Improved sub-segmentation applied to soil images for the detection of pore spaces

Sub-segmentation

The method of the new sub-segmentation is based on the concept of typicality which focuses on finding the most typical or atypical data within a group of data and the PFCM hybrid data grouping and partitioning algorithm. This algorithm has been perfected through different research works that have been carried out, in (Ojeda Magaña & Quintanilla Domínguez, 2009) they make an analogy between the grouping algorithms and the prototype theory that was proposed by (Rosch, 1975). The analogy focuses on the degrees of membership of fuzzy sets which can be interpreted as a relative typicality or in other words probabilistic restriction, this means that it results from an external similarity, since the degrees of membership of an object are limited. to unity, in this case 1. On the contrary, the absolute similarity depends only on the elements of the particular group, due to this the typical or outlier data can be more easily identified within the two target regions (soil and pore) . For the sub-segmentation of soils, the parameter α is used, which belongs to the threshold that is within the established interval [0,1], through this interval it is possible to divide a region according to the similarity value of each object. The selection of the parameter α must be carefully selected because it establishes the limit between the typical and atypical pixels, therefore, it requires a value close to zero for the atypical pixels and close to one for the typical values, this can be seen more clearly in Figure 4.

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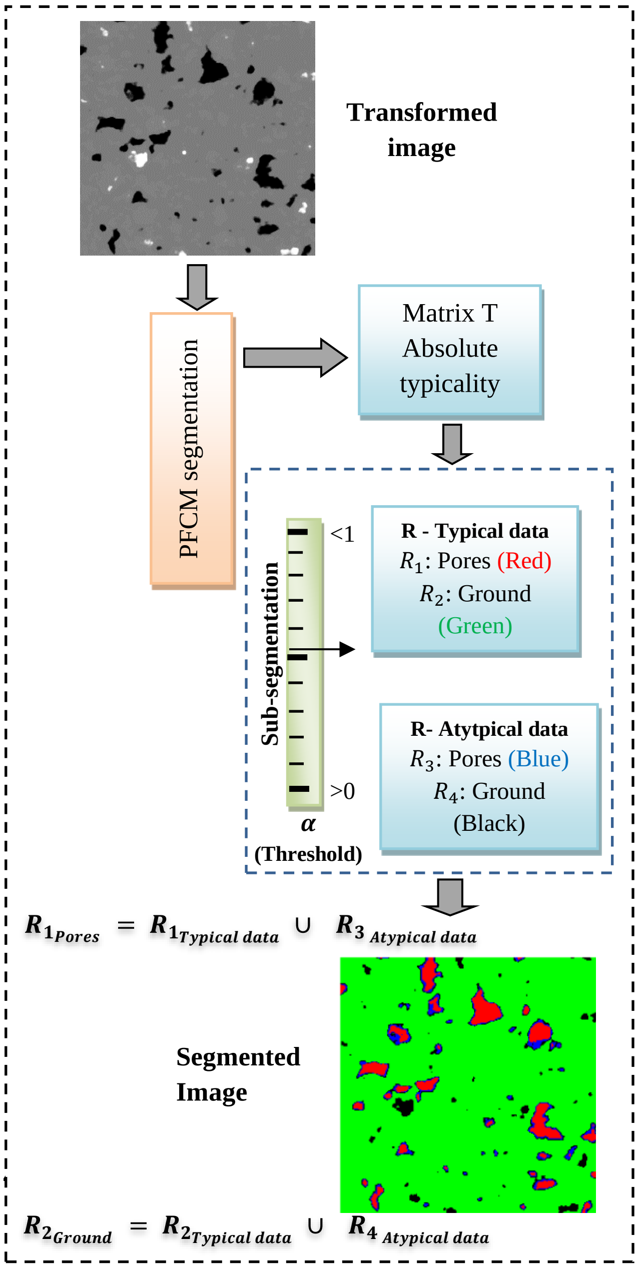

Figure 4 Sub-segmentation process applied to a CT image, image 120 with contrast enhancement parameters (β = 0.5, k = 30)

Improved sub-segmentation

The sub-segmentation method is a robust method for the detection of pore spaces in CT images, however, through various applications in different fields, the need has been found to not only identify atypical data but also to differentiate between the various atypical data in both groups, this due to the lack of homogeneity despite the fact that there are few pixels in that region. In (B. Ojeda-Magaña, 2018) they mention that to reduce the inhomogeneity of the pixels, the solution is to reduce the threshold value until the atypical region becomes more homogeneous.

They also mention that in some of the applications such as the detection of microcalcifications in mammograms, the regions appear as atypical objects that include values of gray levels close to white. Based on this need, the sub-segmentation process was improved and it was divided into two regions, the atypical pixels of the sub-regions, so this helps in the better detection of the objects of interest. The steps that describe the method of the improved sub-segmentation proposal are as follows:

Given a data set Z = $z_1, z_2, \ldots z_N$ corresponding to the N pixels in the image, select the number c (1 <c <N) of clusters or regions S_i, i = 1,2,…, c, the weight of the exponents m> 1, η> 1, and the value of the parameters a> 0 and b> 0.

Step 1. Run PFCM-AO-V to get:

(a) The membership matrix $U = [\mu_{ik}]$

(b) The typicality matrix T= $[\mu_{ik}]$]

(c) Prototypes V= $[v_i]$

Step 2. Label each pixel z_k, K = 1,…, N according to the fuzzy region (FR), with the maximum membership value in U = [μ_ik], for each S_ (i (FR)), i,…, c, as shown in equation 4, so that each pixel z_k can only belong to only one region S_ (i (FR)). Note: these regions will not be used later after this step, although they are of great importance to the segmentation process.

$$S_{i(FR)} = max_i[\mu_{ik}], \quad i = 1, \ldots, c \qquad (4)$$

Step 3. Label each pixel $z_k, K = 1, \ldots, N$ according to the possible region (PR) with the maximum typicality valued in T= $[\mu_{ik}]$, for each $S_{i(PR)}, i, \ldots, c$, as shown in equation 5. Such that each pixel z_k, can only belong to one region $S_{i(PR)}$ for possible regions.

$$S_{i(PR)} = max_i[t_{ik}], \quad i = 1, \ldots, c \qquad (5)$$

Step 4. Obtain the maximum typicality value for each point (pixel) of the previous one $S_{i(PR)}$ matrix and put it in the vector T_{max} :

$$T_{max} = max_i[t_{ik}], \quad i = 1, \ldots, c \qquad (6)$$

Step 5. Label the pixels z_k according to the typicality value of the subvector T_1 to get the following subregions:

$$S_{i\_}typical = \begin{cases} i, if\ t_{ik} = T_1\ i = 1, \dots, c \\ 0, otherwise \end{cases} \quad (7)$$

Step 6. Map the outlier pixels, according to their typicality value, using only the subvector T_2 equation 8. Then map the typicality of this sub vector to gray values of the corresponding pixels. Then a new sub-vector is generated $T_{2(new)}$.

Step 7. Differentiate from prototypes v_i from each region $S_{i(PRA)}$ of the atypical pixels of $T_{2(new)}$. Separate the pixels and save the corresponding labels in two sub-vectors $S_{i\_}atypicalRegion_{c+i}, S_{i\_}atypicalRegion_{2c+i}$ where the labels of the first sub-vector are selected according to:

$$S_{i\_}atypical_{c+i} = \begin{cases} i, if\ = T_{2(new)} \geq v_i \\ 0, otherwise \end{cases} \quad (8)$$

Which will contain the darkest outlier pixels in region i. On the other hand, the elements of the second sub-vector are selected according to:

$$S_{i\_}atypical_{2c+i} = \begin{cases} i, if\ = T_{2(new)} < v_i \\ 0, otherwise \end{cases} \quad (9)$$

Which contain the brightest outlier pixels in region i. So each region PRA_{new} is defined by:

$$S_{i(PRAnew)} = S_{i\_}typical_i \cup S_{i\_}atypicalRegion_{(c+i)} \cup S_{i\_}atypicalRegion_{(2c+i)} \quad (10)$$

Step 8. Select the sub-vector T_1 or the sub-regions($S_{i\_}atypicalRegion_{(c+i)}$,

($S_{i\_}atypicalRegion_{(2c+i)}$) of interest for the corresponding analysis.

