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Water Crisis:

challenges and solutions

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Development of electrochemical sensor based on carbonaceous materials and magnetic nanoparticles for the determination of the Tetracycline in real samples

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Tetracycline (TC) is one of the most commonly antibiotics used in humans and in veterinary medicine. In humans is used to treat disease and also applied to livestock to prevent disease and promote growth. However, their occurrence in aquatic systems has become a concern, as biological impacts and potentials risks to the environment, as well as to human health and consequently the propagation of antimicrobial resistance. Therefore, sensitive, rapid and simple techniques to detect TC residues in environmental samples would be crucial. The electrochemical sensors, in this context, are a viable alternative have low cost and easy sample pre-treatment. In this work was developed an electrochemical sensor with multi-walled carbon nanotubes (CNT) and magnetic core-shell Fe_3O_4@SiO_2 nanoparticles (MNP). The NTCs have their main properties such as high surface area and excellent electrical conductivity. The magnetite (Fe_3O_4) is the magnetic core coated of silica, not only stabilizes the nanoparticles in solution but also provides protection against toxicity. The identification and characterization of functional groups were carried by Fourier Transform InfraRed Spectroscopy (FT-IR). The surface morphology of this materials was done by Scanning Electron Microscope (SEM). The electrochemical measurements were carried with a conventional three-electrode system. A glassy carbon electrode (GCE) modified CNT/MNP as working electrode, an Ag/AgCl electrode as reference electrode, and a platinum wire as auxiliary electrode. The electrochemical behavior of this modified electrode CNT/MNP and the oxidation of TC were investigated by differential pulse voltammetry (DPV) in 0,2 mol/L potassium chloride solution (pH 3,0), used as electrolyte support. Under the optimized conditions, the peaks currents increased linearly with the concentration de TC, in the range from 13,0 to 140,0 µmol/L, with a detection limit of 3,78 µmol/L and quantification limit of 12,6 µmol/L. The kinetic parameters α (charge transfer coefficient) and k_s (heterogeneous electron transfer rate constant) were estimated to be 0,299 and 11,64 s^{-1} respectively. Detection of TC tetracycline will be performed on samples of river water in the response range studied.

Keywords: Tetracycline; Sensor Electrochemical; Multi-Walled Carbon Nanotubes; Magnetic Nanoparticles; Glassy Carbon Electrode.

Financial support: Capes, CNPq, Fapemig and Rede Mineira de Química

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

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Turbidity reduction of raw waters from the water treatment plant of São Brás do Suaçuí, MG, using different coagulants in bench scale.

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In the present work, a bench scale study was carried out to compare the performance of aluminum sulfate and ferric chloride as coagulants in the reduction of turbidity and apparent color of raw water affluent to the water treatment plant in the municipality of São Brás do Suaçuí, MG. Currently the plant uses conventional treatment to treat water and treats on average 14 $L \cdot s^{-1}$. During the treatability study, the ferric chloride coagulants, which is used in the plant, and aluminum sulphate were tested at the following doses 5.0 $mg \cdot L^{-1}$, 6.0 $mg \cdot L^{-1}$, 7.0 $mg \cdot L^{-1}$ (0.03081 $mM \cdot L^{-1}$, 0.03697 $mM \cdot L^{-1}$, 0.04313 $mM \cdot L^{-1}$ Fe) and 0.01762 $mM \cdot L^{-1}$, 0.029605 $mM \cdot L^{-1}$, 0.01727 $mM \cdot L^{-1}$ of Al), respectively. The study was conducted from August to November 2018 and the samples were collected weekly. The tests were carried out in the sanitation laboratory at the Alto do Paraopeba campus of UFSJ. All analyses were performed according to the recommendations of the Standard Methods for the Examination of Water and Wastewater (AMERICAN PUBLIC HEALTH ASSOCIATION, 2005). To determine the alkalinity, the titration method was used. For analysis of the of the data obtained during the experiment, the Statistica 7.0 software was used to evaluate if there was a significant difference between the turbidity values of the raw samples and those of the treated water samples in relation to different doses of coagulant used. The Kruskal-Wallis test was used, non-parametric test, considering a level of significance (α) of 5%. In light of the results obtained, it can be observed that all turbidity values of the raw water were below 20 uT, except in an experiment whose peak reached 135 uT. In relation to the water decanted in the results obtained, it was observed that the best results occurred when ferric chloride 7 $mg \cdot L^{-1}$ was used, with removal of 69.04% in turbidity and 64.47% in apparent color. All values of apparent color were below 15 uH, that is, they met Portaria nº 2.914 / 2011 (Brazilian Potability Standard), except for the peak of turbidity. It is worth mentioning that the filtration step should be performed, which will contribute to a greater reduction of the parameters analyzed. When analyzing the decanted water results for both coagulants considering all dosages there was no significant difference in the turbidity values p = 0.2325 and the apparent color p = 0.4802 of the decanted water samples, considering a significance level of 5 %, that is, p was greater than $p_0 = 0.05$.

