X IBERO-AMERICAN CONGRESS ON
MEMBRANE SCIENCE AND TECHNOLOGY

VI CONGRESO NACIONAL DE LA
SOCIEDAD MEXICANA DE CIENCIA Y TECNOLOGÍA DE MEMBRANAS, A.C.

PROGRAMA DEL EVENTO

EVENT PROGRAM

Centro de Exposiciones y Congresos
Ciudad Universitaria
Ciudad de México, MÉXICO
22-25 de Mayo de 2016

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18:00-20:00 *Welcome Drinks / Brindis de Bienvenida*

MONDAY, MAY 23rd / LUNES 23 DE MAYO

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09:00-09:30 **OPENING SESSION / INAUGURACIÓN**

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(Chair/Moderador: Dr. G. A. Fimbres Weihs)

09:30-10:30 **GAS SEPARATION MEMBRANES FOR CCS**
Prof. Dianne Wiley, Dr. Minh T. Ho
The University of Sydney (AUSTRALIA)

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Universidad de Cantabria (ESPAÑA)

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Z. Beril Gönder, G. Balcioglu, I. Vergili, Y. Kaya
Istanbul University (TURQUIA)

11:40-12:00 MICROFILTRATION OF OIL IN WATER (O/W) EMULSIONS: EFFECT OF MEMBRANE CHARACTERISTICS ON EMULSION PROPERTIES
V. Carpintero-Tepole (1), E. Brito-de la Fuente (2), B. Torrestiana-Sánchez (1)
(1) Instituto Tecnológico de Veracruz (MÉXICO) – (2) Kabi Innovation Centre (ALEMANIA)

12:00-12:20 PURIFICATION AND CONCENTRATION OF THE MAIN GLYCOSIDES FROM STEVIA REBAUDIANA BY ULTRAFILTRATION AND OSMOTIC DISTILLATION
J. C. Martínez-Alvarado, M.G. Aguilar-Uscanga, B. Torrestiana-Sánchez
Instituto Tecnológico de Veracruz (MÉXICO)

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(Chair/Moderadora: Dra. Beatriz Torrestiana Sánchez)

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J. Ortiz-Espinoza, F. A. Ruiz-Treviño
Universidad Iberoamericana Cd. de México (MÉXICO)

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M. Gastelum-Reyes, G. A. Fimbres-Weihs
Instituto Tecnológico de Sonora (MÉXICO)

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15:30-17:30 Poster Session / Sesión de Carteles

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University of Cantabria (ESPAÑA)

2 ESTUDIO DEL EFECTO DE CONDICIONES DE OPERACIÓN EN LA MICROFILTRACIÓN DE LECHE CON MEMBRANAS ISOFLUX
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Instituto Tecnológico de Tepic (MÉXICO).

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Universidad Nacional Autónoma de México (MÉXICO)

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08:30-09:30 *Registration / Registro*

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(Chair/Moderador: Dr. J. Álvarez Sánchez)

09:30-10:30 **ALGAL BLOOMS AND MEMBRANE-BASED DESALINATION**
Dr. Sergio Salinas Rodríguez, Prof. Dr. Maria D. Kennedy
UNESCO-IHE (NETHERLANDS)

10:30-11:00 *Coffee Break*

Oral Session 3 / Ciclo de Conferencias 3
(Chair/Moderador: Dr. A. Maciel)

11:00-11:20 MICROBIAL DIVERSITY IN THE PRETREATMENT OF A REVERSE OSMOSIS DESALINATION PLANT
M. M. Armendáriz-Ontiveros, G. E. Romero-López, J. Álvarez-Sánchez, S. de los Santos Villalobos, G.A. Fimbres-Weihs
Instituto Tecnológico de Sonora (MÉXICO)

11:20-11:40 SEAWATER DESALINATION BY DIRECT CONTACT MEMBRANE DISTILLATION
A.L. Peñaranda-López, B. Torrestiana-Sánchez
Instituto Tecnológico de Veracruz (MÉXICO)

11:40-12:00 ELABORACIÓN DE MEMBRANAS DE CAPA FINA MEDIANTE POLIMERIZACIÓN EN INTERFASE MODIFICADA: EFECTO DEL NÚMERO DE CAPAS Y DE LA CONCENTRACIÓN DEL MONÓMERO EN LA FASE ORGÁNICA
J. B. Morales-Cuevas, S. Pérez-Sicairos, S. W. Lin-Ho, C. A. González-Cerros, J. Álvarez-Sánchez, N. A. Medellán-Castillo
Instituto Tecnológico de Tijuana (MÉXICO)

12:00-12:20 IONIC LIQUIDS AS A MEDIA FOR BIOMASS PRETREATMENT AND ACETYLATION FOR MEMBRANE PRODUCTION
G. González-Sánchez, K. Ruíz-Cuilty, G. I. Orozco, V. Martínez-Burciaga, A. Camacho, M. Monroy, E. Rodríguez De San Miguel, J. De Gyves, L. Ballinas-Casarrubias
Centro de Investigación en Materiales Avanzados (MÉXICO)

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Oral Session 4 / Ciclo de Conferencias 4
(Chair/Moderador: Dr. G. A. Fimbres Weihs)

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Universidad Autónoma de Chihuahua (MÉXICO)

13:20-13:40 HOLLOW FIBER POLYURETHANE MEMBRANES PRODUCED BY QUADRUPLE SPINNERET TO REMOVE SULFUR COMPOUNDS FROM NAPHTHA BY PERVAPORATION PROCESS
R. A. Amaral (1), A. C. Habert (2), C. Piacsek-Borges (2)
(1) Federal University of Rio Grande do Sul – (2) Federal University of Rio de Janeiro (BRASIL)

13:40-14:00	SYNTHESIS AND CHARACTERIZATION OF HYBRID MEMBRANES BASED ON Ph-m-SPEEKK AND POLYSILOXANES FOR FUEL CELL APPLICATIONS A. Gutiérrez-Sánchez, J. C. Ruíz-Segura, A. L. Ocampo-Flores, E. Rodríguez de San Miguel-Guerrero, J. de Gyves-Marciniak Universidad Autónoma de México (MÉXICO)

14:00-15:30 Lunch /Comida

Oral Session 5 / Ciclo de Conferencias 5
(Chair/Moderadora: Dra. J. A. Bañuelos Díaz)

15:30-15:50	EXTRACCIÓN Y RECUPERACIÓN SELECTIVA DE Cd(II) OBTENIDO DE LA DISGESTIÓN DE UNA BATERÍA Ni/Cd A PARTIR DE MEMBRANAS HÍBRIDAS SEMI-INTERPENETRANTES A BASE DE ADOGEN 364 L. Mora-Tamez, N. M. Munguía-Acevedo, E. Rodríguez de San Miguel, J. de Gyves Universidad Nacional Autónoma de México (MÉXICO)
15:50-16:10	DESIGN OF PROTON EXCHANGE MEMBRANES BASED ON POLYMERIC IONIC LIQUIDS FOR FUEL CELL APPLICATIONS A. Ortiz, M. Díaz, I. Ortiz University of Cantabria (ESPAÑA)
16:10-16:30	OPTIMIZATION OF COPPER EXTRACTION USING A POLYMER INCLUSION MEMBRANE (PIM) BASED ON KELEX-100 AS CARRIER E. A. Rodríguez Morales, E. Rodríguez de San Miguel Guerrero and J. de Gyves Marciniack Universidad Nacional Autónoma de México (MÉXICO)
16:30-16:50	Cd(II) ANALYSIS IN WATER SAMPLES USING POLYMER INCLUSION MEMBRANE SORPTION COUPLED TO SPECTROSCOPIC METHODS E. Rodríguez de San Miguel Guerrero, R. González-Albarrán, J. de Gyves y Marciniak Universidad Nacional Autónoma de México (MÉXICO)

18:00-21:00 Conference Banquet / Cena de gala

WEDNESDAY, 25th MAY / MIÉRCOLES 25 DE MAYO

08:30-09:30 *Registration / Registro*

Plenary lecture 3 / Conferencia Plenaria 3
(Chair/Moderador: Dr. M. Torres Rodríguez)

09:30-10:30
MEMBRANE TECHNOLOGY AND SOCIETAL CHALLENGES IN THE 21ST CENTURY
Dra. Inmaculada Ortiz Uribe
Universidad de Cantabria (ESPAÑA)

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Oral Session 6 / Ciclo de Conferencias 6
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EFFICIENT REMOVAL OF CHROMATE AND ARSENATE BY POLYMER-ENHANCED ULTRAFILTRATION
J. Sánchez, B. L. Rivas
University of Concepción (CHILE)

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TRATAMIENTO DE DESCARGAS ACUÍCOLAS EN UN BIORREACTOR DE MEMBRANAS SUMERGIDAS: REUSO DE AGUA Y NUTRIENTES
J.C. Orantes, I. Negra-Jiménez y A. Munro
Universidad Michoacana de San Nicolás de Hidalgo (MÉXICO)

11:40-12:00
POPULATION AND DIVERSITY OF MARINE BACTERIA, AND ITS RELATION TO PHYSICOCHEMICAL PARAMETERS OBSERVED IN CORTES SEA
G.E. Romero-López, S. De los Santos-Villalobos, G.A. Fimbres-Weihs, J. Álvarez-Sánchez
Instituto Tecnológico de Sonora (MÉXICO)

12:00-12:20
TRATAMIENTO DE UN EFLUENTE INDUSTRIAL TÓXICO MEDIANTE UN PROCESO DE MEMBRANA CON UF MICELAR ASISTIDA
P. S. Zaragoza-López, C. R. Muro-Urista, M. C. Díaz-Nava, J. C. González-Juárez
Instituto Tecnológico de Toluca (MÉXICO)

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Oral Session 7 / Ciclo de Conferencias 7
(Chair/Moderador: Mtro. Vicente Esquivel Peña)

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RECUPERACIÓN DE Cr(III) DE EFLUENTES DE CURTIDURIA POR MEDIO DE ULTRAFILTRACIÓN ASISTIDA POR FORMACIÓN DE COMPLEJOS (UFAC) UTILIZANDO POLIACRILAMIDA COMO ACOMPLEJANTE
M. del P. González-Muñoz, Ll. P. Medina-Armenta, T. I. Saucedo-Medina, R. Navarro-Mendoza, T. A. Razo-Lazcano, M. Ávila-Rodríguez
Universidad de Guanajuato (MÉXICO)

13:20-13:40
CROSS-FLOW MICROFILTRATION OF A CONCENTRATED O/W EMULSION USING MICROSIEVES OF DIFFERENT PORE SIZES
V. Carpintero-Tepole (1), E. Brito-de la Fuente (2), B. Torrestiana-Sánchez (1)
Instituto Tecnológico de Tepic (MÉXICO)

13:40-14:00	CHARACTERIZATION OF MICROBIAL COMMUNITIES IN AnMBR TREATING PHARMACEUTICAL WASTEWATER Y. Kaya, G. Balcioglu, G. Yilmaz, I. Vergili, Z. B.l Gänder, H. Hasar Istanbul University (TURQUIA)
14:00-14:20	**CLOSING CEREMONY / CLAUSURA**
14:20-15:30	*Lunch / Comida*

PLENARY LECTURES

CONFERENCIAS PLENARIAS

GAS SEPARATION MEMBRANES FOR CCS

D. E. Wiley*, M. T. Ho

School of Chemical and Biomolecular Engineering, The University of Sydney, Australia
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Despite the research effort over the last 10 years, significant development of gas separation membranes is still required in order to drive down their costs and enhance their performance for CCS (Carbon Capture and Storage). Membranes for CCS find application in three main areas: separating and concentrating CO_2 directly (i.e. CO_2 capture in post-combustion, pre-combustion or oxyfiring applications); removing other components from the gas mixture thereby concentrating CO_2 (e.g. removing H_2 from syngas); and, excluding N_2 from a combustion mixture thereby producing a stream with higher CO_2 concentration (e.g. through the use of an oxygen or ion transport membrane). This presentation provides an overview of the research and development fronts that are likely to deliver the greatest benefits for CCS in these three areas. The focus will be on membrane properties and operating requirements as well as key factors that affect the commercial viability of gas separation membranes in comparison with state-of-the-art competitor processes.

ALGAL BLOOMS AND MEMBRANE-BASED DESALINATION

M. D. Kennedy, S. Salinas-Rodríguez*

UNESCO-IHE Institute for Water Education, Environmental Engineering and Water Technology Department, Delft, The Netherlands

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Seawater membrane-based desalination technology has been rapidly growing in terms of online installed capacity (~25 million m^3/day as of 2015), plant size and global application. However, seawater reverse osmosis (SWRO) systems are prone to operational problems such as membrane fouling and clogging of the membrane spacers. To minimize fouling and clogging, pre-treatment of seawater is necessary upstream of the SWRO system. The pre-treatment in most SWRO plants, comprise coagulation followed by granular media filtration (GMF) pre-treatment. In recent years, however, ultrafiltration (UF) is increasingly being used as a preferred alternative to GMF. As more extra-large SWRO plants (>500,000 m^3/day) are expected to be installed over the coming years, frequent chemical cleaning (>1/year) of the SWRO will be unfeasible and installing a reliable pre-treatment system will be even more important.