To improve the sub-segmentation, the matrix T $_{(2\ new)}$ is taken but now with the gray value of the corresponding pixels, so that an order relationship is established with the prototype of each region, from that it is It is possible to establish an order with the prototypes of each region and it is possible to divide the pixels into two groups, the darkest atypical pixels and the brightest atypical pixels.

Results

The use of digital processing techniques such as contrast enhancement through adaptive nonlinear transform to prepare gray intensity levels as well as segmentation through the PFCM hybrid clustering algorithm and sub-segmentation enhancement help To detect the porosity structure in soil images acquired by CT and for this, all the pores of all the images of the sequence that have been taken to each soil sample are required. Normally the soil structure is represented by the pixels with the lightest colors, while the pores are represented by the darkest pixels. In Figure 10 two original images of the ground with low contrast are shown and later the processed image to which the contrast enhancement has already been applied where it is observed that the contrast has been significantly improved, later images are also attached to which they are The process of conventional sub-segmentation has been applied to them. The parameters selected for the PFCM algorithm were: a = 1, b = 2, m = 2 and η = 2 while the threshold that was selected is relatively low α = 0.08 for the conventional sub-segmentation method, this is due to that the object of interest or the atypical subregion to be identified are the pores or pore spaces. The parameters that were chosen for the improvement of the sub-segmentation were (c = 2, a = 1, b = 2, m = 2 and η = 2) and the threshold parameter α = 0.1 is chosen again a close value zero to detect pore outliers. For the conventional sub-segmentation method, each image is segmented into two regions (pore and soil), subsequently it is sub-segmented into four sub-regions, two typical regions and two atypical regions, the results are shown in Figure 5.

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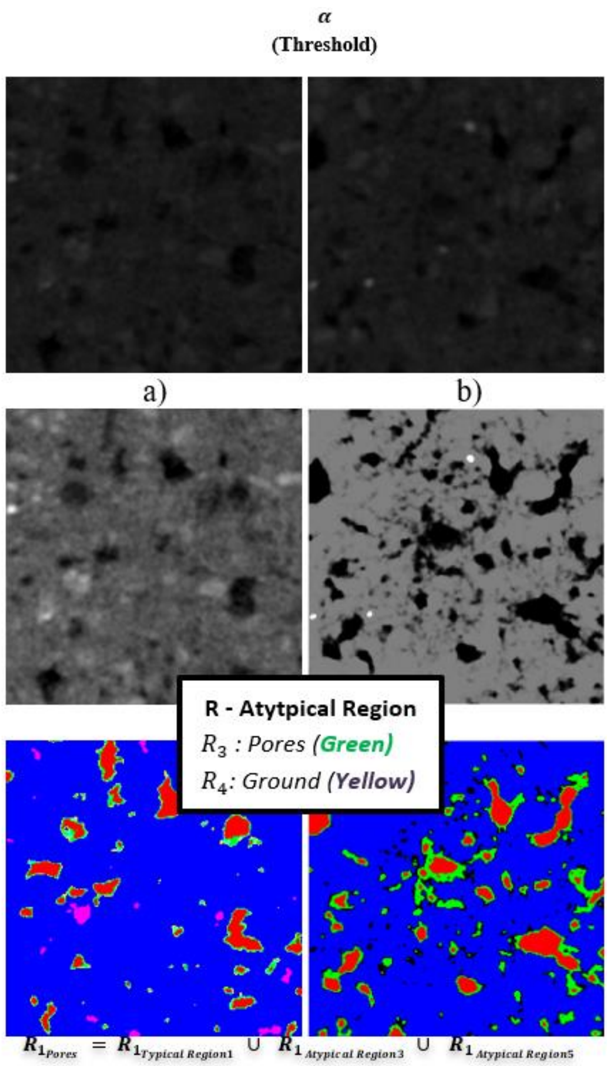

Figure 5 Contrast enhancement process applied to two CT images, a) image 116 with the parameters (β = 0.5, k = 10), b) img 148 with the parameters (β = 0.5, k = 30), for the process of sub-segmentation the parameters a = 1, b = 2, m = 2 and η = 2 were used, with a threshold α = 0.08

For the sub-segmentation improvement method, based on the two groups of pixels (pore and soil), in each of them there are three sub-regions (one typical region and two atypical regions), resulting in six sub-regions that provide more information of interest about the study that is being carried out and provide even more information than the sub-segmentation method. Figure 6 shows the methodology of this process.

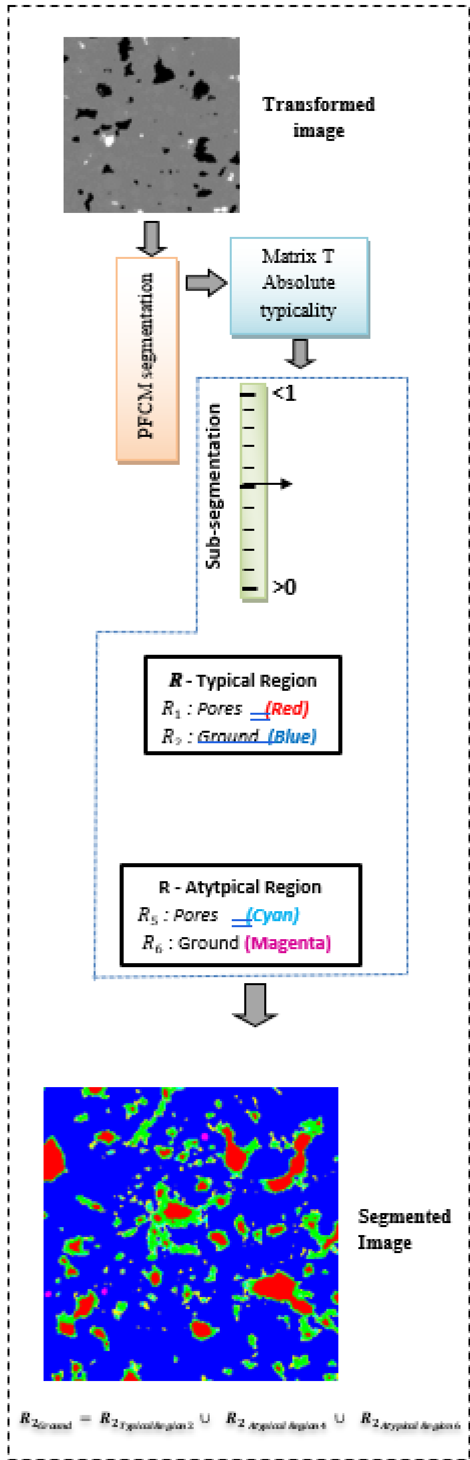

Figure 6 Sub-segmentation improvement process applied to a CT image, image 148 with contrast enhancement parameters (β = 0.5, k = 30. In this process, the six subregions into which the image is divided are clearly observed and the contribution of more information of interest

A result of the contrast enhancement and the enhancement of the subsegmentation of the CT 148 image is also shown, in Figure 7.

