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TRANSFERÊNCIA DE CONHECIMENTO E TECNOLOGIA

LIVRO DE ACTAS

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15-16 DE DEZEMBRO DE 2011

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PROGRAMA DA CONFERÊNCIA / CONFERENCE PROGRAMME

Thursday, 15 December

- 09.00 - 09.30 Registration, Anfiteatro 8.1, Faculty of Engineering
- 09.30 - 10.00 **WELCOME SESSION AND PRESENTATION OF THE RESEARCH UNIT OF TEXTILE AND PAPER MATERIALS**
Ana Paula Coelho Duarte, Vice-Rector for Research and Innovation and Coordinator of the Research Institute
Manuel José dos Santos Silva, Coordinator of the MTP research unit
- 10.00 - 13.00 **SESSION I**
Chairpersons: Rogério Simões and Ana Lopes
- 10.00 - 10.30 **A UBI e o empreendedorismo**
Ana Paula Duarte
ICI, Universidade da Beira Interior
- 10.30 - 11.00 **Dinâmica da interacção tinta / papel na impressão inkjet**
Luís Amaral², António Mendes de Sousa², Nuno Oliveira², António Mendes¹, Sónia Sousa¹, Paulo Fiadeiro¹, Ana Ramos¹
¹ MTP Unit, University of Beira Interior, 6201-001 Covilhã, Portugal
² RAIZ - Institute of Forest and Paper Research, Apartado 15, 3801-501 Eixo, Portugal
³ Grupo Portucel-Soporcel
- 11.00 - 11.30 **Coffee Break and Poster Session**
- 11.30 - 11.45 **Steady and Unsteady Bifurcation Flows of Non-Newtonian Inelastic Fluids**
Hélder Matos, Paulo Oliveira
UMTP, Departamento de Engenharia Electromecânica, Universidade da Beira Interior, Portugal
- 11.45 - 12.00 **Ultrafiltration and biodegradability of cork processing wastewaters: influence of pH**
A. Gomes¹, L. Silva¹, R. Simões¹, N. Canto¹, A. Albuquerque²
¹ UMTP and Department of Chemistry, University of Beira Interior
² Department of Civil Engineering and Architecture, University of Beira Interior, 6201-001 Covilhã, Portugal
- 12.00 - 12.15 **Application of electrochemical methods in sanitary landfill leachate treatment**
A. Fernandes, D. Norma, M. J. Pacheco, L. Ciríaco, A. Lopes
UMTP and Department of Chemistry, University of Beira Interior, 6201-001 Covilhã, Portugal
- 12.15 - 13.00 **Discussion**
- 13.00 - 15.00 **Lunch at the Great Hall of the Faculty of Engineering and Poster Session**
- 15.00 - 18.30 **SESSION II**
Chairpersons: José Lucas and Madalena Pereira
- 15.00 - 15.30 **Effect of continuous post-setting on crystallinity and thermomechanical behaviour of False-Twist Textured Polylactide multifilaments**
A. M. Manich¹, J. Carilla¹, D. López-Santana¹, B. Baena¹, M. Riba², R Prieto², L. Montero², D. Cayuela²
¹ IQAC-CSIC, Barcelona (Spain)
² INTEXTER-UPC, Terrassa (Spain)