An emerging threat to SWRO is the seasonal proliferation of microscopic algae in seawater called algal blooms. These natural phenomena can potentially occur in most coastal areas of the world where SWRO plants are installed. Recent severe algal bloom outbreaks in the Middle East region in 2008 and 2013 have caused clogging of GMF pre-treatment systems which also resulted in inacceptable quality (silt density index, SDI>5) of GMF effluent. The latter eventually led to temporary shutdown of several SWRO plant mainly due to concerns of irreversible fouling of the downstream SWRO membranes. The poor performance of GMF during algal blooms has shifted the focus of the desalination industry to UF as a main pre-treatment for SWRO.

The potential problems which may occur in membrane-based desalination plants (UF pre-treatment followed by SWRO) during treatment of algal bloom impaired waters are: (1) particulate fouling in UF due to accumulation of algal cells and their detritus, (2) organic fouling in UF or RO due to accumulation of AOM, and (3) biological fouling in RO initiated and/or enhanced by AOM. These potential issues are addressed in this lecture.

MEMBRANE TECHNOLOGY AND SOCIETAL CHALLENGES IN THE 21ST CENTURY

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Many countries struggle with the consequences of unsustainable growth programmes, affecting the climate, people and natural resources. On September 25th 2015, UN countries adopted a set of goals to end poverty, protect the planet, and ensure prosperity for all as part of a new sustainable development agenda. Each goal has specific targets to be achieved over the next 15 years where a prominent role of science and technology is mandatory. Energy, medicine and health, clean air and water, transportation, sanitation, management use and conservation of natural resources – all are based ultimately in science and technology.

Owing to their versatility and immense potentials to evolve scientific and technical innovations, membrane technology is probably one of the most prominent strategies that have gained growing scientific and public recognition to provide solutions that can extend the limits of sustainability in some of the 21st Century Societal Challenges.

Different study cases that provide insight into the roles of new membranes and innovative membrane processes in 1) facilitating new water sources, 2) increasing the efficiency in the use of natural resources, 3) helping food security and, 4) facilitating energy security and sustainability will be presented.

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INDUSTRIAL APPLICATIONS OF MEMBRANE TECHNOLOGY

APLICACIONES INDUSTRIALES DE LA TECNOLOGÍA DE MEMBRANAS

Oral Session 1

Oral Session 7

ADVANCED TREATMENT OF CARWASH WASTEWATER WITH THE COMBINATION OF ELECTROCOAGULATION AND NANOFLITRATION PROCESS

Z. Beril Gönder*, G. Balcioğlu, I. Vergili, Y. Kaya

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Car washing requires a large amount of water and the use of chemicals that results in wastewater with a high concentrations of oils, greases, surfactants, waxes, salts and dusts. Increasingly stringent regulations and rising water prices are forcing the carwash industry to develop efficient treatment methods to reclaim the wastewater [1]. Nanofiltration (NF) process is frequently used for water and wastewater treatments with the aim of water reuse. Nevertheless, the main operational problem is membrane fouling for this process which may leads to an increase in operational costs. So, NF should be used with adequate pretreatment method to reduce membrane fouling and improve permeate quality especially for the wastewaters with high solid concentrations. Recently, electrocoagulation (EC) has been applied prior to other treatment processes for the pretreatment of wastewaters. In literature, until now only a few studies have been investigated car wash wastewater with membrane process [2-4], there has been no study about integrated EC-NF process. In this study, the use of two-step process consisting EC and NF in the treatment of real carwash wastewater was investigated with the aim of reuse. In the first step, the effect of operating conditions such as temperature, stirring speed and electrode connection mode on pollutant removal for EC process was investigated. The anode sludge was analyzed using environmental scanning electron microscopy-energy dispersive index (ESEM-EDX) and size distribution measurements. In the second step, cross-flow NF filtration process was applied for further treatment using NF 270 and Desal 5DL membranes. NF filtration experiments were performed by a lab-scale plant in concentration mode of filtration (CMF). Membrane fouling mechanism was evaluated using contact angle, optic profilometer, Fourier transform infrared (FTIR) spectroscopy measurements. EC system was constructed from plexiglass having a dimension of 11×11×10 cm. Iron (Fe) plates (5×5×0.2 cm) were used as sacrificial electrodes. EC experiments were carried out at pH 8, 30 A/m^2 for 30 minutes. The highest removal efficiencies were obtained at 25^0C, 250 rpm with monopolar parallel connection mode for EC treatment. In the first step of the treatment, 88% COD, 89% oil-grease, 91% surfactant and 50% chloride removals were obtained with EC process under the optimum operating conditions. Desal 5DL membrane was determined as appropriate membrane for the second step of treatment according to relatively higher rejection performance especially for chloride and conductivity parameters. It was observed that the permeate was free from suspended solids, sulphate, surfactant, oil-grease and fecal coliform. In addition, COD, chloride and conductivity removal were obtained as >96%, 90% and 80%, respectively. As a conclusion, the experimental results indicated that EC treatment followed by NF process was very effective for advanced treatment of carwash wastewaters.

References

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Acknowledgments

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MICROFILTRATION OF OIL IN WATER (O/W) EMULSIONS: EFFECT OF MEMBRANE CHARACTERISTICS ON EMULSION PROPERTIES

V. Carpintero-Tepole[1], E. Brito-de la Fuente[2], B. Torrestiana-Sánchez[1]

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In the pharmaceutical industry, oil-in-water (O/W) emulsions are used as an effective delivery vehicle for essential fats and energy [1]. The incompatibility of nutrients during sterilization can result in emulsion degradation and instability [2]. Hence, there is a need to search for new alternatives that allow processing O/W emulsions in the pharmaceutical industry. The cold sterilization process based on microfiltration (MF) might be an alternative, since it has been used in the food industry to reduce the microbial load while keeping the physicochemical properties of whole milk and skim milk [3, 4]. Thus in this work, oil in water emulsions with different oil phase concentrations (10 to 30 V/V %) were processed by using microfiltration membranes having different nature (organic, inorganic), microstructure (anisotropic, isotropic) and pore sizes. The effect of the pore size and the internal microstructure of membranes on the physicochemical properties of the emulsions were assessed by drop size distribution, zeta potential, pH and rheological measurements. The number of drops found in emulsions having different oil concentrations was also estimated in order to associate this parameter with the breaking phenomenon occurred during membrane filtration. Results showed that the physicochemical properties of the concentrated O/W emulsions remained unaltered only when using polycarbonate track etched isotropic membranes of pore sizes ≥ 0.4 and 0.26 μm microsieves. These results are explained in terms of the internal microstructure of these membranes. Otherwise, performance in terms of permeate flux was shown to be a function of the d_{drop}/d_{pore} ratio when processing emulsions with the isotropic membranes, but not with the anisotropic membranes tested.

References

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PURIFICATION AND CONCENTRATION OF THE MAIN GLYCOSIDES FROM *STEVIA REBAUDIANA* BY ULTRAFILTRATION AND OSMOTIC DISTILLATION

J. C. Martínez-Alvarado, M.G. Aguilar-Uscanga, B. Torrestiana-Sánchez

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The demand of sweeteners from Stevia (*Stevia rebaudiana Bertoni*) has nowadays increased in the food market due to the non-caloric nature of steviol glycosides. The steviol glycosides content in stevia leaves varies between 4% and 20% dry weight depending on the variety and growing conditions of the plant [1]. Hence, several purification steps are required to efficiently isolate and purify the glycosides of commercial interest. A general membrane process to purify steviol glycosides includes microfiltration (MF) or centrifugation to clarify the aqueous extract; followed by ultrafiltration (UF) to isolate and purify the main glycosides, and nanofiltration (NF) as a final concentration step [2,3]. Hence, different membranes and module configurations have been used and a wide range of operating conditions explored. However, most of the times a rather significant flux decline (up to 80%) is observed over time as well as low yield recoveries and purity values obtained. Hence, there is a need to establish conditions to ensure sustainable flux in the membrane purification process as well as to increase yield recovery and purity of steviol glycosides.

In this work, the purification of the two main glycosides (Stevioside and Rebaudioside-A) from the stevia extract was carry out under sustainable flux with membranes having different molecular weight cut-offs. In order to do that, different hydrodynamic conditions were evaluated to find the best compromise between working under sustainable flux and having less impurities in the extract. In addition, principles from high performance tangential flow filtration and continuous diafiltration were applied in order to increase yield recovery and to reduce operation time. In the concentration step an emergent membrane technology (i.e. osmotic distillation) was used to concentrate the purified steviol glycosides. Results indicate that the experimental strategy applied in this work allow operating the ultrafiltration process under sustainable flux conditions for long period times and selecting a membrane to remove more color and suspended solids than those reported in literature, while keeping >80% yield recovery of glycosides. Otherwise, results from the concentration step showed that the loss of heat between solutions flowing on either side of the membrane drastically influenced performance of the osmotic distillation process. Despite of that, experimental conditions were established to concentrate the purified stevia extract up to ten times.

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CROSS-FLOW MICROFILTRATION OF A CONCENTRATED O/W EMULSION USING MICROSIEVES OF DIFFERENT PORE SIZES

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Oil-in-water (O/W) pharmaceutical emulsions are considered as long-chain triglyceride emulsions derived from purified soybean oil and egg yolk phospholipids [1,2]. They are commercially available in different formulations [3] and are produced using state of-the-art equipment and under current good manufacturing practices (cGMP) [4]. The sterilization of these emulsions is currently conducted by autoclaving, but this is related to degradation of labile components and storage instability [5]. In our research group, the filtration of O/W emulsions was carried out by using "*microsieves*" in a dead-end microfiltration (MF) system without affecting their physicochemical properties. However, when O/W emulsions with an oil concentration ≥ 20% were tested, some droplets remained onto the membrane surface and increased hydraulic resistance. An alternative to reduce fouling and provide an effective membrane cleaning is operate under cross-flow combined with antifouling techniques such as back-pulsing [6]. In this work the effect of using an antifouling technique during the cross-flow microfiltration of a 20% O/W emulsion was studied with microsieves of different pore sizes (0.26, 0.35, 0.5 and 0.8 µm). The physicochemical properties of the emulsion before and after filtration were evaluated in terms of drop size distribution, zeta potential, pH and rheological measurements. Results showed that cross-flow and back-pulsing provided an effective cleaning of microsieves during the process and improved performance by keeping long term sustainable flux values. In addition, permeation rates between 700 and 10,000 L m^{-2} h^{-1} were obtained without affecting the physiochemical properties of the emulsion. These flux values are up to two orders of magnitude higher than those reported for microfiltration of O/W emulsions.

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CHARACTERIZATION OF MICROBIAL COMMUNITIES IN AnMBR TREATING PHARMACEUTICAL WASTEWATER

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The anaerobic treatment processes are commonly preferred for the pharmaceutical wastewater because of high level of chemical oxygen demand (COD) concentrations. But, pharmaceutical wastewater is generally characterized by high toxicity, salinity and the presence of refractory compounds, which limit its biodegradability. The stable formation of microbial aggregates can be limited due to these characteristics of wastewater. Also, the content of pharmaceutical wastewater influences microbial diversity, quantity and physical properties of microorganisms in the anaerobic systems. Anaerobic membrane bioreactors (AnMBRs) are alternative to concentrate degranulated active biomass because of toxicity occurred in anaerobic systems [1,2]. The aim of this study was the carry out an evaluation of microbial diversity (acidogenic, methanogenic and sulfate reducing bacteria (SRBs)) depending on the organic loading rate (OLR) changes in the AnMBR treating pharmaceutical wastewater. The wastewater was taken from a pharmaceutical plant which produces etodolac with the chemical synthesis. Real-time Polymerase Chain Reaction (Q-PCR) and Fluorescent in situ Hybridization (FISH) analysis were carried out to determine microbial population in AnMBR. The AnMBR was operated at pH 7, temperature 35 °C, reactor volume 4 L and infinite sludge retention time for 725 days. COD was gradually increased from 2500 mg/L to 15.000 mg/L with time. According to Q-PCR results, *Methanobacteriales* (MBT) and *Methanosarcinales* (MSL) were detected as dominant archaea in the experiments conducted with COD of 2500 mg/L and 5000 mg/L. Increased after COD of 5000 mg/L, archaea genuses (MBT and MSL) were not almost observed but SRB genus (SRB, dsrA gene and desulfovibrio) were detected in the reactor. The AnMBR was operated up to 15.000 mg/L of COD, but the high concentration of sulphite caused to inhibition starting from 7500 mg/L of COD. Pre-ozonation was applied to the influent of AnMBR to be oxidized sulphite to sulphate. After pre-ozonation, MSL were redetected but SRB genuses were still found as dominant microbial community in the system. In addition, *Bacteroidetes* were found more dominant than *Firmicutes* between acidogenic genus during 725 days. FISH images were also supported that SRB genuses were dominant and caused that distinctive flocs structure. But, methanogenic activity was affected due to increase of H_2S in the AnMBR.