Keywords: Water treatment; jar test; turbidity; color; potability.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Removal of Fluoride from Industrial Wastewater through Adsorption onto Bovine Bone Char

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As the perception of scarcity causes water to be considered a natural resource with social, strategic and economic value, a growing necessity of proper wastewater disposal, as well as treatment for industrial reuse purposes, is observed. Fluoride, a contaminant which was commonly found and studied in natural groundwater, has also become a challenge for some industrial sectors, due to its high load throughout some processes, what demands specific treatment for removal. One of the options among several technologies is adsorption, mainly when low cost adsorbents are applied. Bovine bone char, produced from solid waste generated by food industry and tannery, and whose structure differs from conventional charcoal, as it is mainly composed by calcium phosphate as hydroxyapatite and low quantities of $CaCO_3$, becomes an interesting adsorbent, as far as fluoride removal is concerned. In this context, this study aimed at investigating the removal of fluoride from wastewater through adsorption onto bovine bone char. The adsorption batch mode tests were carried out to assess removal percentage at different solid/liquid ratios (0,5; 1,0; 2,5; 5,0; 10,0; 20,0; 40,0; 80,0 g of bone char/kg of effluent), in a shaker, at 25,0 ± 0,1 °C, 180 ± 1 rpm, for 24 hours. Fluoride in the wastewater was quantified by the ion-selective electrode method. The adsorbent presented high potential for fluoride removal from wastewater and the percentage of removal of fluoride increased with the solid liquid ratio, reaching 99% of removal for the largest ratio assessed (80 g of bone char/kg of effluent). For a solid/liquid ratio of 40 g of bone charl/kg of effluent, a removal of 94% was already possible, meeting legal Brazilian standards of 10 $mg.L^{-1}$ of fluoride for effluent discharge, using 50% the mass of adsorbent, thus, being more economically attractive. Fluoride adsorption isotherms (Langmuir and Freundlich models) were fitted to experimental data and Freundlich model best fit (R^2=0,99) may suggest physisorption mechanism. The maximum adsorption capacity was 4.38 mg of fluoride/g of bone char, and results suggest a promising performance of this adsorbent to remove fluoride from real industrial wastewater.

Keywords: Adsoprtion; Fluoride; Bovine bone char; Industrial wastewater.

Financial support: CNPq, Fapemig, Universidade Federal de São João del Rei.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

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SYNTHESIS, CHARACTERIZATION AND APPLICATION OF COMPOSITES BASED ON CARBON XEROGELS /TiO_2/Fe_3O_4

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Carbon xerogels, CX, are nanostructured materials, characterized by a structure of micro, meso and macropores interconnected through carbon nanospheres, whose size can be modified by varying the conditions of synthesis. One of the main applications of CXs is in catalysis, where these materials function as support for the catalysts metals. The CXs have high adsorbent capacity which favors the contact of the substrate with the catalyst. One major challenge in the use of catalysts is their separation, recovery and reuse. The magnetic separation by the introduction of magnetic particles into the photocatalytic material has been proposed as a viable alternative, although in some cases reduction of the photocatalytic properties is verified when incorporated with titanium oxide. This project aims to explore the production of nano-composites based on CX and TiO_2 containing magnetic particles. This composite should have photocatalytic properties, which must be tested for the degradation of N- (4-hydroxyphenyl) acetamide, commercially known as paracetamol. This is an analgesic and antipyretic, being classified as one of the three most commonly used drugs. The presence of the magnetite and the anatase and rutile phase for TiO_2 and the presence of carbon were verified through the characterizations, using raman spectroscopy, X-ray diffraction. The model molecule used to evaluate the photocatalysis was paracetamol. A magnetic nanocomposite with 90% efficiency in paracetamol degradation in 3 hours was obtained through the sol-gel process. It was measured by absorption in the UV-Vis spectrophotometer (Cary 50 - Varian). The degradation of paracetamol was proven verified by HPLC. In this work, composites based on CXs / TiO_2 / Fe3O4 with photocatalytic and magnetic properties were produced. The presence of the magnetite and the anatase and rutile phase for TiO_2 were verified through the characterization. The recovery and reuse of the CXMTi-Fe_3O_4@SiO_2 composite has not yet been completed in this part of the study, however preliminary studies have indicated that the material after use can be cleaned with the use of UV radiation.