- 15.30 - 16.00 **Sensory Analysis: A New Tool to Characterize Textile Materials**
M. E. Cabeço-Silva, C. Nogueira
 Centro de Ciência e Tecnologia Têxtil, Universidade do Minho, Guimarães, Portugal
- 16.00 - 16.30 **Coffee Break**
- 16.30 - 16.45 **Separation of plasmid DNA from non clarified lysate impurities using berenil as ligand in pseudo-affinity chromatography**
 C. Caramelo-Nunes^{1,2}, M. F. Gabriel^{1,2}, P. Almeida^{1,2}, J. C. Marcos³, C. T. Tomaz^{1,2}
¹ CICS-UBI – Health Sciences Research Centre, University of Beira Interior, 6201-001 Covilhã, Portugal
² Department of Chemistry, University of Beira Interior, Covilhã, Portugal
³ Centre of Chemistry, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal
- 16.45 - 17.00 **Biodegradability of olive mill wastewater**
Luís Roberto Fernandes, Arlindo C. Gomes, Rogério S. Simões
 UMTF and Department of Chemistry, University of Beira Interior, 6201-001 Covilhã, Portugal
- 17.00 - 17.15 **Electrochemical degradation of clofibric acid at different anode materials**
D. Santos¹, M. J. Pacheco¹, A. Gomes², A. Lopes¹, L. Ciríaco¹
¹ UMTF and Department of Chemistry, University of Beira Interior, 6201-001 Covilhã, Portugal
² CCMM, Department of Chemistry and Biochemistry, University of Lisbon, Lisboa, Portugal
- 17.15 - 17.30 **A Perspective on key factors for successful transfer of technology**
I. G. Trindade^{1,2}, M. Pereira^{1,2}, R. Miguel^{1,2}, M. Santos Silva^{1,2}
¹ Unidade de Materiais Têxteis e Papeleiros, Rua Marquês D'Ávila e Bolama, 6201-001 Covilhã, Portugal
² Departamento de Ciência e Tecnologia Têxteis, Universidade da Beira Interior, 6201-001 Covilhã, Portugal
- 17.30 - 18.00 **Discussion**
- 18.00 - 18.30 **Poster Session**
- Friday, 16 December*
- 09.30 - 13.00 **SESSION III**
Chairpersons: Dina Mendonça, Paulo Oliveira, Hélder Matos and Elmina Lopes
- 09.30 - 09.45 **Biological activities of *Hakea sericea* Schrader**
Ângelo Luís, Ana Paula Duarte, Fernanda Domingues
 CICS-UBI Health Sciences Research Centre, University of Beira Interior, 6200-506 Covilhã
- 09.45 - 10.00 **Antioxidant activity of phenolic compounds from *Prunus avium***
S. Santos¹, J. A. Figueiredo¹, M. I. Ismael¹, R. Simões¹, J. Rodilla¹, A. P. Duarte²
¹ UMTF and Department of Chemistry, University of Beira Interior, Covilhã, Portugal
² CICS, Faculty of Health Sciences, University of Beira Interior, Covilhã, Portugal
- 10.00 - 10.15 **Estudo sobre a distribuição da velocidade do escoamento secundário de um fluido viscoelástico FENE-CR numa curva de secção quadrada**
Joana M. Malheiro¹, Paulo P. Oliveira¹, Fernando T. Pinho²
 UMTF, Departamento de Engenharia Electromecânica, Universidade da Beira Interior, Portugal