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INDUSTRIAL APPLICATIONS OF MEMBRANE TECHNOLOGY

APLICACIONES INDUSTRIALES DE LA TECNOLOGÍA DE MEMBRANAS

Poster Session

ESTUDIO DEL EFECTO DE CONDICIONES DE OPERACIÓN EN LA MICROFILTRACIÓN DE LECHE CON MEMBRANAS ISOFLUX

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La producción de queso fresco con leche bronca, permanece entre las preferencias de consumidores, sin embargo, en Nayarit se ha reportado que en 10% de los quesos frescos se podría encontrar *Brucella* spp [1]. La filtración tangencial con membranas cerámicas ha demostrado la reducción del conteo total de bacterias y esporas en leche, dentro de éstas las membranas ISOFLUX® se han propuesto como una alternativa eficaz para la pasteurización de leche por efecto de un gradiente de espesor en la capa activa de filtración [2]. El objetivo de esta investigación fue evaluar las condiciones de operación en un sistema de microfiltración con membranas ISOFLUX® para obtener leche de vaca descremada microbiológicamente estable por un periodo superior al de leche bronca descremada. Se utilizó leche bronca de productores locales en Tepic, Nayarit. Se aplicó un diseño experimental factorial fraccionado 3 [3], en donde los factores y niveles fueron velocidad de recirculación (VR) (5, 5.5, 6 $m \cdot s^{-1}$), temperatura (T) (30, 40, 50 °C) y presión transmembrana (PTM) (0.5, 1, 1.5 Bar). Se estandarizaron 260 L de leche de vaca mediante un prefiltrado (75 µm) y descremado a 10 °C (9000 rpm). Se determinó, acidez titulable (AT) % de grasa (G), sólidos no grasos (SNG), densidad (D), % lactosa (L), % proteína (P), punto crioscópico (PC) y pH con una unidad de análisis de leche Lacticheck MINI™ (Page and Pederson, MA. USA); cuenta estándar (CE) y coliformes totales (CT) se realizaron según NOM-184-SSA1-2002. Se separaron 9 lotes de leche y se microfiltraron en un piloto provisto de una membrana cerámica (TiO_2) ISOFLUX®, con diámetro de poro 1.4 µm, área total de filtración de 0.35 m^2. Se determinó el flux, que es la relación del volumen permeado por unidad de tiempo y unidad de área de filtración ($L \cdot h^{-1} \cdot m^2$). Los resultados se analizaron en el programa estadístico STATISTICA v.8 donde se evaluó el efecto de las condiciones de operación (ANOVA α=0.05), una prueba LSD, se aplicó la metodología de superficie de respuesta, y un estudio de perfiles de respuesta deseables (PRD) para determinar las condiciones óptimas de operación. A estas condiciones y un lote adicionado con 5% p/v de fructanos AGP se les determinó estabilidad microbiológica, donde se evaluaron diariamente por 5 días los análisis proximales y microbiológico ya descritos. El análisis proximal de la leche estandarizada fue: AT= 1.75 ±0.05 g/L, G= 0.97 ±0.1%, SNG= 8.17 ±0.15%, D= 1.25 ±0.05 g/mL, L= 4.45 ±0.2%, P= 2.82 ±0.15%, PC −0.433 ±0.001 °C y pH 6.66 ±0.01. Se determinó el recuento inicial de CT en 6.6 Log_{10} y CE 7.4 Log_{10}. El mayor flux lo alcanzaron los tratamientos con la T más alta (50 °C), 370, 380, y 411 ($L/h \cdot m^2 \cdot bar$) respectivamente. Estadísticamente no se encontró efecto significativo de los tratamientos sobre AT, G, SNG, D, PC, y pH. Sin embargo, VR afectó P y L siendo los tratamientos VR más baja (5 m/s) los que presentaron mayor permeación de estos compontes (P = 97.41 ± 1.78%, L= 98.76 ± 0.78), el PRD arrojó condiciones óptimas en VR=5 $m \cdot s^{-1}$, T=50 °C, PTM=1.25 bar. El recuento y análisis estadístico de CT y CE, arrojó que T y VR tienen efecto significativo sobre los tratamientos. No se encontró diferencia significativa entre los tratamientos 4, 5, 7 y 9 los cuales superaron una reducción logarítmica de 5 Log_{10} (5.1 ± 0.4 Log_{10}) para CT y 4 Log_{10} (4.2 ± 0.3 Log_{10}) para CE lo cual indica que el proceso tiene un efecto análogo a una pasterización convencional[3] en la reducción de CT. El PRD arrojó que las mejores condiciones para estas respuestas (CT y CE) son a VR=6 $m \cdot s^{-1}$, T=30 °C, PTM=1.5 bar. Se optó por definir como mejores condiciones, las encontradas en la reducción logarítmica de moo, debido a que ésta es un factor determinante en los objetivos de investigación. Se determinó estabilidad microbiológica de

5 días para el tratamiento óptimo y de 4 días para el óptimo adicionado con fructanos según el límite de ácido láctico (2.19 g/L).

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EVALUATION OF ULTRAFILTRATION PROCESS FOR TREATMENT OF NEJAYOTE

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The Nixtamalization wastewaters (NWs) are a by-product of food processing industry. The extract is produced from maize processing industry by a common Nixtamalization process applied to maize as pretreatment in order to have more manageability of the grains during their post processing [1]. Nejayote and this is an important contributor to environmental pollution, but an alternative treatment is by membrane process. The aim of this study was to evaluate a membrane process as ultrafiltration to recover high added value compounds as well as avoid the water and environmental pollution by effluent. The narrow membrane (1 kDa) presented high retention values (R_i) on TSS (100%), TSC (77.58%), carbohydrates (75.77%), turbidity (30.76%) and TOC (79.98%); however, the membrane presented low retention (1.90%) in polyphenols.The recovery of chemical components by membrane technology is a real approach to the treatment of food wastewaters as well as seems to be a valid tool on food industry for processing aqueous systems. In addition, the fractionation of NWs using a narrow membrane supports the contribution to avoid the environmental pollution by food wastes.

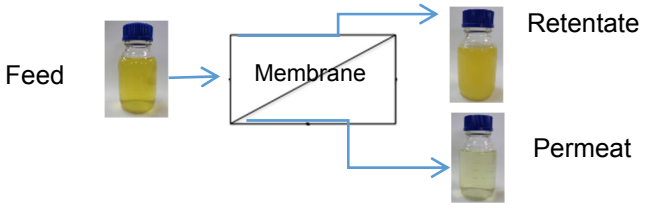

Figure 1. Samples of Nejayote before and after processing by ultrafiltration (1kDa)

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GAS SEPARATION

SEPARACIÓN DE GASES

Oral Session 2

ENTRECRUZAMIENTO DE MEMBRANAS POLIMÉRICAS MEDIANTE TRATAMIENTO TÉRMICO PARA EVITAR LA PLASTIFICACIÓN

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Se han medido propiedades de transporte de CO_2 puro y algunos gases ideales en un polímero que se ha entrecruzado vía tratamiento térmico, PNC-CH≡CH. El polímero se preparó mediante la polimerización de isatina y bifenilo, el cual posteriormente se hace reaccionar con bromuro de propargilo para obtener el PNC-CH≡CH. Tres diferentes tratamientos térmicos se emplearon para llevar a cabo el entrecruzamiento (80 °C – 24 h / 150 °C – 24 h), (80 °C – 24 h / 170 °C – 24 h) y (80 °C – 24 h / 170 °C – 24 h). Los coeficientes de permeabilidad se incrementan en promedio 30% a medida que se eleva la temperatura de para llevar acabo el entrecruzamiento, sin observar pérdidas significativas en la selectividad hacia pares de gases. Pruebas de solubilidad muestran que el polímero entrecruzado es insoluble en solventes como cloroformo y NMP, por lo que se espera que éste tratamiento disminuya el fenómeno de plastificación de sus membranas.

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GAS SEPARATION

SEPARACIÓN DE GASES

Poster Session

PROPANE/PROPYLENE SEPARATION THROUGH FACILITATED TRANSPORT COMPOSITE MEMBRANES

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Separation of olefin/paraffin gas mixtures from refinery processes off-gases has been traditionally performed by cryogenic distillation, which is a highly capital and energy intensive operation. To overcome this handicap, process intensification through facilitated transport composite membranes is proposed in this work.

Previous works of our research group reported the use of facilitated transport composite membranes integrating the use of PVDF-HFP polymer, $BMImBF_4$ ionic liquid and $AgBF_4$ silver salt. In this type of membranes, the silver cations react selectively and reversibly with the olefin, allowing the separation via mobile and fixed carrier mechanisms. Ionic liquids are used as membrane additives because in addition to their negligible vapor pressure that avoids solvent losses by evaporation, they provide stability to the metallic cation dissolved inside, acting as a medium for facilitated transport with mobile carrier. This technology offers a commercial attractive separation alternative thanks to their modular form of operation, high values of selectivity and permeability, and low operational costs.

In the present work, continuous flow propane/propylene permeation experiments were conducted at several experimental conditions and membrane compositions. Moreover, basing on the experimental data collected, a mathematical model description of the system is proposed fitting the remaining parameters. This will allow the design and optimization of the propane/propylene separation process at industrial levels.

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SÍNTESIS Y CARACTERIZACIÓN DE COPOLIAMIDAS AROMÁTICAS COMBINANDO GRUPOS PENDIENTES VOLUMINOSOS

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La incorporación de grupos pendientes voluminosos en la cadena principal de poliamidas aromáticas es una estrategia para mejorar sus propiedades de solubilidad y de transporte de gases, entre otras [1]. En el presente trabajo se reporta la síntesis y caracterización de nuevas copoliamidas aromáticas conteniendo *tert*-butil y dibenzobarreleno, como grupos pendientes voluminosos. Estas copoliamidas fueron sintetizadas mezclando el ácido 5-*tert*-butilisoftálico (TERT) y el ácido 5-(9,10-dihidro-9,10-etanoantraceno-11,12-dicarboximido) isoftálico (DEAIA) [2] (1:1 relacion molar), los cuales se hicieron reaccionar con tres diaminas comerciales por el metodo de policondensación de Yamazaki [3]. Todas las copoliamidas formaron fibras al ser precipitadas en metanol y fueron capaces de formar membranas en dimetilformamida (DMF) por el método de evaporación de disolvente. Las copoliamidas aromáticas obtenidas fueron caracterizadas por FTIR, ^{1}H-NMR, DSC, TGA, solubilidad, viscosidad inherente, densidad, pruebas mecánicas y se evaluó sus propiedades de transporte a gases puros en una celda de permeación de volumen constante a 35 °C y 2 atm de presión.

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SYNTHESIS, CHARACTERIZATION ANG GAS TRANSPORT PROPERTIES OF AROMATIC POLY AND COPOLYAMIDES BEARING BULKY FUNCTIONAL GROUPS

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Membrane technology has received significant attention as an environmentally friendly and economical gas separation technology. Among the various materials used for gas separation membranes, aromatic polyamides have been widely studied due to their outstanding thermal and mechanical resistance [1,2]. In this work, we report the synthesis and characterization of a novel polyaramide poly(hexafluoroisopropylidene hydroxyisophthalamide) (**PA**) bearing -OH group in the main polymer chain and the effect that random copolymerization of bulky substituents have on this aramide chemical in physical properties. Two syntheses of random copolyaramides were carried out: *a*) by direct polycondensation of the diamine 4,4'-(hexafluoroisopropylidene) dianiline (HFA) with different comonomer ratios of 5-tert-butylisophthalic acid (TERT) and 5-hydroxyisophthalic acid (HIA) and *b*) by a consecutive mild esterification reaction of **PA** to introduce 3,5-bis(trifluoromethyl) benzoyl (BTFB) bulky pendant groups via reaction with the free -OH groups in **PA** main chain. All the synthesized polyamides and copolyamides are readily soluble in organic solvents and present high thermal stability up to 400 °C. It was found that combination at random of -OH groups with TERT or BTFB groups in copolymers **CPA 1** and **CPA 2** was very effective for increasing *FFV*, polymer interchain distance and for improving gas permeability (*P*) for all tested gases (CO_2, O_2, N_2, CH_4) and selectivity (α) for CO_2/CH_4 and CO_2/N_2. In particular, copolymer **CPA 2b** containing -OH and BTFB groups, exhibited high gas permeability and good selectivity (P_{CO2} = 60.17 and P_{CH4} = 2.67, α = 22.53). A comparison with other polyamides and polyimides indicates that bulky group substitution tends to improve both selectivity and permeability overcoming the usual trade off for gas separation.