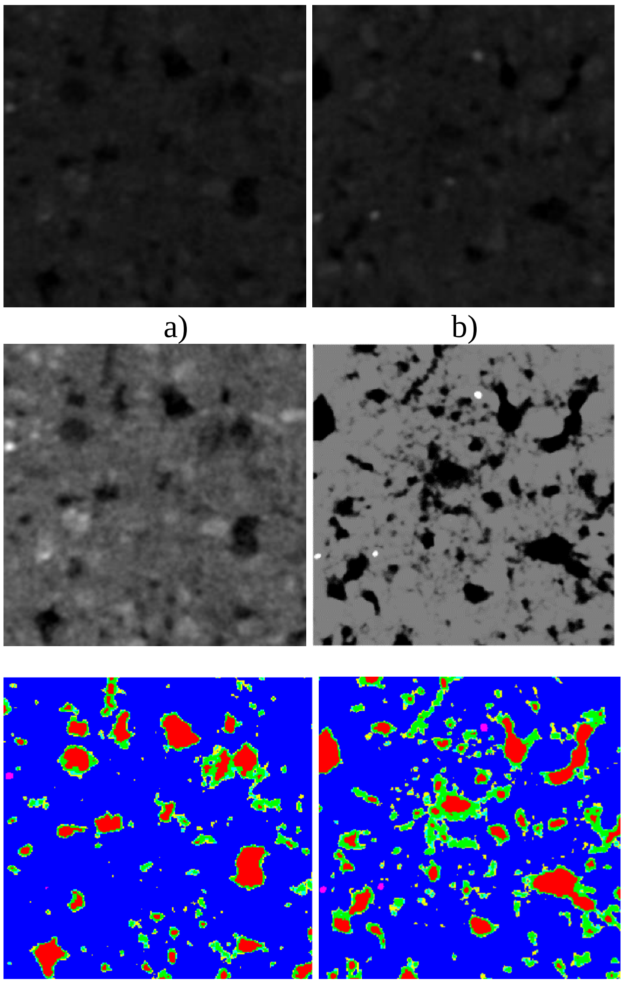

Figure 7 Contrast enhancement process applied to two CT images, a) image 116 with the parameters ($\beta = 0.5$, $k = 10$), b) image 148 with the parameters ($\beta = 0.5$, $k = 30$), for the process of the improvement of sub-segmentation, the parameters $a = 1$, $b = 2$, $m = 2$ and $\eta = 2$ were used, with a threshold $\alpha = 0.1$

Preprocessing for contrast enhancement, segmentation by means of the PFCM clustering algorithm, as well as conventional sub-segmentation and sub-segmentation enhancement have been applied to 256 images (image 100 - image 356), keeping the parameters contrast enhancement and PFCM algorithm used in this results section. For conventional sub-segmentation a threshold of 0.08 and in the case of sub-segmentation improvement a threshold of 0.2.

Conclusions

With the help of digital signal processing and data grouping algorithms it is possible to segment images to find regions of interest and by means of a threshold which is applied to the conventional sub-segmentation technique and the improvement of sub-segmentation.

It is possible to find subregions of interest that focus on the typicality and non-typicality of the data, which promotes reaching a more concise and precise result than a particular segmentation. An advantage of sub-segmentation techniques is that the threshold can be adjusted in a range of [0,1] so that objects can be adjusted to these threshold levels, while the other methods search through a number. discrete groups in order to approximate objects of interest. The tests shown in the present research work show promising results and verify that the methodology shown here is quite robust for the segmentation of soil images, for the moment the inspection analysis of the results of the segmentations carried out here have been evaluated by the visual inspection method, for which reason it is subsequently intended to implement a quantitative analysis method to verify the homogeneity of porosity of the segmented soil images, as well as the development of synthetic images to perform the quantitative analysis, this because there is no there is an ideal comparison of a real image by the nature of the image acquisition.

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Article

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Cybersecurity dashboard

Cuadro de mando de ciberseguridad

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Abstract

The main objective of the present article is to report results gathered from an interactive dashboard application, which main objective is to apply new software and IT technologies to collect information by using several APIS in order to get information and centralize it, then it can be visualized in an interactive dashboard. The methodology used in this project was based mainly by using an specialized software for data analysis which offers an structured an ordered information of data, besides this software also displays alarms that are found in the organization's web pages that are located in cloud services and integrated through Microsoft Azure. In order to weave the different possible attacks which each individual platform could detect such as: malware, authentication bypass, phishing on e-mails, targeted attacks to the companie's virtual machines, malicious ip, etc. The contribution of this project is the integration of several local platforms or those ones located in cloud services serving to SME (Small and medium enterprises) and which are distributed in several branches, either domestic or abroad, then after the interactive dashboard would show live alerts in order to make the correct decisions concerned to cybersecurity issues.

Interactive dashboard, Cybersecurity, Azure

Resumen

El presente trabajo presenta los resultados obtenidos de la aplicación del dashboard interactivo. El cual tiene como objetivo aplicar un nuevo software y tecnologías para la recolección de la información a través de varias API para centralizar la información y poder visualizarla en un tablero interactivo. La metodología de desarrollo se basó principalmente con un software especializado para el análisis de datos, que ofrece una visualización ordenada y estructurada de los datos y alertas encontradas en varios portales de la organización localizados en la nube e integrados a través de Microsoft Azure, para entrelazar los diversos posibles ataques que cada plataforma de manera individual pueda detectar como malware detectado, inicio de sesión desconocidos por parte de los usuarios, phishing en los correos, ataques a máquinas virtuales de la compañía, IP maliciosas, etc. La contribución de este proyecto es la integración de diversas plataformas locales o en la nube que se tienen en muchas pymes, distribuidas en varias sucursales, ya sea en el país o en el extranjero y se puede tener la información y las alertas de manera inmediata para la toma de decisiones relacionadas con la ciberseguridad.

Pizarrón interactivo, Ciberseguridad, Azure

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Introduction

One of the purpose of new technologies is to give several benefits to society and to final users; it has been accomplished to some extent. New technologies have also created new attractive markets with great growing capabilities. However those capabilities come together with risks almost inherently, therefore not only do we get opportunities but also new threats. (KIPPEO, 2020).

Nowadays many companies undergo cyberattacks and these attacks remain growing, this according to the opinion of more than 750 experts and worldwide decision makers. The 76.1% of these experts indicate that from 2020 on cyberattacks will grow and will be focused to infrastructure, 75 % of these experts also indicate that cyberattacks specialized in getting money and valuable information assets will increase.

According to a report, cyberattacks are in 7th position of a lists of main risks that we will face worldwide in 2020 these risks are also in the 8th position in the level of impact (Blog Smartekh, 2018).

Cybersecurity is the area of informatics that protects IT infrastructure as well as, stored or moving information. In order to protect information cybersecurity uses standards, rules, protocols, methodologies, tools and laws to minimize risks related to infrastructure or information.

According to Kaspersky Lab y B2B International (See Figure1), the average cost of a cybersecurity incident in Latin America continues rising , it is interesting to mention that not only does the average cost increase within companies but also by third parties. Therefore, companies must apply cibersecurity measures to their infrastructures and companies must know how partners deal with cibersecurity issues.

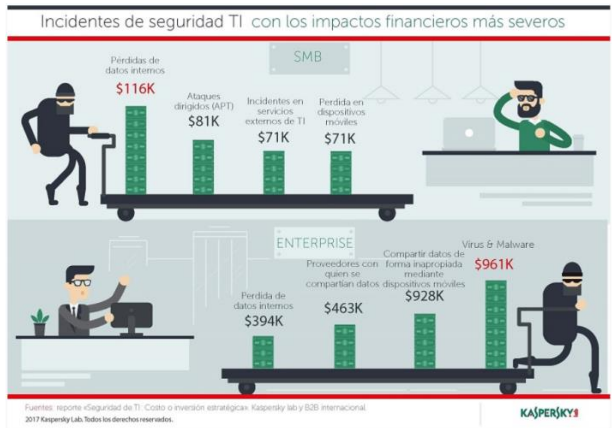

Figure 1 Cibersecurity incidents in 2017
Source: Kaspersky

Nowadays Information is considered as one of the most important assets in an organization and information security as well, informatics security must protect the integrity, confidentiality and availability of information.

Being successful when protecting the 3 basic principles of information, security allows companies to ensure business continuity.

However, the most important asset is corporate reputation. Companies that do not know how manage a cybersecurity incident specially costumers communications and shareholders will undergo a damage in their reputation which is extremely difficult to deal with and recover. A Forbes Insight report indicates that 46% of organizations had already suffered a damage in their reputation and in the value of their brands as a result of an attack. (Sofistic Cybersecurity, 2019).

Informatics security encompasses software (databases, metadata, files), hardware and everything that organizations values and represents risks, if third parties get confidential information then it becomes a privileged information then it could be used against organizations, therefore informatics security is a very important area that must be taken into account by organization to keep safe critical information.