Keywords: catalysts 1; nanostructured materials 2; magnetic nanocomposite 3; Carbon xerogels 4; degradation 5.

Choose the Thematic Area: ( ) TA1 ( ) TA2 (x) TA3 ( ) TA4

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Enzyme - based biodegradation of 2,4 dichlorophenol and 4-Bromophenol in aqueous solution.

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Chlorophenols and bromophenols compounds are fast recognized as hazardous compounds and their disposal may contaminate soil and water causing a serious ecological problem as environment. These compounds are widely used in polymer industries and in the manufacture of pesticides and herbicides, therefore, the removal these pollutants is currently relevant. In this context, the use of enzymes in the biodegradation of phenolic compounds is an efficient, low cost and ecologically friendly alternative, since these natural catalysts acts under mild conditions of temperature and pressure and is biodegradable. In this study *horsehadish peroxidase* enzyme (HRP) was investigated as catalyst in the removal of 2,4 dichlorophenol (2,4 DCP) and 4 – bromophenol (4 -BP) in water. The pollutants (1,2 mmol. L^{-1}) were degraded by HRP (16,65 ± 1,27 U $mL^{-}1$) in a reaction medium containing 2,4 mL of phosphate buffer (0.05 mol L^{-1}, pH 6.5), 0.8 mL de H_2O_2 (2 mmol L^{-1}) and 0.2 mL of enzymatic solution. The degradation assays were carried at 25º C by 30 minutes. Controls were carried out in the absence of H_2O_2. The HRP catalyzed degradation was 71.92 ± 0.76 % for 4-bromophenol and 93.18 ± 0.71 % for 2,4 - dichlorophenol after only 30 minutes of reaction. The controls carried out in the absence of H_2O_2 suggest the adsorption of phenolic compounds on the catalyst surface, since was observed a removal of approximately 47% and 37% of 4 - bromophenol and 2,4 dichlorophenol, respectively, in the absence of these co-substrate. The rapid degradation of investigated compounds in this work (only 30 minutes) is a great advantage when compared to others enzymatic treatments described in the literature which major drawback is related to long treatment period (until 10 hours). On the one hand the physical and chemical methods frequently used to reduce the chlorinated and brominated organic compounds pollution shows several limitations such as high cost, limited degradation ability, and hazardous by products. Therefore, the enzymatic treatment proposed on this work has potential application in the treatment of industrial effluents containing 2,4-DCP and 4 - BP.

Keywords: phenolic compounds; biodegradation; wastewater treatment; peroxidase enzyme.

Financial support: CAPES, CNPq and FAPEMIG.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Impact of catchment land use on stream periphyton communities and whole-stream metabolism at the Atlantic Forest – Cerrado transition

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The transformation of natural into human-altered landscapes may adversely affect lotic ecosystems by altering their water quality, ecosystem structure and functioning. Aquatic biofilms are key biological compartments of streams and rivers, contributing significantly to their ecosystem metabolism, as well as carbon and nutrient cycling. The aim of this study was to assess land-use effects on stream water quality, algal biofilm community structure, as well as whole-stream metabolism, by comparing these variables among streams with differing land cover and use (pasture, agriculture and urbanization, as well as control streams with natural vegetation). The studied streams are located in the Rio das Mortes catchment, in the upper Rio Grande basin, in a transition zone between the Atlantic Forest and the Cerrado savanna biomes. Land use affected stream water quality and urban stream exhibited highest concentrations of nitrogen (N) and phosphorus (P) forms and dissolved organic carbon (DOC), as well as lowest concentrations of dissolved oxygen (DO) among the studied streams. The investigated agricultural stream had higher dissolved N concentrations, and the studied pasture stream lower dissolved inorganic N and DOC concentrations than natural reference streams. There were significant differences in algal community structure among streams of different land use. A distance-based redundancy analysis (dbRDA) suggested that algal community structure, as identified by light microscopy, was affected by land use, which explained 46.3% of the community variability among streams types. Stream characteristics, such as nutrient and DO concentrations, light and temperature conditions, as well as pH values partially explained the variability in community structure. Further, ecosystem metabolism, i.e. rates of gross primary production (GPP) and community respiration (CR), of the studied streams was assessed by the open-channel DO change technique. All streams were heterotrophic (GPP:CR < 0.5) suggesting that the metabolic activity of streams in the studied region is mainly supported by allochthonous C sources. The highest average GPP among all streams was found in an urban stream (5.25 g DO m^{-2} d^{-1}). Rates of CR were also highest in urban streams, and measured values were among the highest reported in the literature (70 g DO m^{-2} d^{-1}), pointing to massive organic C inputs into urban streams associated with domestic sewage discharge. Agricultural streams did not differ from natural streams in GPP and CR. Low GPP rates in pasture/agriculture streams (≅ 0.3 g DO m^{-2} d^{-1}) may have been due to substrate characteristics, since the fine and unstable sediments present in these streams are commonly considered poor substrates for algal colonization. Additionally, cattle trampling may have contributed to increased water turbidity. Moreover, a reduction in allochthonous organic matter inputs to agricultural streams, caused by riparian clearcutting, may have influenced CR in these streams. In summary, our results suggest that land use adversely affects ecosystem structure and functioning of running waters at the at the Atlantic Forest – Cerrado transition, and that impact mechanisms are land use type-specific.