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MODELLING AND SIMULATION OF MEMBRANE PROCESSES

MODELADO Y SIMULACIÓN DE PROCESOS DE MEMBRANA

Oral Session 2

CFD STUDY OF OPTIMAL FREQUENCY PULSATILE FLOW FOR MASS TRANSFER ENHANCEMENT IN SPACER-FILLED RO MEMBRANE CHANNELS

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In order to address the shortage of water around the world, reverse osmosis (RO) desalination technology has proved be an effective and reliable option. This process has disadvantages such as the gradual fouling of the membrane. One of the major drawbacks of RO technology is the formation of a layer of high concentration near the membrane surface. This phenomenon is commonly referred to as concentration polarization. It reduces the flux of solvent trough the membrane and accelerates the onset of fouling. The effect of concentration polarization is partly mitigated by the spacer nets also used to keep the membrane leaves apart in spiral wound membrane (SWM) modules. The presence of spacers promotes flow instabilities and increases mixing [1]. As the Reynolds number increases, the flow pattern in the channel changes from "steady" to "oscillating" to "vortex shedding" flow [2]. Forcing oscillating perturbations in the membrane channel (by means of electro-osmosis or pulsatile flow) can induce the shedding of vortices generated by the spacer filaments [3]. This phenomenon can occur at Reynolds numbers lower than those at which vortex shedding occurs without external perturbations. This work uses computational fluid dynamics (CFD) simulation techniques to evaluate a 2D model of a membrane channel with flow obstructions (spacers), representative of a SWM module. The aim of the present work is to explore the relationship between vortex characteristics, pressure drop and mass transfer enhancement under pulsatile flow. With this objective, data from multiple parametric simulations are analyzed. The cases model a pulsating feed for varying Reynolds numbers, both below and above the unperturbed transition to unsteady flow. Mass transfer enhancement with pulsatile flow is found to promote the vortex shedding flow regime under specific perturbation frequencies, leading to enhanced mass transfer. However, the pressure drop also increases as the instabilities in the flow are promoted. The results show that although the increase in energy costs at the same permeate flux is lower for pulsatile flow than for increasing the feed flow rate, the optimal pulse frequency may not necessarily be the one at which mass transfer is maximized. This is because pressure drop is also maximized at the "peak" frequency, but significant mass transfer enhancement can be achieved at much lower pressure drop if the oscillating frequency is slightly off the peak.

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MEMBRANE PROCESS ENGINEERING

INGENIERÍA DE PROCESOS DE MEMBRANA

Poster Session

PHYSICO-CHEMICAL PARAMETERS OF XOCONOSTLE (*OPUNTIA JOCONOSTLE)* JUICE CLARIFIED BY MEMBRANE FILTRATION

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Cactus pear crops are an important fruit in semiarid regions in Mexico [1]. However, membrane process and physical-chemical parameters have not been studied. A proposition for a membrane process in the production of a native Mexican cactus (Xoconostle) is discussed in this study. The Xoconostle juice was clarified by cross-flow ultrafiltration (UF) using tubular polysulfone membranes. The viability of the process was analyzed in terms of productivity (flux permeate of 58 L m^{-2} h^{-1}), fouling index (77.92%) and cleaning efficiency (89.42%) by batch concentration configuration. The proposed method presented high retention of turbidity (87.50%); on the contrary, low retentions of pH (0.98%), total soluble solids (10.17%), carbohydrates (33.17%), polyphenols (2.10%), betalains (5.52%), and antioxidant activity (15.74%) were observed. Finally, a clear juice (3.79 ± 1.3 NTUs) was obtained with high antioxidant activity (21.40 ± 1.1 TEAC), high polyphenols (27.50 ± 0.2 mg gallic acid L^{-1}) and betalains contents (18.80 ± 0.6 mg L^{-1}). On the other hand, there were significant changes in color properties due to the decrease of L, b* and C values by removal of turbidity on the juice. Finally, the h° value was decreased (from 39.96 to 10.14), which means the redness grade was increased.

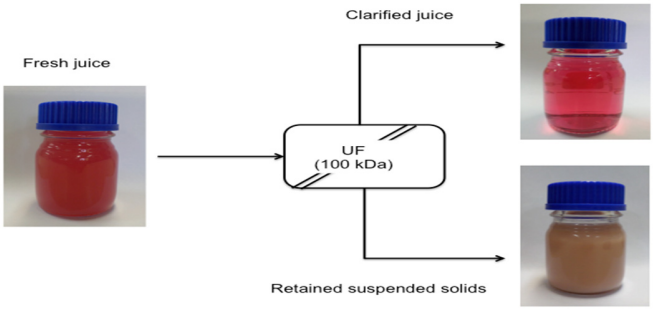

Figure 1. Samples of xoconostle juice before and after processing by ultrafiltration (100 kDa)

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DESALINATION

DESALINIZACIÓN

Oral Session 3

MICROBIAL DIVERSITY IN THE PRETREATMENT OF A REVERSE OSMOSIS DESALINATION PLANT

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Biofouling in reverse osmosis (RO) membranes is the main factor limiting productivity and performance of seawater desalination for human consumption [1]. This is due to the adhesion and growth of specific microorganisms on the membrane, depending on the feed water [2]. One way to reduce biofouling is to pretreat raw seawater before it is introduced into the RO membrane units, as it is possible to eliminate microorganism population and nutrients present in the feed. This work aims to quantify the population and microbial diversity in the Sea of Cortez before, during and after pretreatment. This is done by means of classical microbiology techniques as well as field parameters, in order to gain insights into the mechanisms that lead to RO membrane biofouling. Water from the Sea of Cortez was collected (280 L) at a depth of 4 m and at a distance of 3.76 km from the coast (27° 53' 1.28" N and 110° 47' 5.56" W). Temperature (T), electrical conductivity (EC), total dissolved solids (TDS), salt percentage (% salt), dissolved oxygen (DO), pH and redox potential (ORP) were quantified. Three hours after sampling, the collected water was pretreated in the pilot RO desalination plant located at the Instituto Tecnológico de Sonora (ITSON). Pretreatment included sand filtration, activated carbon, softening and UV treatment. Samples were taken after each pretreatment process and population, microbial diversity and quality parameters (T, CE, STD, % salt, OD, pH and ORP) were analyzed. Six hours after the pretreatment sampling, microorganisms were isolated using serial dilutions. In order to provide nutritional growth conditions similar to those of the natural environment, seawater was used to prepare the culture medium. Preliminary qualitative observations suggest a limited effect on microbial population by sand filtration, a moderate effect by activated carbon, and relatively larger effects by the softening and UV treatments. Quantitative results will also be reported and discussed. Although the results show that pretreatments reduce microbial population in feed water, there is still bacteria present after UV treatment. This suggests possible mutation conferring adaptive capacity [3], i.e. resulting in bacteria more resilient to further pretreatment, leading to RO membrane biofouling.

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SEAWATER DESALINATION BY DIRECT CONTACT MEMBRANE DISTILLATION

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Fresh water availability is a global problem. In some arid countries, where water scarcity is severe, desalination processes of seawater and brackish groundwater have been used to obtain fresh water. Nowadays, reverse osmosis (RO) is the worldwide technology more used for desalination. However, this process has low boron rejection [1,2] and the operating pressure is elevated, requiring a high energy consumption which represents a half of the total cost of water production [2]. Direct contact membrane distillation (DCMD) has been investigated worldwide as a low-cost process to replace conventional separation processes. However, a drawback of the process is the scaling on membrane's surface caused by the hydrophilic contaminants from seawater. A common method to control scaling in conventional desalination processes is adding anti-scaling agents in the feed side [3]. This alternative has not been fully explored for DCMD and some controversy appears among authors on whether the use of anti-scaling improves or affects process performance [1, 4, 5].

In this work, the effect of operation conditions and different anti-scaling agents was evaluated on the DCMD process performance, by using two membranes made on request (not commercially available) and seawater. It was found that temperature and feed flow rate have a strong influence on the water vapor flux. Membrane thickness affects the process, but it became significant only when working at 70°C and using high feed flow rates. Results also showed that adding anti-scalants during the desalination process increased water vapor flux up to 49.2%.

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DESALINATION
DESALINIZACIÓN

Poster Session

OPERATION OF COMMERCIAL COMPOSITE MEMBRANES IN CROSS FLOW CELL FOR MARINE WATER DESALINATION

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Water is a vital resource for social and economic development worldwide. For this reason, the design and planning of possible alternatives for the supply of water are necessary. The high pollution levels in rivers, reservoirs and groundwater, give rise to an important alternative: the desalination of sea water to obtain fresh water [1]. One technique that has risen in prominence in the last years for this purpose is Reverse Osmosis (RO), a process in which water is forced to pass through a semipermeable membrane in order to eliminate or concentrate the solutes in the solution [2]. This research aims to operate a bench scale membrane cell using commercial composite membranes to desalinate synthetic sea water. Three commercial membranes with different characteristics were used. The first was RO ACM4, designed for low pressure and high flux RO. The second was RO AD, designed to be chlorine resistant and operate at high pressure and high salt concentration. The third was RO BW30FR, designed to be fouling resistant, and to operate at low pressure and high flux. Synthetic sea water (35,000 ppm) was used in the experimental cross flow rig. Measurements included the pump input frequency (Hz), permeate flow (L/min), retentate flow (L/min), temperature (°C), pressure (psi), permeate flux (LMH) and observed salt rejection (%) [3], [4]. The RO ACM4 membrane had the best performance with a salt rejection of 94.6% and a flux of 19.37 LMH. This presentation will show the advances of this research to this date.

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MEMBRANE SYNTHESIS, FABRICATION AND MODIFICATION

MEMBRANAS SÍNTESIS, FABRICACIÓN Y MODIFICACIÓN

Oral Session 3

Oral Session 4

ELABORACIÓN DE MEMBRANAS DE CAPA FINA MEDIANTE POLIMERIZACIÓN EN INTERFASE MODIFICADA: EFECTO DEL NÚMERO DE CAPAS Y DE LA CONCENTRACIÓN DEL MONÓMERO EN LA FASE ORGÁNICA

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A nivel mundial la demanda de agua potable está incrementando y en países como México algunas necesidades se cubren con aguas subterráneas que son acondicionadas para uso humano mediante tecnología de membranas [1]. El desarrollo de membranas de película delgada, para osmosis inversa (OI) y nanofiltración (NF), tomó relevancia luego que Cadotte propuso la técnica de polimerización en interfase (PI) para obtener membranas de poliamida [2]. Durante el proceso de PI se obtiene una capa de estructura resistente, con densidad de carga en la superficie para una diferente capacidad de transporte iones, reflejándose en un alto rechazo de sales y alto flujo de permeado. Las membranas obtenidas mediante PI separan sustancias por diferencia de tamaño, relacionándose de manera directa el tamaño del poro con la aplicación de la membrana y costes de operación; un mayor coste de operación surge con un tamaño de poro menor; además, para membranas con carga superficial, aplica el fenómeno de exclusión de Donnan repeliendo aquellos cuerpos con la misma carga que la observada en la superficie de la membrana.[3] Las membranas de NF tienen aplicaciones en los tratamientos de agua residual e industrial, presentando características de separación en un intervalo intermedio a ósmosis inversa y ultrafiltración (UF). En el presente trabajo se aborda la continuación en la exploración de las condiciones de síntesis de membranas mediante PIM, evaluando el tiempo de reacción entre las fases involucradas en PI, la velocidad de desplazamiento de la membrana al aplicar la fase orgánica, el efecto de la membrana soporte y se aborda un diseño de experimentos 3^*k* con el número de capas de la fase orgánica y la concentración del a fase orgánica como variables.