Another topic to consider is data analysis to improve important data visualization for companies; data visualization examines a set of data to make conclusions so that companies can make the best decisions or just to get more information about several topics.

With the development of internet and use of mobile devices in productivity today there is a term used mainly by youngsters called BYOD (Bring your own device) with BYOD young people in an organization prefer to use mobile devices for productivity at work. There are several companies such as Blackberry, Miradore etc, that have already created services and dashboards in order to manage enterprise management mobility (EMM) and BYOD management, EMM services manage applications, data , real time monitoring of users sessions, resources, network monitoring, geolocating, remote destruction of mobile devices, security incidents monitoring, geolocation of stolen equipment, users blocking, users location etc.

EMM services are and excellent tool to protect integrity, confidentiality and availability in information in organizations.

Problem

In most of the SME (Small and medium enterprises) information related to cybersecurity obtained from different sources within the companies is decentralized, that information does not have a proper format, design, or a correct interaction for users, hence it is not possible display information of all areas or branches when a cyberattack occurs.

Justification

By having an interactive cybersecurity dashboard for real time cybersecurity incidents it concentrates information with tailored filters and requested reports for each IT department in every branch, it is also very possible to reduce or eliminate with high precision cyberattacks performed within the organization.

Methodology

Stage methodology proposal with 5 stages:

Stage 1, Licensed Software analysis owned by the company which is: Power BI,Tableau and QlickView

Stage 2, tools comparison and learning curve. It was found that either Tableau or Power BI allows to perform several advanced visualizations which let take the best of data.

It was also found that Tableau is oriented to make tailored analysis performing into a deeper level, whereas Power BI generates powerful dashboards from an executive insight this is due to its great level of integration and compatibility.

A Power BI great feature is that that allows import visualizations that are generated from other users who use the platform. That visualization may be re-used or be adapted into a new report that is being generated.

Stage 3, Using Azure API to chart

Stage 4, Selecting a tool to import data in order to integrate all the dashboard tools, for this case JSON was selected due to its ease of functionality and security.

Stage 5, Connecting API with data and JSON integration tools

Development

In order to develop the present project the corresponding cybersecurity topics were applied, to create a specialized dashboard.

Very specific technologies were also used to centralize the information related to cybersecurity, there were also used analysis tools to solve cyberattacks situations that occur within the company and then to come up with immediate solutions to security incidents

In figure 2 we can see the integration of risk events.

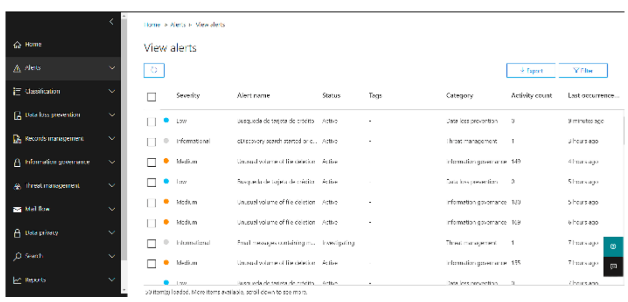

Figure 2 Visualization of alerts in the application Microsoft Azure Identity Protection web page
Source: own elaboration

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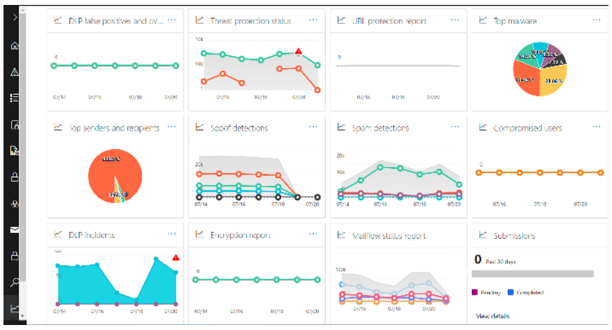

Figure 3 Screen shot from the Application showing charts Microsoft Azure Identity Protection web page
Source: own elaboration

The figure 3, shows the most common cyberattacks with vulnerability rates in real time, where as figure 4 shows a report about users at risk, figure 4 also shows location in facilities and departments, figure 5 shows a report of types of attacks with date and time.

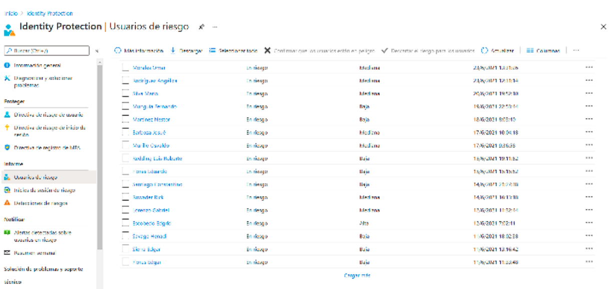

Figure 4 Screen shot from the application showing a risk users report from Microsoft Azure Identity Protection web pages
Source: Own elaboration

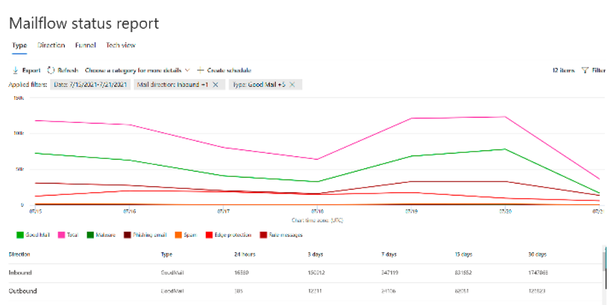

Figure 5 Screen shot from the application showing types of attacks. Microsoft Azure Identity Protection web pages
Source: own elaboration

The company in which this study was applied counts with 4 industrial plants, 200 employees each one, distributed in the Mexican area called the Bajio, 100 employees have access to Microsoft Azure platform, within the same platform there can be found several sections that gather different types of information.

Therefore in the moment in which the person in charge of cybersecurity requires to check any issue related to cybersecurity events has to deal with the problem of accessing an specific section of the platform to get any specific information and then again to visit another section to get that specific information about the same problem once again. A tool was integrated in Azure to make the charts, in the charts it can be displayed data and information obtained from cyberattacks in real time.

With that API it is possible to visualize the information mentioned before in any web browser.

In order to achieve the visualization in any browser the methods HTTP, GET, POST, PUT, DELETE were used. The output format that is obtained only JSON hence, manipulation, storing and processing of information does not require previous treatment for its analysis. See Figure 6 to check the code that was used.


```
{
    "id": "74d4b5311d27f965a9e8a2404e765055bd87a2c0726a6bff4868080f7977c537",
    "azureTenantId": "f29ce9bd-a312-4e1e-8efe-ba51acfd8426",
    "azureSubscriptionId": null,
    "riskScore": null,
    "tags": [],
    "activityGroupName": null,
    "assignedTo": null,
    "category": "UnfamiliarLocation",
    "closedDateTime": null,
    "comments": [],
    "confidence": null,
    "createdDateTime": "2021-07-21T13:47:42.0496162Z",
    "description": "Sign-in with properties we have not seen recently for the given user",
    "detectionIds": [],
    "eventDateTime": "2021-07-21T13:47:42.0496162Z",
    "feedback": null,
    "incidentIds": [],
    "lastEventDateTime": null,
    "lastModifiedDateTime": "2021-07-21T13:50:13.7246235Z",
    "recommendedActions": [],
    "severity": "low",
    "sourceMaterials": [],
    "status": "newAlert",
    "title": "Unfamiliar sign-in properties",
```


Figure 6 reference code to an structured JSON o in Microsoft Graph Explorer
Source: own creation

The methods that were mentioned before make a search of metadata to get an update of the electronic dashboard by using recent data.

In order to review every classified vulnerability it is necessary to make an effective risk analysis, the first step is to identify all the assets within the organization. Those assets include every resource that is used to manage and exchange information within the organization, such as software, hardware, communication devices, digital and analog documents, even human resources must be considered.

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Risk analysis requires creating detailed reports about cybersecurity and the several measures applied in the organization. Those reports let us measure the level of success that the organization is undergoing when preventing and mitigating cybersecurity incidents, reports also let us detect weakness or errors that require applying corrective measures.

Talking about these measures, we can stand out the next ones.