- 10.15 - 10.30 **Synthesis and characterization of electrically conductive textile/PEDOT samples**
 I. G. Trindade^{1,2}, C. Gaiolas^{1,2}, J. Lucas^{1,2}, R. Miguel^{1,2}, M. Santos Silva^{1,2}
¹ Unidade de Materiais Têxteis e Papeleiros, Rua Marquês D'Ávila e Bolama, 6201-001 Covilhã, Portugal
² Departamento de Ciência e Tecnologia Têxteis, Universidade da Beira Interior, 6201-001 Covilhã, Portugal
- 10.30 - 11.00 **Coffee Break and Poster Session**
- 11.00 - 11.15 **Ionization of Acid Orange 7 in Different Ionic Media**
M. J. R. G. Pires, M. I. A. Ferra, A. M. M. M. B. Amaro
 Chemistry Department, University of Beira Interior, 6201-001 Covilhã
- 11.15 - 11.30 **Risk assessment of water resources**
A. S. Rebelo¹, M. I. A. Ferra², A. M. M. M. B. Amaro², I. M. S. C. Gonçalves²
¹ Adm. Região Hidrog. Algarve
² Chemistry Department, University of Beira Interior, 6201-001 Covilhã
- 11.30 - 11.45 **A transferência de conhecimento e tecnologia na última década: breve análise de modelos e resultados**
 Madalena Pereira^{1,2}, Isabel Trindade¹, M.Santos Silva^{1,2}, Rui Miguel^{1,2}, José Lucas^{1,2}
¹ Unidade de Materiais Têxteis e Papeleiros
² Departamento de Ciência e Tecnologia Têxteis, Universidade da Beira Interior, 6201-001 Covilhã, Portugal
- 11.45 - 12.00 **Perovskite thin film electrodes for environmental applications produced by RF-Magnetron Sputtering**
 S. Sérgio¹, A. Costa², Y. Nunes¹, L. Ciríaco³, M. J. Pacheco³, A. Lopes³, M. I. Pereira², M. E. Melo Jorge²
¹ CEFITEC, Departamento de Física, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, 2829-516 Caparica, Portugal
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³ Departamento de Química, UMT, Universidade da Beira Interior, 6201-001 Covilhã, Portugal
- 12.00 - 12.15 **NanocrystallineTiO2 films prepared by sputtering for Rhodamine G photodegradation: catalytic efficiency, photo stability and reusability studies**
 B. Barrocas^{1,2}, O. C. Monteiro², M. E. Melo Jorge², S. Sérgio¹
¹ CEFITEC, Departamento de Física, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, 2829-516 Caparica, Portugal
² CCMM, Departamento de Química e Bioquímica, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal
- 12.15 - 13.00 **Discussion**
- 13.00 - 15.00 **Lunch at the Great Hall of the Faculty of Engineering and Poster Session**
- 15.00 - 17.00 **SESSION IV**
Chairpersons: Rui Miguel and Rita Salvado
- 15.00 - 15.30 **O efeito do conhecimento nas tramas da próxima geração têxtil**
Fernando Merino
 Centro Tecnológico das Indústrias Têxtil e do Vestuário de Portugal – CITEVE

- 15.30 - 16.00 **Eco Textile Developments**
James Mendolia
A. A. S. Fashion Marketing, Parsons The New School for Design, New York, USA
- 16.00 - 16.15 **A Intervenção do Design em Causas Humanitárias como o Controlo da Malária**
C. Pinheiro^{1,2}, M. J. Geraldés^{1,2}, R. Gomes³
¹ Unidade de Materiais Têxteis e Papeleiros, 6201-001 Covilhã, Portugal
² Departamento de Ciência e Tecnologia Têxteis, Universidade da Beira Interior, 6201-001 Covilhã, Portugal
³ Departamento de Engenharia Têxtil - Universidade do Minho, Guimarães, Portugal
- 16.15 - 16.30 **Desenvolvimento de um boné para apoio à mobilidade de deficientes visuais**
N. Nascimento^{1,2}, R. Salvado^{1,2}, F. Borges³, P. Araújo⁴
¹ Unidade de Materiais Têxteis e Papeleiros, 6201-001 Covilhã, Portugal
² Departamento de Ciência e Tecnologia Têxteis, Universidade da Beira Interior 6201-001 Covilhã, Portugal
³ Instituto Federal de Educação, Ciência e Tecnologia da Paraíba, Brasil
⁴ Universidade da Beira Interior- Instituto de Telecomunicações
- 16.30 - 16.45 **Modelização da resistência à abrasão de tecidos de lã e poliéster em função das características estruturais de fios convencionais**
N. Monteiro, R. Miguel
Unidade de Materiais Têxteis e Papeleiros e Departamento de Ciência e Tecnologia Têxteis, Universidade da Beira Interior 6201-001 Covilhã, Portugal
- 16.30 - 17.00 **DISCUSSION and FINAL SESSION**
Chairpersons: Manuel Santos Silva, Ana Lopes, José Lucas and Rogério Simões

Characterization of a leachate from a sanitary intermunicipal landfill. Analysis of the content in metals at several stages of the wastewater treatment plant.