Con el fin de incrementar el valor A, manteniendo el desempeño de membranas obtenidas mediante polimerización en interfase (PI), se desarrolló una técnica de polimerización en interfase modificada (PIM) aplicando la fase orgánica mediante "*spray*" logrando duplicar el valor A y manteniendo el porcentaje de rechazo de Na_2SO_4 a 1000 ppm, respecto a la membrana obtenida con PI. En PI se demanda un exceso de la fase orgánica para garantizar la distribución homogénea de esta sobre la membrana impregnada con la solución acuosa de amina. El método modificado permite reducir el consumo de esta fase, sintetizando aproximadamente 6 membranas de una capa con 50 mL de solución, que representa 6 veces la cantidad de membranas obtenidas con PI empleando el mismo volumen de fase orgánica. Se trabajó con un diseño de experimentos 3^*k* siendo las variables la concentración de la fase orgánica y el número de capas aplicadas con "*spray*". Ambos factores tuvieron un efecto significativo sobre el desempeño de las membranas, presentando un efecto inverso sobre el valor A y un efecto directo sobre el porcentaje de remoción. En general se puede considerar que es posible la modificación de la técnica de PI aplicando la fase orgánica mediante "*spray*".

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IONIC LIQUIDS AS A MEDIA FOR BIOMASS PRETREATMENT AND ACETYLATION FOR MEMBRANE PRODUCTION

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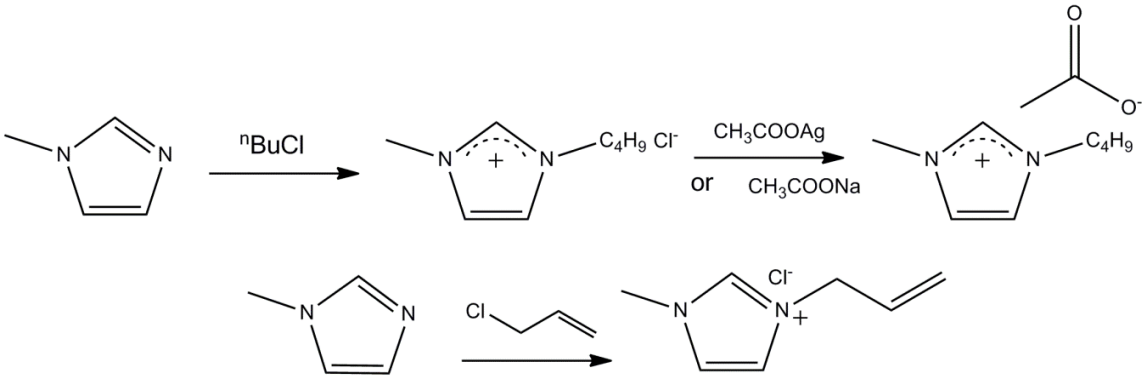
Many processing alternatives are being studied to efficiently recover biomass polymers from waste [1]. In the last few years, a new philosophy has been developed due to the growing restrictions in the environmental laws; this new concept is based on the sustainable processing of biomass into value-added products. [2] Ionic liquids (ILS) have been widely studied as a very attractive alternative for green chemistry [3]. In this work, the Bmim [Cl] and Amim [Cl] ionic liquids were synthesized by different reported routes, as well the Bmim [AcO], using sodium and silver acetates. The reactions were as follows:



And they were evaluated as a media for biomass (oak sawdust) dissolution. A relation of 0.8:1 (%w/w biomass/LI) was used. Contact time was of 3, 6 or 9 h, and there were evaluated at two different temperatures (100 °C and 120 °C). Acetone, methanol and Ethanol were tested as anti-solvent media. Results show that Cellulose is mainly dissolved and lignin precipitated in the conditions studied. Homogeneous acetylation was attained in BMIM [Cl] and AMIM [Cl]. Membranes were obtained using the acetylated biomass and characterized by FTIR, DSC, and SEM.

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NANOCOMPOSITES OF CELLULOSE TRIACETATE FOR WATER PURIFICATION

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Membrane technology is nowadays one of the main processes for water treatment. In the North part of Mexico water scarcity has been originated by long drought periods in a semiarid and arid environment. This phenomenon has overcome serious disorders in water supply for human consumption. One primary effect is produced over water quality. Due to the geological composition of underground water deposits, mineral lixiviation has promoted the presence of high toxic metals, which concentrate at higher levels than the allowed maximum limits. In this regard, governmental organizations have encouraged the use of advanced technologies for water purification. Actually, there are around 365 osmosis plants in Chihuahua State. The main problem arose by this technological implementation is membrane replacement. For instance, membrane production using economic materials could be a good alternative for their operation. Recently our results on membrane production using cellulose chemical derivatives have been reported [1-5]. These are used in combination of Activated carbon or chemically modified lignin. Mechanically and biologically, these materials obtained could be superior to the commercial acetate cellulose membranes. In this work a description of the nanocomposites obtained made of cellulose triacetate are presented. Results on water purification from Chihuahua state are also evidenced and the advances made on membranes obtained from biomass waste, composed mainly of cellulose triacetate.

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CONACYT PROJECT NO. 183970.

HOLLOW FIBER POLYURETHANE MEMBRANES PRODUCED BY QUADRUPLE SPINNERET TO REMOVE SULFUR COMPOUNDS FROM NAPHTHA BY PERVAPORATION PROCESS

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Emission of sulfur compounds to the atmosphere is universally recognized as one key target to be reduced. For membrane pervaporation which is considered as a potential purification process of fuels, dual-layer polyurethane (PU)/polyethersulfone hollow-fiber membranes were prepared. A novel fabrication technique is proposed using a quadruple spinneret to produce the fiber with such morphology by simultaneous spinning of two polymer solutions in the presence of two corresponding precipitation media. Activated carbon was added into the PU solution to improve the transport properties of the selective layer. Resulting hollow-fiber membranes showed very good adhesion between the selective layer and its support, in addition to an effective removal of a sulfur compound such as 2-methyl thiophene from a typical model fuel, an indication of good prospects for both the fabrication technique and for sulfur removal by pervaporation of fuels.

SYNTHESIS AND CHARACTERIZATION OF HYBRID MEMBRANES BASED ON Ph-m-SPEEKK AND POLYSILOXANES FOR FUEL CELL APPLICATIONS

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In the last decade, with the aim of developing a less contaminant way to produce electrical energy, research on proton exchange membranes (PEM) for fuel cells has gained a major interest. Today, the reference in the field is Nafion, a perfluorinated polymer with sulphonic acid groups. The main advanatges of this polymer are a high proton conductivity (100 mS/cm at 80 °C and 95% RH) and good thermal and mechanical stabilities. However, Nafion experiments dehydration close to 100 °C diminishing the membrane conductivity, the diffusion coefficient to MeOH is relatively high (10^{-6} cm^2/s) and it also has an elevated cost [1,2].

In an attempt to improve these drawbacks, in this work we synthesized a poly(aryl ether ether ketone ketone) (Ph-m-PEEKK) and via post-sulphonation with concentrated sulphuric acid, the sulphonated polymer Ph-m-SPEEKK. The latter was characterized by FTIR, ^{1}H and ^{13}C NMR on 1D and 2D, and elemental analysis.

PEMs prepared with Ph-m-SPEEKK (88% of sulphonation degree) present high thermal stability and low diffusion coefficient to MeOH compared with Nafion. In order to improve the stability and diminish the diffusion coefficient an organic-inorganic phase was prepared using polydimethylsiloxane (PDMS) crosslinked with tetraethylorthosilicate (TEOS) or phenytrimethoxysilane (PTMS) in a 1:5 molar ratio and added in 10, 15 and 20% respect to Ph-m-SPEEKK. These siloxane phases were characterized by FTIR.

Membranes prepared with Ph-m-SPEEKK are slightly more conductive (94.2 mS/cm) than Nafion 117 (87.6 mS/cm) at 80 °C. Hybrid membranes prepared with PTMS as crosslinker showed higher conductivity than Nafion 117 and the base polymer (i.e. membranes with 20% of the siloxane phase PDMS:PTMS had a conductivity of 134.0 mS/cm and with 20% PDMS:TEOS, 83.4 mS/cm at 80 °C). This effect is probably due to a change in the nanostructure of the hybrid material. The diffusion coefficients of Ph-m-SPEEKK and hybrid membranes with TEOS or PTMS, determined at 20 and 60 °C were lower than Nafion 117. However, an increase with temperature was observed. This effect being more noticeble for the Ph-m-SPEEKK membranes than for the hybrid membranes containing 20% of the siloxane phases.

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MEMBRANE SYNTHESIS, FABRICATION AND MODIFICATION

MEMBRANAS SÍNTESIS, FABRICACIÓN Y MODIFICACIÓN

Poster Session

OBTENCIÓN DE MEMBRANAS DE CAPA FINA MEDIANTE POLIMERIZACIÓN EN INTERFASE MODIFICADA: CONSTRUCCIÓN DE EQUIPO PARA LA SÍNTESIS Y EFECTO DE LA APLICACIÓN DE FASES MEDIANTE "*SPRAY*".

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El crecimiento demográfico ha creado un aumento en necesidades de servicios como el agua para uso consuntivo, en México se cubre el 37% de esta necesidad con aguas subterráneas,[1] las cuales llegan a acondicionarse para su uso mediante tecnología con membranas. Las membranas de capa fina tomaron importancia desde que se propuso la técnica de polimerización en interfase en 1981,[2] en la que se hace reaccionar un par de fases inmiscibles, cada una disuelve un monómero (típicamente piperazina en la fase acuosa y cloruro de trimesoilo en la fase orgánica) y en la interfase de los líquidos se forma una película delgada que se deposita sobre la superficie de la membrana soporte, dando lugar a la membrana de capa fina que cabe dentro de la categoría de membranas de nanofiltración (NF).[3] Las membranas de NF obtenidas mediante PI poseen carga superficial y ello les permite, además de remover sustancias por diferencia de tamaño, aplicar el fenómeno de exclusión de Donnan, repeliendo aquellas sustancias con la misma carga de la superficie de la membrana. En el presente trabajo se plantea la construcción de un sistema que permita la aplicación de las fases de la PI mediante "*spray*" y el primer acercamiento a las condiciones de operación del sistema para la modificación de la técnica de polimerización en interfase (PIM); se varió el tipo de solvente usado en la fase orgánica, el número de capas aplicando ambas fases mediante "*spray*" y finalmente observó el efecto de la combinación de la aplicación de las fases de manera convencional y mediante "*spray*".

Con el fin de contribuir a la actual opción de acondicionamiento de agua potable, se trabajó en la construcción de un prototipo para evaluar la polimerización en interfase modificada (PIM) y explorar las condiciones experimentales de dicha técnica. La innovación en la técnica de polimerización en interfase (PI) radica en la aplicación de las fases mediante "*spray*", que pese a ser un cambio simple implicó múltiples consideraciones. El prototipo se fabricó pensando en garantizar la aplicación de las fases de modo uniforme, constante y reproducible a fin de producir una capa de poliamida muy delgada sobre la superficie de la membrana soporte de polisulfona. Se determinó que en la PIM diversas variables podían ser modificadas y que comúnmente no se manipulan en PI. Se optó por fijar algunas de ellas (presión de aplicación de la fase, distancia de aplicación, etc.) y se variaron algunas otras (tipo de solvente, flujo de material, entre otras); con la experiencia se fueron ubicando los niveles de los factores a modo de lograr membranas con un buen desempeño. Los resultados obtenidos indican que la síntesis de membranas aplicando ambas fases mediante "*spray*" logra un pobre desempeño en estas, obteniendo membranas con rechazo de Na_2SO_4 a 1000 ppm y valor A inferiores a lo obtenido con PI. Por otro lado, la síntesis de membranas aplicando solo la fase orgánica con "*spray*" alcanza porcentajes de remoción de Na_2SO_4 (a 1000 ppm) y valor A que igualan y/o mejoran los resultados obtenidos mediante PI.

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pVAc BASE MATERIAL FOR MEMBRANES PREPARATION POLYMERIZATION REACTION KINETICS MEDIATED BY MICROWAVES

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Currently the development of membrane materials is the focus of research in membrane based gas separation, fuel cells particularly proton exchange membrane fuel cell (PEMFC). Poly(ethylene-vinyl acetate) (EVA) is a typical semicrystalline thermoplastic copolymer widely used as membranes. It is recognized that the use of microwave mediated polymerization produces an increase in the yield and reduces the reaction time. In this work we report the effect of solvent media on the polymerization reaction of VAc monomer, under controlled conditions of temperature at 70 °C and molar ratio of $[VAc]_0/[Ru^{II}]_0/[Al]_0/[CCl_4]_0$ = 200/1/1/1. The reactions were activated by microwaves (MW) and conventional heating (CH). Four different solvents were tested; low and high dielectric constants then three Ru^{II} complexes were probed mediating the polymerization reaction. The comparative kinetic study of the results of VAc polymerization reaction, under MW and CH, showed interesting results using DMSO solvent with the highest value of dielectric constant. The kinetic data were analyzed using a first-order model. The reaction kinetics are very much dependent on the activation method, $k_{p,\,MW} = 1\times10^{-2}$ and $k_{p,\,CH} = 6\times10^{-4}$, so these values indicate that the reaction activated by MW proceeds 16.4 times faster than the reaction activated by CH. It is important to say that the character of the VAc polymerization reaction under MW, in presence of DMSO solvent, goes on by a living polymerization mechanism, the M_n increasing with the conversion and it is very similar in value to the theoretical M_n. The living character was probed and confirmed through the formation of the copolymer p(VAc-co-MMA).