- Security software and firewalls installation.

- Automated security systems in the cloud and disaster recovery plans implementation.

- Implementation of security protocols to reinforce security in passwords.

- Implementation and review users roles and policies for minimum privilege.

- Implementation of mirror servers to ensure high availability in the systems, use of alternative systems.

In this study case the electronic dashboard was developed considering the ISO 27001:2015 norm: Information Security Management Systems (ISMS) it is an international norm that allows ensure confidentiality, integrity and availability in data and in information and also in systems that process confidential or sensitive information. Any organization in the world owns sensitive or confidential information that must be protected against cyberattacks that represent a risk or a threat. The information is the most important asset in an organization, one of the main objectives of the norm ISO 27001 is to helps us protect our information assets.

As a solution for the proposal a security dashboard was developed, in the section Security it can filter information related to security incidents as it can be seen in figures 2,3,4 and 5, there it can be shown filtered information in different categories, risk level, status, information destination, security actions and indicators.

For this study case we focused in categories, status and risk level in which cyberattacks can be identified by their filters and policies that are used to classify a type of attack occurring, which office is being affected, users involved or affected in the attack and additional information that is integrated within the cybersecurity dashboard.

In order to visualize information or online reports on the security dashboard 3 compatibles solutions were analyzed, respecting the main objective of the application: Power BI, Tableau and QlikView. It was found that either Tableau or Power BI allows different advanced visualizations and take the best of data and information.

It was also identified that Tableau is oriented for tailored and deeper data analysis, in the other hand with Power BI it is possible to generate or create more powerful dashboards for executive use it is due to its great integration level and compatibility.

One advantage when using Power BI is that one that allows importing visualizations from other users in the platform, and they (visualizations) can be reused or be adapted in a new report that is being generated.

Once a tool was defined the connection was made by using the exclusively developed API to work with Microsoft Graph Security.

The APPI mentioned before collects information from different platforms and from user’s services such as e-mails, anti-viruses, policies for malware detection. The APPI gives the opportunity to the developers to create their own queries and also to generate reports from scratch, it also allows to know much deeper how the organization’s infrastructure works, this information can be seen in figure 7.

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status	tags	Situación	triggers	uriClickSecurityStates	Usuario
newAlert	List	Impossible travel activity	Table	Table	aazpiroz
newAlert	List	Impossible travel activity	Table	Table	ssosa
newAlert	List	Activity from an anonymous proxy	Table	Table	kolsen
newAlert	List	Activity from an anonymous proxy	Table	Table	ncastell
newAlert	List	Impossible travel activity	Table	Table	ilopez
newAlert	List	Impossible travel activity	Table	Table	enarvaeza
newAlert	List	Impossible travel activity	Table	Table	jzeimet
newAlert	List	Impossible travel activity	Table	Table	djferrer
newAlert	List	Impossible travel activity	Table	Table	jgalvan
newAlert	List	Impossible travel activity	Table	Table	lgranger
newAlert	List	Mass delete	Table	Table	treyes
newAlert	List	Impossible travel activity	Table	Table	evicente
newAlert	List	Impossible travel activity	Table	Table	abgonzal
newAlert	List	Impossible travel activity	Table	Table	becerril
newAlert	List	Impossible travel activity	Table	Table	djferrer
newAlert	List	Activity from an anonymous proxy	Table	Table	lwelly
newAlert	List	Impossible travel activity	Table	Table	aazpiroz
newAlert	List	Impossible travel activity	Table	Table	becerril
newAlert	List	Impossible travel activity	Table	Table	abgonzal
newAlert	List	Impossible travel activity	Table	Table	mvillanueva
newAlert	List	Impossible travel activity	Table	Table	sergio.castillonm
newAlert	List	Mass delete	Table	Table	mibarra
newAlert	List	Impossible travel activity	Table	Table	gtrinidad
newAlert	List	Malware detection	Table	Table	sergio.castillonm
newAlert	List	Impossible travel activity	Table	Table	jarpalacios
newAlert	List	Impossible travel activity	Table	Table	lbarron

Figure 7 Screen shot that shows the process for information and data transformation by using Power BI
Source: Power BI application

Power BI offers several types of connections that allow us to make designs, connections and reports for the electronic cybersecurity dashboard where, according to the assigned permissions users can access to the different levels of information.

Once that required information in the dashboard was identified, different charts were chosen, also reports and filters, this according to information requirements, and validations from users in the dashboard for each possible cybersecurity issue.

The figure 5 shows the highest level with 22 recurrences and value of 5 as a minimum vulnerable value.

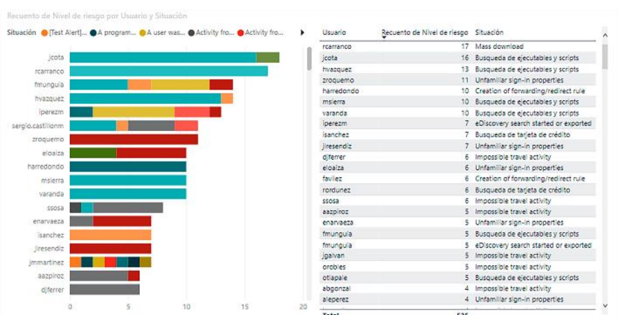

Figure 8 Screen shot of data transformation to charts by using Power BI
Source: Own elaboration

Results

Within the tests and results, it was concluded that the electronic dashboard includes new functions, charts, reports and information that was not found in the other sites. It gives an interactions to what we read, besides it also adds prioritization in an interactive way which allows personal in charge of cybersecurity to locate areas that must be attended and reinforce cybersecurity and mitigate or eliminate attacks that the organization is undergoing.

Besides some other benefits are included:

- Own interactive platform creation.
- Information and data centralization for better cybersecurity management.

- The use of new technologies to display critical information and to be able to interact with data and information that was not possible to visualize in the platforms that were mentioned before.

- In the dashboard more precise data is presented that can be used in future audits.

- The electronic dashboard also comes with options that let add more information origin points; it also lets to create an extra relation with information and data that can be used by the company and the people in charge of cybersecurity.

- Analysis and data management is more precise when using tools like the present dashboard.

Figure 9 shows the main screen with the different states of security levels in the organization, in which we can review users at risk separated by date, users, risk level and a description of the current situation. Here we can also check recent and unknown sessions, it helps us locate in which part of the world an unknown session was established.

The dashboard also shows in a chart the exact time the unknown session occurred so that we can see users at higher risk levels in the organization.

Figure 9 Dashboard screen shot at its final state
Source: own elaboration.

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In figure 10 we can see the charts created due to the organizations' need in order to verify weekly and monthly information about cyberattacks that were detected in users, virtual machines, cloud storage, data bases and e-mail service and also being able to review in numbers each one of the situations at risk.

Figure 10 Dashboard screen shot at its final state
Source: Own elaboration

In figure 11 we can see detailed reports for the different offices in the organization, these reports are used to carry out a correct cybersecurity incident management, according to the work areas, in order to get a feedback to each office depending on the risk level exposure.

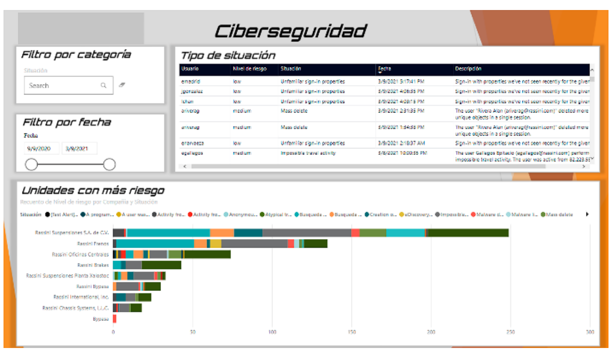

Figure 11 Screen shot with information per office
Source: own elaboration

Conclusions

At the end of the development of the present project we conclude, that it contributed with new opportunities to create reports and also using the information and data that was never used for cybersecurity main objectives within the organization.

By having an electronic dashboard, the organization has total control over the different risks and cyber threats that occur day by day. The dashboard also lets us make a more detailed analysis of how cyberattacks occur and how to avoid them.