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Abstract

In this work the content in seven metals was analysed in samples from a leachate, collected in a sanitary intermunicipal landfill. Samples were collected in three stages of the wastewater treatment plant, just before the biological treatment, just after the biological treatment and from the ultrafiltration permeate. Pb, Cr, Cu, Fe, Mn, Cd, Zn content was determined. Fe was the most abundant of the analysed metals with 22.2 mgL⁻¹ in the samples before the, 41.3 mgL⁻¹ after the biological treatment and 4.0 mgL⁻¹ in the ultrafiltration permeate. Cd content was below detection limit of AAS. Zn, Cu, Cr, Mn and Pb contents are between those limits. The values obtained are in accordance with the range reported in the literature for the analyzed metals. The results obtained suggest that there is a higher concentration of metals in the fraction after the biological treatment, consistent with the fact that there is a recirculation of the ultrafiltration concentrate to this stage. The permeate of ultrafiltration presents the lowest metal content, which indicate an efficiency of the treatment stages so far in metal removal. From the point of view of metal recovery, the best stage to collect samples seem to be after the biological treatment.

Introduction

Leachates from landfills constitute an environmental problem due to infiltration and contamination of soils and groundwaters. In their composition there are four main groups of pollutants designed in literature as dissolved organic matter, inorganic macrocomponents, xenobiotic organic compounds and heavy metals^{1,2}.

Heavy metals are an environmental problem because they tend to accumulate in living organisms and are not biodegradable. On the other hand, some metals have economical interest and it is important to find ways to recover them. So, to remove metals may have both an environmental and an economical motivation³.

The design of wastewater treatment plants (WWTP) dedicated to leachates from landfills may have multiple approaches². In this study the WWTP performs a treatment that comprises a biological step, followed by an ultrafiltration operation. The ultrafiltration concentrate is recirculated into the biological treatment.

In order to analyze the best point where to start an efficient metal recovery procedure in the leachate treatment process, we decided to collect samples from several stages in the leachate treatment process and analyse the content in several metals.

In this work we characterize a leachate from a sanitary intermunicipal landfill concerning seven metals (Pb, Cr, Cu, Fe, Mn, Cd, Zn) in three stages of the wastewater treatment plant: before the biological treatment, after the biological treatment, and from the ultrafiltration permeate.

Materials and Methods

1. Sample collection

The leachate samples in the study were provided by a municipal sanitary landfill and collected in November of 2010. A single sample was collected at each point in containers of 5L. The first sample was collected, just before the biological treatment, the second was collected in the same way just after the biological treatment and a third sample was collected from the permeate of the ultrafiltration. The samples were placed at 4°C until processing and analysis.

2. Sample treatment

All material used in the experimental part was decontaminated using an acid solution with nitric acid and distilled H₂O in the ratio of 1:5.

The samples studied had a heterogeneous appearance, dark color and high turbidity and so in order to obtain representative samples for analysis, the vessels containing the samples were intensively stirred to homogenize all of your content.

The pH was measured in the unit WTW pH Meter 526.

To prepare the samples for the analysis was followed a treatment process of acid digestion. Samples were placed in erlenmeyers with differential proportions of *aqua regia*. Appropriate volumes of *aqua regia* were added to different samples, since it is important to minimize the volume. The results obtain have shown that it was sufficient a ratio of 1:3 (3 parts of *aqua regia* for 1 part of sample in volume) in samples “before the biological treatment”, a ratio of 2:3 (3 parts of *aqua regia* for 2 parts of sample) for samples “after the biological treatment” and finally the ratio of 2:1 (half the volume of the sample in *aqua regia* was used in this case) for the samples of ultra-filtration permeate.

In order to improve the efficiency of sample digestion, the capped samples were subjected to magnetic stirring (Breda Scientific) about 30 min at 40-60°C making digestion and evaporation more efficient and faster. After this step, the samples were placed in a sand bath at 110±10 °C to total digestion of organic matter, i.e. the final solution it must be clear and transparent. Then, the samples were filtrated for flasks using filter paper, always at the lowest possible volume.