FUNCTIONAL DEPOLYMERIZED CHITOSAN MEMBRANES

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Chitosan has important functional properties such as biodegradability, biocompatibility and low toxicity which make it an attractive material for biotechnological and industrial applications. In this context an enzymatic pathway for depolymerized chitosan membrane production, in order to reduce their molecular weight, was obtained. The chitosan used was obtained from municipal solid waste. To depolymerize chitosan an enzyme complex, CELUZYME XB® was used. This process was evaluatedd by measuring apparent viscosity and the intrinsic viscosity as well as the viscosity average molecular weight. The enzyme-substrate optimal conditions for enzymatic hydrolysis were determined. The optimal temperature and pH were as follows, pH=5 T=50 °C in the enzyme-substrate ratio 1:5. It was confirmed that the complex used has good ability to enzymatic hydrolysis at the site of glycosidic bond of chitosan. Depolymerized chitosan membranes were prepared by the method of evaporating the solution at a controlled temperature. Important parameters that control the physical characteristics of the membranes, such as pH, molecular weight and percentage of deacetylation of chitosan were also determined. Antioxidant activity was evaluated through the stable free radical DPPH method further weight percent. The membranes were characterized by FTIR spectroscopy and antioxidant capacity was evaluated by UV-visible spectroscopy.
In addition preliminary studies of the functionality of the membranes are presented in fruits of guava gender Psidium.The results are of value for the production of low molecular weight chitosan and chitosan membranes with a biotechnological interest.

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PECTINA SOPORTADA EN MEMBRANA DE POLIPROPILENO FUNCIONALIZADA

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En el presente trabajo se reporta el soporte de pectina sobre una membrana de polipropileno funcionalizada con grupos hidroxilo y carbonilo (PP-AA-PEC).

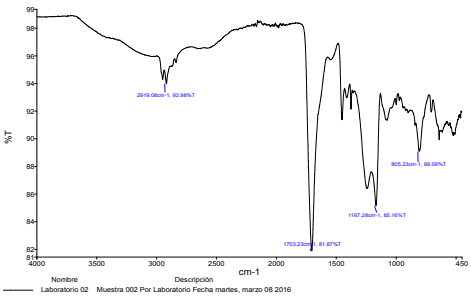

Figura 1. FT-IR-ATR de membrana funcionalizada PP-AA (0.15%).

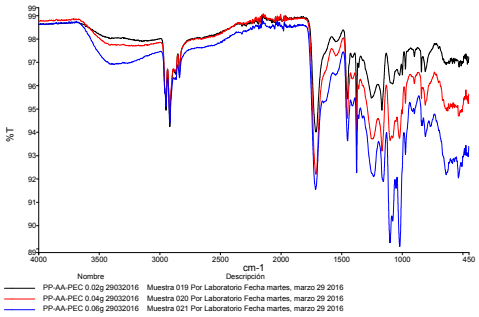

Figura 2. FT-IR-ATR de membranas PP-AA-PEC con diferentes concentraciones de pectina.

Para inmovilizar la pectina sobre membrana de polipropileno se llevó acabo la funcionalización de la membrana con ácido acrílico (0.15%) y se caracterizó por FT-IR-ATR (**Figura 1**). La inmovilización de la pectina se llevó a cabo en la membrana funcionalizada variando la concentración de pectina, obteniendo las diferentes membranas PP-AA-PEC (**Figura 2**).

NOVEL MEMBRANES AND THEIR APPLICATIONS

MEMBRANAS NOVEDOSAS Y SUS APLICACIONES

Oral Session 5

EXTRACCIÓN Y RECUPERACIÓN SELECTIVA DE Cd(II) OBTENIDO DE LA DISGESTIÓN DE UNA BATERÍA Ni/Cd A PARTIR DE MEMBRANAS HÍBRIDAS SEMI-INTERPENETRANTES A BASE DE ADOGEN 364

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Hasta ahora numerosas membranas poliméricas han sido desarrolladas para la separación selectiva de especies metálicas a partir de disoluciones acuosas, como son las membranas líquidas soportadas (SLMs, por sus siglas en inglés) y las membranas poliméricas de inclusión (PIMs por sus siglas en inglés) [1]. Éstas se encuentran compuestas generalmente por tres componentes principales: un soporte polimérico, un plastificante y un extractante o acarreador a partir del cual se puede llevar a cabo el transporte del soluto de interés a través de la membrana. Aún cuando las SLMs y las PIMs ofrecen una alta selectividad y altos coeficientes de difusión, ambas membranas presentan pérdida sucesiva del extractante [2].
Como alternativa a estos dos tipos de membranas se han desarrollado nuevas membranas híbridas semi-interpenetrantes (SIHMs por sus siglas en inglés) empleando la mezcla comercial de aminas terciarias Adogen 364 como extractante, el triacetato de celulosa (CTA, por sus siglas en inglés) como soporte polimérico, el nitrofeniloctil éter (NPOE, por sus siglas en inglés) como plastificante y una mezcla de siloxanos (MS) que corresponde a una red orgánica/inorgánica a base de poli(dimetilsiloxano) (PDMS, por sus siglas en inglés) y tetraetilo ortosilicato (TEOS) como agente entrecruzante. También se realizaron experimentos de extracción líquido-sólido para elucidar el mecanismo de transporte del Cd(II) a partir de Adogen 364. Una vez optimizada la membrana ésta se empleó en la recuperación selectiva de Cd(II) a partir de una muestra real de una batería Ni/Cd con un porcentaje de extracción satisfactorio. Finalmente, la estabilidad de la membrana híbrida se comparó con la de una polimérica de inclusión durante 13 ciclos de extracción sucesivos. Los resultados mostraron que las SIHMs poseen una excelente estabilidad y selectividad con permeabilidades comparables a las de una PIM bajo las mismas condiciones.

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DESIGN OF PROTON EXCHANGE MEMBRANES BASED ON POLYMERIC IONIC LIQUIDS FOR FUEL CELL APPLICATIONS

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One of the most promising technologies for power generation are Proton Exchange Membrane Fuel Cells (PEMFCs). PEMFCs are electrochemical devices which convert directly the chemical energy of oxidation-reduction reactions into electrical energy. These electrochemical devices have high electric efficiency and low environmental impact [1].

Several authors are working in the upcoming commercialization of this technology. However, there are technical aspects that must be overcoming before their implementation. The proton exchange membrane, which is the key component of a PEMFC, needs a considerable improvement regarding its performance without external humidification [2]. This is of great importance because it allows working at temperatures above 80 °C and eliminate the management of water.

Concerning this aspect, many authors are working incorporating ionic liquids as proton exchange components in PEMFCs. Ionic liquids, which are in liquid state at room temperature, have attractive properties for this application, such as thermal and electrochemical stability and high anhydrous conductivity.

There are several strategies in order to incorporate ionic liquids inside the proton exchange membrane. One of them deals with the polymerization of an ionic liquid monomer [3]. This option avoids the leak of the ionic component during the fuel cell operation.

In this work, membranes based on polymeric ionic liquids have been designed for their use as electrolytes without external humidification. For this purpose, the ionic liquids 1-(4-sulphobutyl)-3-vinylimidazolium trifluoromethanesulphonate [HSO_3-BVIM][OTF], 1-sulfobutyl-3-metylimidazolium 2-sulfoethylmethacrylate [SBMIm][SEM] and 1-sulfobutyl-3-vinylimidazolium 2-sulfoethylmethacrylate [SBVIm][SEM] were polymerized under ultraviolet light. The ionic conductivity and fuel cell performance were tested without external humidification.

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OPTIMIZATION OF COPPER EXTRACTION USING A POLYMER INCLUSION MEMBRANE (PIM) BASED ON KELEX-100 AS CARRIER

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Nowadays, new less polluting methods to extract heavy metals are necessary for different purposes, for example, industrial, environmental or analytical determinations. Polymer inclusion membranes (PIM) have shown high extraction efficiency, selectivity and stability in comparison to other types of extraction such as liquid-liquid extraction. In this work a new PIM for copper extraction was synthetized and optimized using Kelex-100 as carrier. Different factors were evaluated: carrier and plasticizer concentrations, percentage of CTA (Cellulose triacetate), pH and concentration of formic acid in the strip solution. As a result, high percentages of extraction (97%) were obtained using pH=1.0 in the strip solution and Tris (2-ethylhexyl) phosphate (TEHP) as plasticizer. Under optimal extraction conditions, the PIM shown high selectivity under the presence of concomitants metals (zinc, cadmium and iron), but was not selective for lead; in addition this membrane was stable during four cycles of 24 hours. Small volumes in the strip solution were studied to determinate the preconcentration factor using this new PIM; a preconcentration factor of 30 was achieved with one milliliter of strip solution. A possible future application for this membrane is the selective preconcentration of copper for in situ analytical determinations.

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Cd(II) ANALYSIS IN WATER SAMPLES USING POLYMER INCLUSION MEMBRANE SORPTION COUPLED TO SPECTROSCOPIC METHODS

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Heavy metals are toxic metals or metalloids which are persistent in all parts of the environment and cannot be degraded or destroyed. Human activity affects the natural geological and biological redistribution of them through pollution of the air, water, and soil. Generally they are present at low concentrations and therefore measured by atomic absorption and emmission methods, which provide highly accurate and sensitive measurements. However environmental scientists are incresingly in the need of measurements technologies that can be used closer to the sample requiring analysis in more demanding out-of-lab situations that those found in traditional labs, restricting the employment of such complex equipments.
Polymer inclusion membranes (PIM) are a kind of membranes adequate as a preconcentration method [1], with the additional advantages of an easy shyntesis and the possibility to performed in-situ metal analysis [2, 3].
In this work, a sample preconcentration method for measuring Cd(II) in waters employing a PIM was developed and characterized and direct two channels (UV-VIS and MID-IR) analyses on the membrane conducted to quantitatively measured the amount of metal using the partial least squares (PLS) chemometric algorithm. Solid-liquid extraction experiments allowed the identification of the extraction equilibrium, obtaining the parameters and profile of the extraction isotherm, and the evaluation of the enrichment factor. It was observed that the results obtained by the analysis of the PIM combined with FTIR compared well to those generated by flame atomic absorption spectroscopy (FAAS) so that the new method could be very suitable for on-site analyses with portable equipment.

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NOVEL MEMBRANES AND THEIR APPLICATIONS

MEMBRANAS NOVEDOSAS Y SUS APLICACIONES

Poster Session

DEVELOPMENT OF A POLYMER INCLUSION MEMBRANE BASED-OPTODE FOR THE QUANTIFICATION OF Pb(II) FROM AQUEOUS SOLUTIONS

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Lead is a common environmental pollutant due to its common industrial uses, such as in plants that process lead-acid batteries or produce lead wire or pipes, and in metal recycling and foundry companies. Lead exposure can occur from contact with lead in air, household dust, soil, water, and commercial products and it can end up in groundwater and surface water from the atmosphere or soil. Lead presents a wide pathophysiological spectrum as it causes hematological, gastrointestinal, and neurological dysfunction and prolonged exposure may also cause chronic nephropathy, hypertension, and reproductive impairment [1]. Because of this its rapid determination in environmental matrices by adequate in-field measurement devices is a matter of high relevance.

Optical sensors, often called “optodes”, are a particular type of chemical sensor where spectroscopic measurements associated with chemical reactions are carried out. With optodes based on a second component (“Simon optodes”), the analyte recognition by ionophores is shown by an optically active component also placed in the membrane, e.g. an indicator or chromoionophore, which responds selectively to the primary recognition process [2]. Detection is achieved by a simultaneous co-extraction or ion-exchange of anions and cations which is accompanied by a change in the optical property measured (usually absorbance or fluorescence). In recent years, analytical chemists found one of the most challenging tasks is constructing highly sensitive and selective optodes for field monitoring of toxic species. The entrapment of the ionophore in a membrane is a straightforward technique with multiple advantages. In this work, a typical polymer inclusion membrane (PIM) consisting of a based polymer, a plasticizer and a carrier (ionophore) was used for lead(II) sensing in synthetic aqueous solutions. The influences of type of based-polymer, plasticizer, and ionophore, membrane composition, thickness and area, pH of the aqueous solution and metal concentration were studied. The enrichment factor of the preconcentration method and the extraction efficiency were evaluated as well. Quantitative analysis of the metal in the PIM was performed using the partial least squares (PLS) chemometric method.