The electronic dashboard creates a new way to depict data through Power BI software. Data analysis is a very powerful tool that is currently being developed all together with new IT technologies.

Data analysis also helps the organization to better organize data and information in order to make better decisions. Converting data from the application into visual.

Turning data from the application into visual representations helps employees to describe concepts, discover areas of opportunity, explore options and to make the best decisions everything carried out in a persuasive way.

Virtual supports are necessary to help people make the best decisions.

Cybersecurity is a topic affects everybody in the same way either by having just an e-mail or by managing an entire web site with sensitive information.

It just a failure in the chain that can compromise our security systems, therefore organizations should always attend security information recommendations to avoid major problems.

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Article

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Analysis of the relationship of the input parameters in an independent way and their effect on the efficiency of the treatment of wastewater with activated sludge technology

Análisis de la relación de los parámetros de entrada de forma independiente y su efecto en la eficiencia del tratamiento de aguas residuales con tecnología de lodos activados

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Abstract

The research analyzes the possible effects of three design parameters: flow, biochemical oxygen demand and suspended solids in mixed liquor in the operation of a domestic wastewater treatment plant with activated sludge technology from a conventional process. Applying the elementary calculations equations for this type of treatment, each of the three design parameters was varied, keeping the others constant, it was observed and analyzed how the dependent variables respond: hydraulic retention time, mass load, volumetric load, needs oxygen, sludge recirculation, excess sludge and treatment efficiency. Observing the results of each of these behaviors, it is verified that the most important factors to achieve high efficiency are the reactor volume, the regulation of Suspended Solids in Mixed Liquor (SSLM) through the operation of the recirculation flow and the regulation of the oxygen entering the reactor. This work is an alternative analysis to understand the operation of the reactor in a treatment with activated sludge.

Treatment water, Sludge activated, Suspend Solids in the Mixture Liqueur, Reactor volume

Resumen

La investigación analiza los posibles efectos de tres parámetros de diseño: caudal, demanda bioquímica de oxígeno y sólidos suspendidos en licor mezcla en el funcionamiento de una planta de tratamiento de aguas residuales domesticas con tecnología de lodos activados de proceso convencional. Aplicando las ecuaciones elementales de cálculo para este tipo de tratamiento, se hizo variar cada uno de los tres parámetros de diseño manteniendo constante las otras, se observó y analizo como responden las variables dependientes: tiempo de retención hidráulico, carga másica, carga volumétrica, necesidades de oxígeno, recirculación de lodos, exceso de lodos y eficiencia del tratamiento. Observando los resultados de cada uno de estos comportamientos se comprueba que los factores más importantes para lograr una alta eficiencia son el volumen del reactor, la regulación de los Sólidos Suspendidos en Licor Mezcla (SSLM) mediante la operación del caudal de recirculación y la regulación del oxígeno que ingresa al reactor. Este trabajo es una alternativa de análisis para comprender el funcionamiento del reactor en un tratamiento con lodos activados.

Aguas residuales, Lodos activados, Solidos suspendidos en licor mezcla, Volumen de reactor

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Introduction

The population of the city of Tarija with respect to the last census of 2012 has grown at a rate of 3%, it currently has 222,116 inhabitants, the coverage of the sanitary sewer service is 81%. The wastewater flow is approximately 416 L/s, only 200 L/s are those that are treated by a lagoon system. To cover part of the water treatment deficit, a new plant with conventional activated sludge technology is being put into operation, it will have a capacity to treat an average flow of 210 L/s (756 m^3 / hr) projected for a future population of 98,000 inhabitants with a design period of 30 years [1].

Figure 1 Photograph of the San Blas treatment plant

The treatment of wastewater with activated sludge is an alternative for the purification of wastewater [2]. The water that comes out of the primary treatment (sedimentation) enters a biological reactor with aeration, followed by a clarifier where the sludge settles, from which the water comes out with a very acceptable quality of treatment, with the possibility of being reused for example in irrigation systems [3-7]. It consists of putting the residual water in contact with a culture of microorganisms (biological treatment) under aerobic conditions inside a reactor [4] as shown in Figure 2.

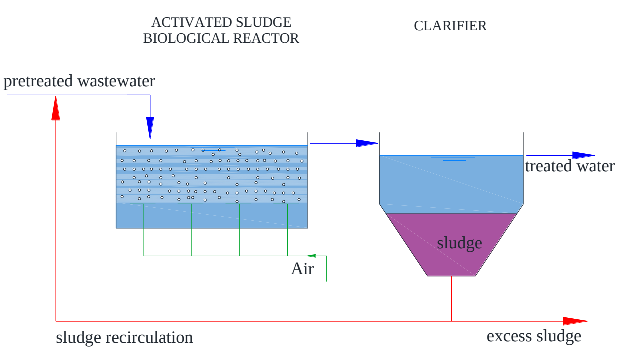

Figure 2 Reactor and clarifier scheme
Source: Own elaboration

The treatment of wastewater with activated sludge is a continuous flow process with suspended biomass, and the adequate concentration within the reactor must be kept constant, through recirculation of sludge, purging and control of the retention time. The activated sludge is produced by the sedimentation of flocs where bacteria, fungi and protozoa abound [2,8]. This sludge contains microorganisms in charge of oxidizing the organic matter and thus purifying the residual water. There are variants such as: High load, medium load, prolonged aeration, nutrient reduction and others [2].

This work was carried out for the (referential) design parameters of the domestic wastewater treatment plant in the department of Tarija in Bolivia. It is a new plant with conventional activated sludge technology that has: Grates, grit remover, degreaser, consists of four lines with primary settler, biological reactor, clarifier, disinfection, sludge recirculation and sludge treatment process. The proposal is that the treated water can be used in agricultural irrigation complying with adequate quality standards. Bolivia does not have an approved regulation for reuse, but it does have guide values such as those described in the following table:

Parameter	Unit	Limit values for use in irrigation
DQO	mg/L	< 100
DBO5	mg/L	<30
SST	mg/L	< 50
pH	-	6.5 - 8.4
CE	mS/cm	0.7 - 3.0
Temp.	°C	-
N-NH3	mg/L	< 30 - NT
P	mg/L	-

Table 1 Guide Values used in Bolivia
Source: Technical Magazine: Bolivia water and environment - Number 4 - August 2019

The contribution of this research is to try to explain how the following variables affect efficiency; the flow rate, volume of the reactors, Biochemical Oxygen Demand, Suspended Solids in Mixture Liquor and dissolved oxygen. Considering as a hypothesis that it is possible to determine the efficiency in a Wastewater Treatment Plant from the reactor volume, BOD, SSLM, dissolved oxygen and recirculation flow.

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The objective was to analyze the relationship of the input parameters independently and their effect on the efficiency of wastewater treatment with activated sludge technology in one of the 4 lines that make up this treatment plant.

Methodology

The variation of the parameters was analyzed: inlet flow, inlet BOD, SSML and oxygen needs. Applying the activated sludge equations (kinetic model for the design of this treatment system), the behavior of the variables was calculated: reactor volume, hydraulic retention time, recirculation flow, oxygen needs, excess sludge and treatment efficiency.

Graphs were made where the behaviors of the most important variables were described and they were analyzed, issuing criteria of effects of input parameters on the operation and treatment efficiency based on Guide values used in Bolivia, and conclusions were also issued.