1. Analysis by Atomic Absorption Spectroscopy (AAS)

For the metals analysis an atomic absorption spectrometer Perkin-Elmer Model 3100 was used. Standard solutions of each metal were prepared from standard solutions by proper dilution with HNO₃ 0.01M. Three samples of each stage were measured and corresponding statistical treatment of the values was performed.

Results and Discussion

Before any sample collection the pH of each one was measured. The sample “before the biological treatment” had a pH of 8.11, the sample “after the biological treatment” had a pH of 7.80 and the sample “ultrafiltration permeate” had a pH of 6.77. This is in accordance with the fact that before the ultrafiltration, an acidification process occurs.

The sample of first stage of the treatment process was more difficult to digest; requiring a larger volume of *aqua regia* and longer digestion followed by the sample after

biological treatment, and finally, the sample of the permeate of the ultrafiltration, which requires a lower volume of digestion solution and less time for digestion. These are consistent with the content in organic matter of each stage. The results obtained are presented in Table 1. Fe was the most abundant metal. Cr and Zn present also significant values. The metals content is within the range of values presented in literature^{2,5} for leachates of landfills.

The stage after the biological treatment is where the leachate presents the highest metal content. This is probably due to the fact that there is a recirculation of the concentrate of the ultrafiltration back to the tanks where the biological treatment occurs. It is a result consistent with the evaluation made in literature^{1,6,7} i.e. that metals in leachates are mostly associated with organic molecules and adsorbed on colloidal fractions.

Table 1 – Metals content in each stage of collection of landfill leachate (mg L⁻¹)

Stage of collection	Fe	Cr	Zn	Cu	Mn	Pb	Cd
Before biological treatment	22.34 ± 0.03	4.04 ± 0.30	1.76 ± 0.39	0.12 ± 0.00	0.40 ± 0.07	-*	-*
After biological treatment	41.27 ± 0.13	5.48 ± 0.00	2.36 ± 0.10	0.21 ± 0.00	0.66 ± 0.00	0.31 ± 0.10	-*
ultra-filtration Permeate	4.01 ± 0.18	0.79 ± 0.00	0.52 ± 0.03	0.01 ± 0.00	0.10 ± 0.01	0.09 ± 0.00	-*

* values obtained are not within the limit of detection.

Conclusions

The studied leachate presents low concentrations on the metals studied, namely on the heavy metals Pb and Cd.

The leachate samples just after the biological treatment present the highest metal content. This may be due to the recirculation of the ultrafiltration concentrate back to the lagoon where the biological treatment is done.

This study characterized the leachate from a intermunicipal landfill at several stages of the WWTP showing that the content in the analysed metals is within the ranges described in literature.

References

1. Kjeldsen, P., Barlaz, M. A., Rooker, A. P., Baun, A., Ledin, A. and Christensen, Present and long-term composition of MSW landfill leachate: a review, *Critical Reviews in Environ. Sci. and Tech.*, 32, 298, 2002.
2. Renou, S., Givaudan, J. G., Poulain, S., Dirassouyan, F. and Moulin, P., *J. Hazardous Mat.*, 150, 468, 2008.
3. Fu, F and Wang, Q., Removal of heavy metals from wastewaters: an overview, *J. Environmental Management*, 92, 407, 2011.

4. Rodrigues, P., “Degradação Electroquímica Aplicada ao Tratamento de Lixiviados de Aterros Sanitários”. Ms. Dissertation, Universidade da Beira Interior, Covilhã, 2010.
5. Öman, C. B. and Junestedt, C., Chemical characterization of landfill leachates – 400 parameters and compounds, *Waste Management*, 28, 1876, 2008.
6. Jensen, D. L., Ledin, A. and Christensen, T. H., Speciation of heavy metals in landfill leachate polluted groundwater, *Wat. Res.*, 33, 2642, 1999.
7. Gounaris V., Anderson, P. R. and Thomas M. Holsen, T. M., Characteristics and Environmental Significance of Colloids In Landfill Leachate, *Environ. Sci. Tech.*, 27, 1381, 1993.

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