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DESARROLLO DE MEMBRANAS POLIMÉRICAS DE INCLUSIÓN PARA LA RECUPERACIÓN DE PLATINO

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El platino es un metal ampliamente usado para distintas aplicaciones; en catalizadores, dispositivos eléctricos y electrónicos, joyería y dispositivos biomédicos entre otras. Debido a su alto costo, poca abundancia y alta demanda se hace necesario procesar, por ejemplo, catalizadores gastados, residuos electrónicos, equipo usado y ensambles membrana electrodos para la separación, recuperación y reciclaje del platino. Los métodos comúnmente usados para la separación y extracción de platino se basan en procesos hidrometalúrgicos que incluyen la lixiviación y extracción por disolventes, entre otros. Se sabe que la separación selectiva de especies metálicas en disolución acuosa se puede llevar a cabo de forma eficiente mediante el uso de membranas poliméricas, lo cual ha sido poco reportado para el caso del platino. En este trabajo se plantea el desarrollo de membranas poliméricas de inclusión (PIMs) para la recuperación de Pt de catalizadores empleados en celdas de combustible. Las PIMs se prepararon empleando como soporte polimérico, acetato de celulosa (CA) o acetato ftalato ácido de celulosa (CAH), un extractante (ADOGEN 364, CYANEX 301 o ALIQUAT 336) y un plastificante (NPOE o TBEP), en todas las combinaciones posibles. La evaluación de las membranas se lleva a cabo en una celda de transporte y se determina la extracción de Pt a partir de medios acuosos, optimizando las fases acuosas de extracción y reextracción. Los resultados indican altos porcentajes de extracción (>90%) en una hora de experimentación con la combinación adecuada de soporte polimérico, extractante y plastificante.

DESARROLLO DE UN SISTEMA DE MEMBRANA POLIMÉRICA DE INCLUSIÓN PARA PRECONCENTRACIÓN Y CUANTIFICACIÓN DE Cr (VI) EN SOLUCIONES ACUOSAS

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El cromo es un metal pesado que se encuentra en la naturaleza en su forma trivalente, Cr (III), el cual ayuda en el metabolismo de la glucosa y la síntesis de los ácidos aminonucleicos del cuerpo humano; sin embargo, debido a los desechos industriales que se arrojan a ríos y lagos, también se ha encontrado en su estado hexavalente, Cr (VI), el cual es potencialmente tóxico y carcinógeno [1]. Es por esta razón que se ha tratado de comprender el comportamiento del cromo en sistemas de aguas naturales y poder obtener una solución para extraer este metal y evitar un cambio drástico en la ecología del mundo. En la actualidad la destrucción o transformación de contaminantes orgánicos o biológicos presentes en aguas naturales es un aspecto muy estudiado en el campo de la química y tecnología ambiental, sin embargo, las especies más tóxicas como el Cr (VI) no se biodegradan con facilidad y los métodos de químicos o biológicos para disminuir su presencia presentan demasiadas restricciones o tiene un muy alto costo [2].

Actualmente son pocas y costosas las técnicas analíticas utilizadas para determinar las bajas concentraciones de ciertos metales, como lo son la espectroscopía de absorción atómica, la espectroscopía de emisión atómica con plasma acoplado inductivamente-espectrometría de masas y métodos de inyección de flujo. Además para estas técnicas es necesario realizar un pretratamiento largo y tedioso de la muestra, por lo cual que se suele recurrir a la realización de métodos de preconcentración [3]. Uno de estos métodos de preconcentración es el uso de membranas. En una definición muy general una membrana es una barrera que permite el paso selectivo de ciertas especies. Las membranas poliméricas se empezaron a utilizar como alternativa a los procesos de extracción con solventes. En particular, las membranas poliméricas de inclusión tienen la ventaja de extraer el metal de la solución y retenerlo, lo que aunado a una síntesis sencilla y la posibilidad de efectuar el análisis del metal contenido en ella de forma directa, sin realizar ningún pretratamiento de la muestra [4], las hace candidatas idóneas para determinaciones analíticas.

En este trabajo se investiga el uso de Aliquat 336 como extractante para Cr (VI) de soluciones acuosas a través de una membrana polimérica de inclusión como sistema de preconcentración. Se evalúan las principales variables que afectan el proceso de extracción para la optimización de las condiciones experimentales. La cuantificación se hace en la misma membrana utilizando regresión multivariable por el método de mínimos cuadrados parciales (PLS).

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ON THE USE OF POLYMER INCLUSION MEMBRANES TO OBTAIN SUPPORTED METAL NANOPARTICLES AS CATALYSTS

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One of the key areas of research today is the development and use of increasingly more efficient and economic catalysts, with the aim of a better use of natural resources by consuming less energy.
Nanoparticles (NPs) can be considered as the linking point between both types of catalysis, homogeneous and heterogeneous. NPs have high reactivity due to their small size and large number of atoms on the surface; consequently, NPs are highly unstable and tend to agglomerate [1, 2]. In recent years, the use of membranes has been proposed as a support medium and template for NPs synthesis aiding in the control of the size and increasing their stability [3-5]. In this work we report the synthesis and stabilization of platinum nanoparticles using a polymer inclusion membrane based on a polymeric support, a plasticizer and a commercial amine as carrier [6]. After extraction and formation of platinum NPs in the membrane, to test its catalytic activity, it was used as catalyst in the reduction of 4-nitrophenol with sodium borohydride. After 3 h of reaction time an efficiency of 99% was obtained.

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HYDROLYTIC DEGRADATION OF POROUS POLY(Ɛ-CAPROLACTONE) MEMBRANES FOR NEURAL TISSUE ENGINEERING

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Keywords, biodegradable scaffolds, hydrolytic degradation, poly(£-caprolactone), tissue engineering

One of the main challenges in regenerative medicine is the regeneration of brain tissue due to its extremely limited re-growth after a substantial damage. Tissue Engineering (TE) is a promising technology that employs artificial scaffolds as support to create an adequate environment to stimulate and facilitate in vitro neural cell adhesion and proliferation [1]. In previous works [1, 2], poly (ε-caprolactone) flat membranes (PCL) were developed in order to act as a scaffold for neural TE showing favourable results of morphological and nutrient transport properties, as well as cell adhesion and proliferation. PCL was the selected material due to its biocompatibility and biodegradability in the long term. A good substrate material should accomplish with a degradation rate that matches the cell proliferation, so the loss of the mechanical properties of the substrate are replaced by the regenerated tissue. The high porosity of the PCL membranes fabricated [1-2] would presumable accelerate the normal PCL degradation rate (1–2 years). The aim of this work is the study of the PCL membrane hydrolytic biodegradability in order to establish the adequacy these PCL scaffolds for in vitro neural tissue regeneration.

PCL membranes were prepared by phase inversion technique [1, 2]. Briefly, PCL polymer solution 15% w/w in N-methylpyrrolidone (NMP) was prepared. The polymeric solution was then casted in a glass plate and immersed in a coagulation bath of isopropanol. The PCL membranes have been kept at 37 °C submerged in a phosphate buffer solution (PBS, pH 7.4) to study the hydrolytic degradation (BPS-PCL). Control PCL samples at 37°C not submerged in PBS are also evaluated (Control-PCL). The change with degradation time of the physical properties, such as aspect, weight, porosity, molecular weight, and nutrient transport and mechanical properties have been evaluated. Neural cell culture is currently under conduction to establish the rate ratio between degradation and neural cell growth.

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WATER TREATMENT

TRATAMIENTO DE AGUA

Oral Session 6

Oral Session 7

EFFICIENT REMOVAL OF CHROMATE AND ARSENATE BY POLYMER-ENHANCED ULTRAFILTRATION

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Chromium and arsenic are a very toxic chemical species associated to serious problems of environmental pollution as well as several diseases. Chromium species are mainly present in wastewater from different industries such as metal plating, paints and pigments, leather tanning, textile dyeing, and printing inks and also in additives for wood preservation among others [1]. On the other hand, the high arsenic concentrations in the environment are coming from natural sources and human activities such as waste chemicals, the smelting of arsenic bearing minerals, the burning of fossil fuels, and the application of arsenic compounds in many products [2].

In this work the removal of chromate and arsenate anions was studied by polymer-enhanced ultrafiltration (PEUF) technique by washing and enrichment methods. The extracting agents were water-soluble polymers (WSPs) containing quaternary ammonium salts with chloride or methylsufate counterions. PEUF is a hybrid method that involves interaction of the functional polymer with the chromate or arsenate ion, forming a new polymer-ion macromolecule whose molecular weight is above the ultrafiltration membrane molar mass cut off; therefore, it is retained by size exclusion [3], (see Figure 1).

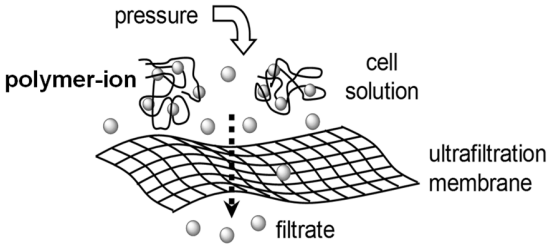

Figure 1. Principle of PEUF.

Through to PEUF washing method, the Cr(VI) and As(V) (30 mg/L) removal experiments were carried out at different pH levels (3, 6, and 9). The results showed highest retention capacity of Cr(VI) and As(V) at pH 9. The retention capacity in both cases was optimum for polymers containing chloride counterions. The decrease in the arsenic retention ability of the WSPs is likely due to an increase in the ionic strength of solution by the presence of different concentrations of Na_2SO_4 or NaCl [2]. The study of polymer:anion ratio showed the optimum molar ratio as 10:1 and 20:1 for efficient chromium and arsenic removal respectively. The maximum retention capacity was determined by the enrichment method. It was between 79 to 165 mg ion retained/g polymer.The retention-elution process shows that the elution process of the arsenate and chromate ions from polymers can be performed when the polymer-ion was in contact with the acid solution from the reservoir.

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TRATAMIENTO DE DESCARGAS ACUÍCOLAS EN UN BIORREACTOR DE MEMBRANAS SUMERGIDAS: REUSO DE AGUA Y NUTRIENTES

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La acuicultura tiene un importante crecimiento a nivel mundial, que demanda el desarrollo de nuevas tecnologías para una producción más eficiente y sustentable. Los biorreactores con membranas sumergidas (BRM), están siendo cada vez más estudiados en la industria acuícola para tratar efluentes en sistemas acuícolas con recirculación (RAS; por sus siglas en inglés). Esta biotecnología permite transformar los residuos en biomasa microbiana, que puede ser aprovechada como fuente complementaria de alimento para los peces y recircular el agua tratada.

En el presente trabajo se estudia, a escala laboratorio, la eficiencia de asimilación de nutrientes nitrógeno, fosforo y materia orgánica en la biomasa de un BRM, que es alimentado con los lodos del sistema de retención de sólidos de un RAS de cultivo de tilapia (Oreochromis sp.) con una densidad de cultivo de 20 a 30 kg/m^3, con tallas que van desde los 150 a 400 g. En una primera etapa se desarrolla la biomasa en el biorreactor hasta una concentración de Sólidos suspendidos volátiles de alrededor de 5000 mg/L, partiendo de un inoculo con biomasa de la planta de tratamiento de aguas residuales de Pátzcuaro, Mich. Una vez alcanzada la estabilización, la alimentación de los lodos acuícolas al biorreactor se realiza a diferentes concentraciones: 0.05, 0.1, 0.2, 0.3 y 0.5 kgDQO/kgSSV•d, complementado con ácido acético para una adecuada relación carbono/nitrógeno.

Se alcanza una eficiencia global de remoción de la DQO del 97%, con un efluente tratado libre de sólidos en suspensión. La asimilación de nutrientes que se alcanzo es del 99%, 56% y 7% para el nitrógeno amoniacal, nitrógeno orgánico y fosfatos respectivamente. En estudios en curso, además de lo anterior, se evalúa la calidad nutrimental de la biomasa para determinar su reúso como fuente complementaria de alimento para los peces. Utilizando los lodos de sistemas acuícolas intensivos para producción de biomasa en un BRM, se logra la recuperación de agua y nutrientes no utilizados por los peces, disminuyendo las descargas al ambiente.

POPULATION AND DIVERSITY OF MARINE BACTERIA, AND ITS RELATION TO PHYSICOCHEMICAL PARAMETERS OBSERVED IN CORTES SEA.