The input variables considered were:

a) Design flow (Q), is the amount of water to be treated (m^3/h).

b) Biochemical oxygen demand (BOD_5), indicates the amount of dissolved oxygen (mg/L) that is required for the biological degradation of organic substances contained in wastewater [1,2]. This variable is simulated at the reactor inlet. According to historical records in the sanitary sewer system of the city of Tarija for wastewater for domestic use, the values can vary from 150 to 350 mg/L (raw water without treatment).

c) Suspended solids in mixed liquor (SSLM), it is the key factor in the treatment with activated sludge, it is the concentration of suspended solids in the aeration tank, it is mainly composed of microorganisms and non-biodegradable suspended matter [7-8]. The typical variation range is 2000 to 4000 mg/L. [2.8].

d) Suspended volatile solids in mixed liquor (SSVLM), (mg/L) in a sample of mixed liquor will consist mainly of microorganisms and organic matter [4-5]

e) Sludge age (days), is the average residence time of the microorganisms in the reactor [1-8], for a conventional system and without nutrient removal it is between 3 to 15 days.

f) Biocinetic coefficients, characterize the life of the essential microbial mass for the treatment by activated sludge, there are average values that can be used, (Growth coefficient: Y = 0.65 mg SSV / mg BOD; Mortality coefficient: Kd = 0.06 1 / day) but, it is best to define them in the laboratory [6] for each specific project in order to optimize energy costs due to the use of electromechanical equipment. Regarding the electrical energy consumption associated with the artificial aeration of aerobic reactors, this represents the main cost in wastewater treatment. It is estimated that it can reach up to 75% of the operating costs of waste water treatment plant [9].

From the input data, the output variables are simulated:

a) Volume of the reactor (m^3); it is where biological purification processes take place.

b) Hydraulic retention time, the water in the reactor with aeration must remain for a certain time to achieve a high degree of purification [5-8], this value is between 4 and 8 hours according to design recommendations [8-2].

c) Mass load, is the mass flow of substrate, either BOD or COD that is applied to the reactor, this value can be between 0.2 and 0.5 kg BOD 5 / kg MLSS • day.

d) Volumetric load, called organic load, is the mass flow of BOD or QOD per unit of effective volume of the reactor, this value is between 0.5 and 1.5 kg BOD_5 / m^3 • day;

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e) Oxygen needs (kg O_2 / day or in mg / L), oxygen is needed in the reactor for the proliferation of microorganisms, it is supplied by fine bubble diffusers [7], this value must be between 1 and 3 mg/L, higher values do not provide benefit, rather there is an unnecessary consumption of electrical energy especially when the flow decreases and the hydraulic retention time increases.

f) Recirculation Flow (L/s), to maintain a relatively constant quantity of microorganisms (MLSS) in the reactor, it is necessary to recirculate a certain quantity of sludge from the clarifier to the reactor [5-7].

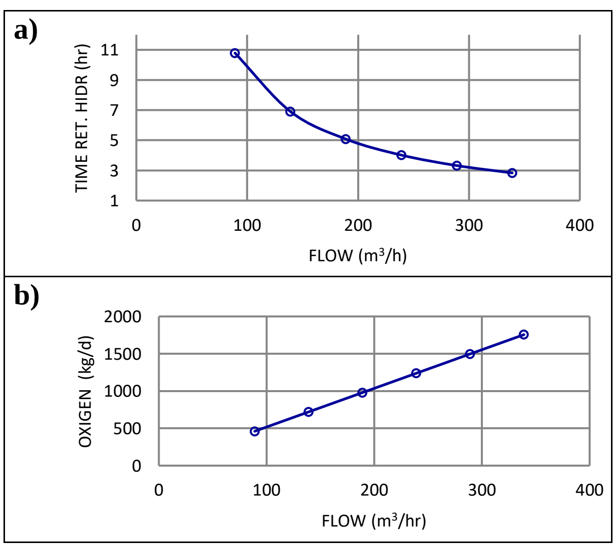
g) Excess sludge. The sludge that is not required to be recirculated is purged to the sludge treatment process in an average amount of 1.68 kg SST / day.

h) Efficiency, measures in percentage the degree of purification of the water that leaves the clarifier with respect to the entrance.

Results

The effects of the input variables foresee analyzing the situation when the reactor is already built, that is, at constant volume. There are other parameters that must be regulated to achieve adequate yields.

Flow effects



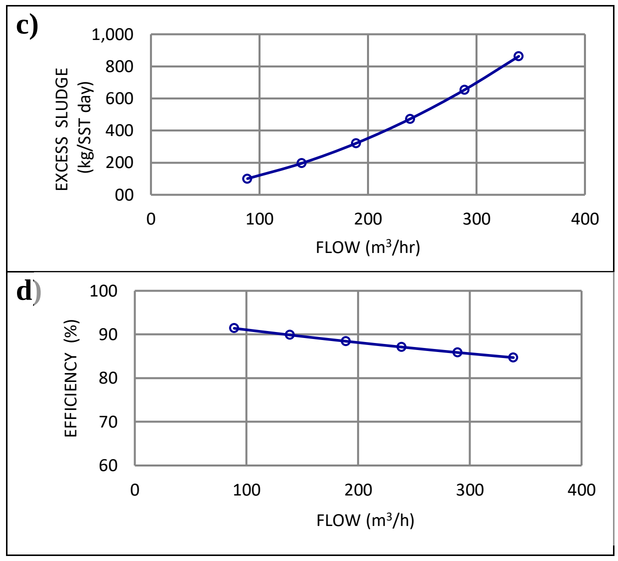


Figure 3 Flow effects: a) Hydraulic retention time; b) Oxygen requirements; c) Excess of sludge; d) Efficiency
Source: Own elaboration

The higher the flow rate (Figure 3a), the retention time decreases in a very sensitive way and affects all other processes, because the water with the organic matter will remain in the reactor for less time and the microorganisms will have less retention time to degrade the organic material. Not all organic matter will be removed, and the effluent will have high BOD_5 values. If the flow rate increases, more oxygen will be needed (Figure 3b), to compensate for the increased volumetric load. The recirculation flow rate increases because more microorganisms are needed, this to maintain a suitable microorganism concentration in the reactor. The amount of excess sludge increases (Figure 3c), this because the volumetric load has also increased. Efficiency decreases (Figure 3d), because if the flow increases for the same volume it causes the hydraulic retention time to decrease, therefore the efficiency decreases. If the volume cannot be expanded, one solution is to increase the recirculation flow and more oxygen injection.

That is why it is important to control the flow that enters the reactor, for this automatic flow meters are used, as necessary, the water is stored in the inlet collector to the plant for times less than the day and the water input is regulated in one or more of the treatment lines.

Effects of BOD

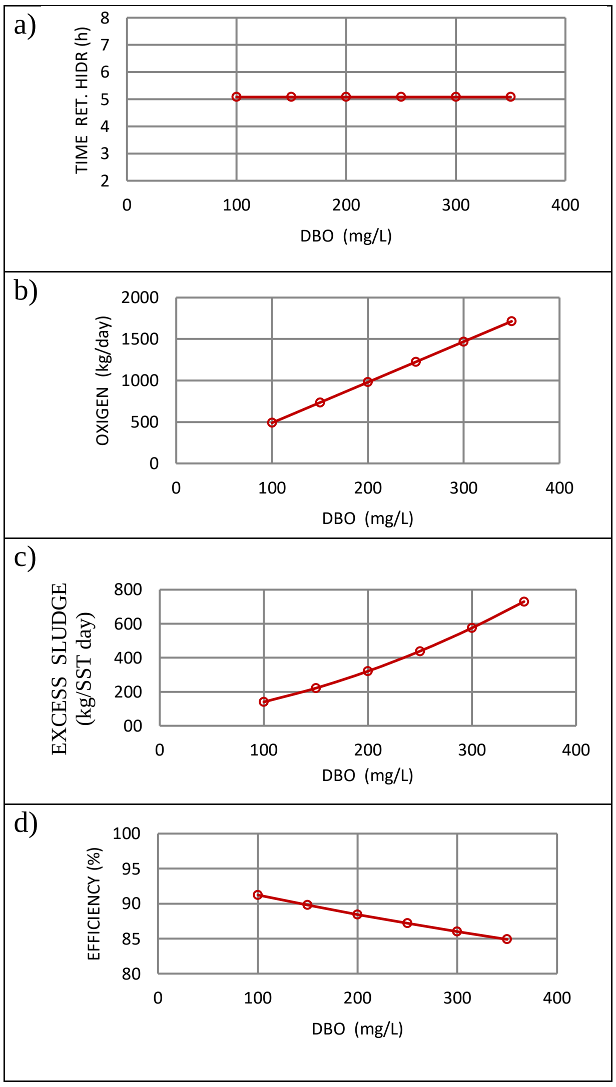


Figure 4 Effects of BOD: a) Hydraulic retention time; b) Oxygen requirements; c) Excess of sludge; d) Efficiency
Source: Own elaboration

The increase in BOD does not affect the hydraulic retention time (Figure 4a) because it only depends on the flow and volume. Given the increase in BOD, and keeping the volume and flow constant, there is a considerable increase in the mass load and the volumetric load. The increase in BOD means more food for the microorganisms, causing an increase in the need for oxygen in a sensible way (Figure 4c), having constant volume and retention time, more work is needed, more energy consumption. It increases the excess sludge (Figure 4c), because a greater amount of organic matter has entered and because the recirculation flow has not changed. There is a drop in efficiency (Figure 4d) due to the increase in the pollutant load and because the retention time cannot be increased. This situation could be improved with an increase in recirculation and an increase in oxygen in the reactor.

Effects of SSLM

The hydraulic retention time only depends on the flow and volume, being these constants, there will be no change in this parameter (Figure 5a). If the reactor volume is constant then the increase in the SSLM does not affect the volumetric load. At a constant volume with an increase in SSLM, an increase in oxygen is not required (Figure 5b) because the mass load is lower, therefore the microorganisms make less effort to degrade organic matter because there is little food. This is an indication that the recirculation flow rate can be lowered. The increase in SSLM produces more excess sludge (Figure 3c) in less time because there are more microorganisms that accelerate the process. The increase in SSML means an increase in the microorganisms in charge of purifying the water, if the volume and flow are constant, there will be a smooth increase in efficiency (Figure 5d).

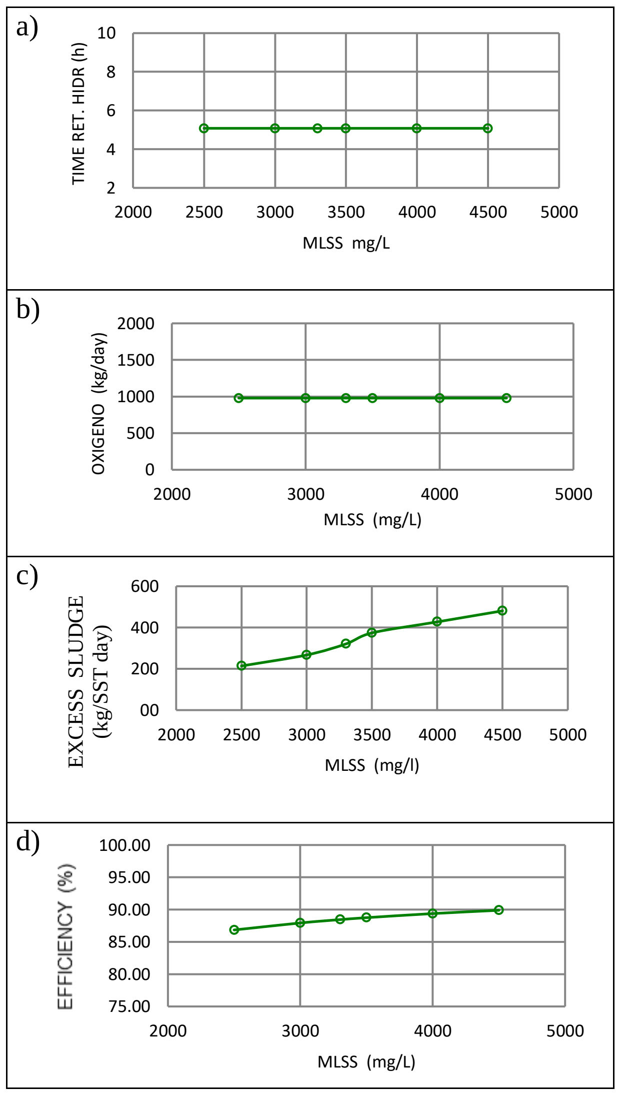


Figure 5 Effects of SSLM: a) Hydraulic retention time; b) Oxygen requirements; c) Excess of sludge; d). Efficiency
Source: Own elaboration

Conclusions

In the analysis of the graphs, it was possible to predict the moments in which the system can present low and high efficiencies.

When the reactor volume is immovable, (in operation) the most important variables according to the analysis of the graphs and bibliographic review are the SSLM that can be regulated with the recirculation flow and the injection of oxygen into the reactor. Efficiency drops with increasing flow rate and increasing BOD; Given the increase in flow and BOD5, the SSML and oxygen are increased in order to maintain efficiencies greater than 90%. For this reason, there must be a balance between the organic load (Q, BOD) with the microorganisms (SSVLM) and oxygen injection.

The BOD arriving at the plant is not controllable; the flow rate can be controlled to some extent by storage in the inlet manifolds and a battery of reactors which come into operation as the flow rate increases; SSLMs are controllable by recirculation flow. To regulate the inflow, it is recommended to implement storage and regulation basins.

The monitoring or measurement of the flow, BOD5 and SSLM at constant volume, in an activated sludge plant in operation is very important because it could be verified that it produces variations in the efficiency of the system and it must be prepared to take the most appropriate actions such as regulation of the inlet flow, regulation of the recirculation flow and regulation of oxygen entering the reactor.

The oxygen that is injected into the reactor through the diffusers must be regulated according to the oxygen needs calculated based on the organic load that enters the reactor. If there is oxygen deficiency, the efficiency will decline and if there is excess oxygen, it does not improve the efficiency, it is maintained and can even decrease since it can impair the good formation of flocs, in addition there is unnecessary electrical energy expenditure. From the analysis of the set of graphs, it can be seen that activated sludge technology has the advantage that it can withstand variations in pollutant load by monitoring the parameters of dissolved oxygen, SSLM, BOD5 and others in order to take the regulatory measures described. in the previous paragraphs.

As future work, it is recommended to carry out simulations in software such as LINX ASM1, AQUASIM and others [3,5,10] making combinations of variation of the input parameters, for example if the flow rate increases and the BOD decreases or vice versa; Simulations of the effect of the presence of nutrients such as nitrogen phosphorus can be carried out, which in adequate quantities are necessary for the proper functioning of the system.

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[Title in Times New Roman and Bold No. 14 in English and Spanish]

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Text in Times New Roman No.12, single space.

General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

Development of headings and subheadings of the article with subsequent numbers

[Title No.12 in Times New Roman, single spaced and bold]

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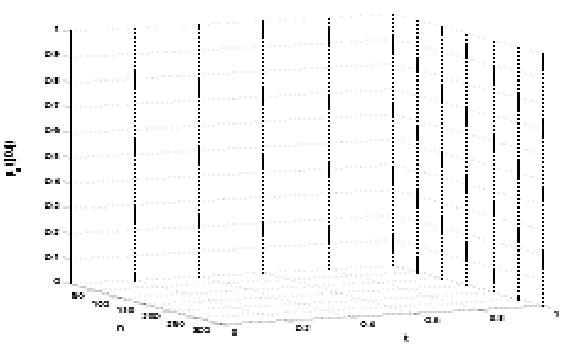

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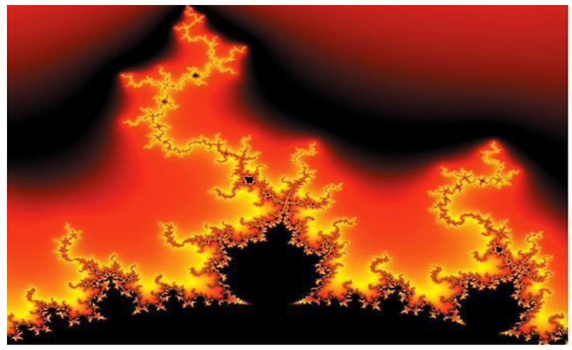

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$$Y_{ij} = \alpha + \sum_{h=1}^{r} \beta_h X_{hij} + u_j + e_{ij} \qquad (1)$$

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Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

The results shall be by section of the article.

Annexes

Tables and adequate sources

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Indicate if they were financed by any institution, University or company.

Conclusions

Explain clearly the results and possibilities of improvement.

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