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Marine environment is an abundant source for the isolation of bacteria. Some of these bacteria will survive water pretreatments, and later reverse osmosis desalination process, and find its way to the central membranes, were they will attach to the membrane surface, proliferate, form colonies, excrete polysaccharides, and in a last stage, form a biofilm [1]. Biofilm formation alone represents 30% of the biofouling found on reverse osmosis membranes [2]. The major negative impacts of biofilms, is the clogging of membranes, resulting in an increase of pressure applied needed to perform reverse osmosis, a decrease on the resultant permeate flux, and a general reduction of the membrane's shelf life. The present study was aimed to develop an analysis of physicochemical characteristics and bacterial populations isolated in Guaymas, within the Cortes Sea. Three sampling points, include three sub points and two depths each, were set, in order to achieve various comparison data points. The first two sampling points are inside an estuarine, enclosed by a natural formation breakwater, while the third point was set on open seas. Physical parameters like Dissolved Oxygen (DO), pH, salinity (TDS), Temperature (T) directly influence microbial communities. Serial dilutions were performed to enumerate bacterial populations. Samples were taken through bailer equipment, and were kept at 4 °C. Microbial growth was completed within 24 h after the water samples were collected. In order to obtain from those extractions, the major amount of marine bacterial possible, a modified marine growth medium was designed, matching the salinity conditions found on this marine ecosystem. Bacterial diversity and population demonstrate to have a direct relation to the location of the samples, as they were taken in or outside the estuary. Finally, correlation factors between these physicochemical parameters, and the isolated bacterial colonies were also analyzed.

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TRATAMIENTO DE UN EFLUENTE INDUSTRIAL TÓXICO MEDIANTE UN PROCESO DE MEMBRANA CON UF MICELAR ASISTIDA

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En este trabajo se aborda la evaluación del tratamiento de un efluente industrial tóxico, mediante procesos de membrana micelar asistida (pmma); utilizando como agente micelar el surfactante catiónico hexadecil-trimetil-amonio (hdtma). En el estudio se realizaron cuatro pruebas, 1) tratamiento del efluente modificando el pH, 2) evaluación del efecto de la adición de una sal, 3) considerando los factores anteriores y 4) el tratamiento PMMA sin realizar ninguna modificación. Como proceso control se llevó a cabo la UF directa y los parámetros de control de calidad del efluente fueron DQO, turbiedad, conductividad, solidos totales y pH. En todas las pruebas se utilizó una membrana polimérica escala laboratorio con un umbral de corte de 13 kda.

Dentro de los resultados obtenidos se encontró que el porcentaje máximo de remoción de DQO fue de 95% en PMMA referido a la prueba 3; mientras que las pruebas 1, 2 y 4 alcanzaron porcentajes ligeramente menores a ese valor. Por tanto debido al aumento de conductividad en el efluente por la adición de sales, es recomendable utilizar un tratamiento referido a la prueba 4.

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RECUPERACIÓN DE Cr(III) DE EFLUENTES DE CURTIDURIA POR MEDIO DE ULTRAFILTRACIÓN ASISTIDA POR FORMACIÓN DE COMPLEJOS (UFAC) UTILIZANDO POLIACRILAMIDA COMO ACOMPLEJANTE

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En este trabajo se reportan los resultados obtenidos en la retención del Cr(III) contenido en soluciones sintéticas y reales (baños de curtido provenientes de una industria curtidora de León, Gto.), por medio de Ultrafiltración Asistida por Formación de Complejos, utilizando como polielectrolito una poliacrilamida (PAM) comercial, con el objetivo de realizar una retención eficiente del Cr(III) en condiciones de acidez de los baños de curtido. Primeramente se estudió la formación del complejo entre el Cr(III) y la PAM, en diferentes condiciones y en función del tiempo. Las soluciones así obtenidas se utilizaron para realizar el estudio de la retención del complejo Cr(III)-PAM por una membrana de UFAC con diferentes pesos moleculares de corte. Se evaluaron diferentes parámetros tanto químicos como hidrodinámicos que tienen influencia en la eficiencia del proceso de retención como son el pH, la concentración del polielectrolito, la concentración de ion metálico, el contenido de iones sulfato, y la presión de trabajo. Los resultados obtenidos muestran que el porcentaje de retención del complejo PAM/Cr(III) depende del pH, teniéndose a un pH < 3 una retención por abajo del 50% y a un pH arriba de 4, se tienen retenciones del 95%.. Los iones sulfato tienen influencia en la eficiencia de retención de Cr(III), ya que a mayor concentración la retención de Cr(III) es menor. El porcentaje de retención del complejo PAM/Cr(III) aumenta con el incremento de la concentración de poliacrilamida. Teniendo a concentraciones de PAM de 1.13×10^{-2} mol/L (3% p/v) una retención de Cr(III) por encima del 90%, tanto a pH 3.5 como a pH 5.
Los resultados del estudio de la retención del Cr(III) contenido en soluciones provenientes de la industria del curtido se muestran en la Tabla 1 en donde se ha incluido el porcentaje de retención de Na^+, Mg^{2+} y Ca^{2+} los cuales se encuentran presentes en las soluciones de baño de curtido.

Tabla 1. Porcentajes de retención de Cr^{3+}, Na^+, Mg^{2+}, Ca^{2+} de un efluente de curtiduría. [PAM]= 3 g/L, [Cr(III)]= 195 mg/L, [Na^+]= 12,200 mg/L, [Mg^{2+}]= 139 mg/L, [Ca^{2+}]= 129 mg/L.

	[PAM] g/L	% R de Cr(III)	% R de Na^+	% R de Mg^{2+}	% R de Ca^{2+}
3.503	3	75.26	8.65	15	8.82
4.023	3	78.52	8.13	15.59	14.13
4.501	3	80.21	8.89	15.69	14.33

Se puede observar que el Cr(III) tiene porcentajes de retención elevados (cercanos al 80% en el intervalo de pH estudiado), en tanto que los otros iones metálicos pasan a través de la membrana, entre un 85 y 90%.
Los resultados obtenidos son muy favorables ya que se logra retener al Cr(III) logrando su recuperación y la separación de los otros iones metálicos, lo que puede permitir su reutilización en el proceso de curtido.

*WATER **T**REATME**NT***
TRATAMIENTO DE AGUA

Poster Session

OXIDACIÓN HÚMEDA CATALÍTICA DE FORMALDEHÍDO MEDIANTE UN REACTOR DE MEMBRANA

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El formaldehído es un contaminante ambiental con evidencia de efectos adversos sobre la salud a concentraciones superiores a 0.9 ppm, resulta ser un compuesto cancerígeno para los humanos [1,2]. El formaldehído existe en mayor concentración en las descargas de aguas residuales industriales, textil, farmaceutica alimentos, etc [3,4]. Debido a su toxicidad, los efluentes líquidos que contienen altas concentraciones de formaldehído son difíciles de tratar por procesos convencionales, por lo que es necesario el uso de tecnología avanzada que puede ser combinada con los sistemas convencionales para hacer posible una mejora significativa en la calidad del efluente de agua [5]. Por lo tanto, los tratamientos químicos de oxidación surgen como solución prometedora para la degradación de compuestos orgánicos. En particular, la oxidación húmeda catalítica (CWO), ya que las condiciones de operación son más suaves, selectivas a la formación de CO_2 como producto final de la oxidación de los contaminantes orgánicos [5,6]. El CWO es un proceso que generalmente se lleva a cabo en reactores convencionales, una alternativa potencial es utilizar otro tipo de reactores como puede ser el reactor de membrana catalítica. El cual se basa en el uso de una membrana como soporte donde se deposita el catalizador, el fundamento de este tipo de reactor consiste en hacer que las fases hagan contacto en la superficie de la fase activa depositada sobre el soporte cerámico poroso [7].

En este trabajo se presenta la síntesis de una membrana catalítica y catalizadores en polvo de óxidos mixtos de Co-Cu-Ce soportados en Al_2O_3 comercial en polvo y en una membrana tubular de microfilatración comercial de γ-Al_2O_3, que es usada como soporte para el deposito de la fase activa de Co-Cu-Ce. Los catalizadores fueron caracterizados por XRD, SEM/EDS. Para evaluar la eficiencia de los materiales catalíticos impregnados con los óxidos mixtos se realizaron estudios de actividad catalítica con la reacción CWO de una solución de formaldehído con concentración de 500 ppm en un reactor de membrana semicontinuo y en un reactor convencional de tanque agitado, con flujo continuo de la fase oxidante. Con ambos sistemas de reacción se obtiene 75% de coversión, pero el catalizador en polvo presenta desactivación tras el primer ensayo de reacción, no así la membrana catalítica, que continua activa despues de 4ciclos de reacción, además de que las pruebas de permeación con N_2 antes y después de los ensayos, presentan valores similares (antes 1.95×10^{-7} mol $N_2\cdot m^{-2}\cdot s^{-1}\cdot Pa^{-1}$ y después 1.39×10^{-7} mol $N_2\cdot m^{-2}\cdot s^{-1}\cdot Pa^{-1}$) por lo que se podría sugerir que la membrana no absorbió productos secundarios dado que se presume que estos no se formaron por el tipo de contacto entre las fases que se tiene en esta configuración dereactor de membrana tipo contactor.

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POTENCIALES INDICADORES DE LA OPERACIÓN DE UN BIORREACTOR CON MEMBRANAS SUMERGIDAS, PARA EL TRATAMIENTO DE UN EFLUENTE ACUÍCOLA

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Recientemente se ha incrementado la búsqueda de indicadores que permitan controlar la operación de reactores biológicos. En este caso se estudia la microfauna presente en la biomasa de un Biorreactor con membranas sumergidas (BRM), como un indicador del rendimiento del proceso biológico del tratamiento. Se empleó un biorreactor, con un módulo de membranas planas sumergidas, a escala laboratorio, el cual fue alimentado continuamente con los sólidos residuales de un RAS (sistema acuícola recirculado; por sus siglas en inglés: recirculated aquaculture system), de cultivo de tilapia (*Oreochromis niloticus*). Se probaron 5 niveles de carga orgánica (CO): 0.05, 0.1, 0.2, 0.3 y 0.5 g_{DQO}/g_{SSVLM}•d. Se monitorearon constantemente los parámetros de operación (*e.g*. carga orgánica, DQO, oxígeno disuelto, eficiencia de remoción, velocidad de consumo de oxígeno, sólidos suspendidos); así como el análisis microbiológico. Se identificaron, a nivel de género, 35 taxas de protozoarios y metazoarios presentes en la biomasa y se clasificaron con base en los grupos principales: ciliados fijos, ciliados reptantes, ciliados libres, ciliados carnívoros, amebas testadas, rotíferos, suctíferos y nematodos. Se determinaron abundancias relativas y se estimaron los índices de diversidad biológica. Los resultados muestran que a medida que se va incrementando la carga orgánica, hay una evolución de las diferentes comunidades presentes en la biomasa y que una mayor diversidad de géneros de microfauna interactuando entre sí, en especial degradando y consumiendo la mayor parte de la materia orgánica, podría suponer un mejoramiento del funcionamiento del sistema ecológico dentro del reactor. Los resultados obtenidos en el análisis estadístico (DCA; por sus siglas en inglés: Detrended Correspondence Analysis y Regresión Lineal) muestran que se establecieron cinco comunidades de microfauna correspondientes a cada carga orgánica, estructuradas funcionalmente, de acuerdo con sus requerimiento nutricionales, condiciones ambientales y de operación del reactor biológico. Además se identificaron algunas poblaciones que están altamente correlacionadas con algunas variables operativas (R^2>80%), las cuales podrían ser establecidas como bioindicadores del funcionamiento del sistema ecológico dentro del reactor.

TRANSPORT OF VANADIUM (V) THROUGH POLYMER INCLUSION MEMBRANES

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Increasing use of vanadium in different industries including alloys and steel manufacturing, electrochemical coating and catalysts causes environmental concern about the toxic effluents [1]. Several techniques have been proposed for the recovery of vanadium, such as leaching followed by precipitation, ion exchange and solvent extraction [2]. Separation of vanadium by liquid membranes is recommended for low concentration solutions [3].

In the present research, the extraction of vanadium (V) from natural waters was studied using polymer inclusion membranes in order to achieve optimal extraction conditions. Membranes were synthetized using Aliquat 336 (trioctyl methyl ammonium chloride) as extractant, 2-nitrophenyl octyl ether (2-NPOE) as plasticizer and cellulose triacetate (CTA) as polymeric support. Solutions of NH_3 and NaOH were used as stripping phases. Best transport of vanadium was obtained with solutions of NaOH.

The effect of the NaOH concentration (0.1–0.5 M) was studied as well, a recovery exceeding 90% was obtained at 0.5 M. In addition, extractant concentration was varied (13.3–38.1% w/w); the best transport was obtained with the highest concentration. The effect of plasticizer concentration was also studied (5.3–28% w/w), best results were obtained at 14.3% w/w. Finally, it was observed that while the concentration of vanadium increases, transport decreases.

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