Keywords: land use changes; stream biofilm; algal biofilm; whole-stream metabolism.
Financial support: CAPES, FAPEMIG, CNPq

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student ( ) Graduate Student (x) Professional

Adsorption of paracetamol from water using tannin of guava leaves (Psidium guajava) as precursor of nanostructured *carbons*

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(1) Carbon xerogels (CXs) are porous materials obtained from the polycondensation of aromatic substances, resorcinol being the main raw material used. These materials have an ordered structure of pores, (mesopores combined with micro/macropores) and for this reason can be used in a number of applications, including in adsorption of drugs. Although resorcinol is the most commonly used reagent in the production of CXs, it is expensive and harmful to the environment. Consequently, studies with cheaper and environmentally correct precursors have been conducted in recent decades. Tannins are promising materials, these are natural phenolic compounds derived from wood. The use of tannins to prepare carbon xerogels is not common in the literature, in addition, the formulations reported so far are totally different from those of the present study. In this work was studied the use of guava leaves (*Psidium guajava*) tannin extract (ET) for the production of nanostructured carbon. The tannin carbon xerogel (CXT) produced was used for paracetamol adsorption purposes. The use of drugs has been growing worldwide and is directly related to the increase of the contamination of the environment by these compounds. This contamination occurs mainly when drugs and their metabolites are excreted from the human body through feces and urine. These can be found in surface water and groundwater due to incomplete removal at sewage treatment plants. (2) The CX synthesis process involved the extraction in different ethanol/water ratios and subsequent condensation with aqueous formaldehyde solution, the pH was maintained equal to 3. The organic gel was obtained after 7 days in a water bath at 70 °C. After drying the gel was pyrolyzed at 800 ° C in a tubular oven under N_2 atmosphere, then the adsorption studies were performed. (3) The characteristics of the CXTs obtained were found to be dependent on the alcoholic content of the extract. As the CXTs obtained with higher alcohol content presented a morphology closer to the CXs, a higher hydrophobic character and higher gel density. (4) Comparing the data obtained in paracetamol adsorption, it was observed that the highest value of adsorption capacity (Q) was found for CXT0:100 and CXT10:90, which is in agreement with the textural characterization. The CXs with lower alcohol content presented higher surface area values and average pore diameter. (5) This work demonstrated the potential of guava tannin extracts (*Psidium guajava*) as raw material to obtain porous carbons by the sol-gel process. In addition, its application as an adsorbent in the removal of paracetamol in aqueous solution has been shown to be efficient.

Keywords: guava, carbon gels, tannins, leaves, paracetamol

Financial support: CAPES and FAPEMIG

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Removal of black eriochrome textile dye from aqueous solution by combined electrocoagulation-electroflotation methodology

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Synthetic dyes from the textile industry are used on a large scale, generating several problems in the environment. The textile sector stands out due to the high demand of water required in its processes and the consequent generation of large volumes of effluents, and It is estimated that in the production of cotton fabric, for example, water consumption may range from 100 to 300 $L.Kg^{-1}$. When these dyes are dumped without proper treatment in aqueous effluents, they immediately interfere with the aquatic ecosystem in several ways. One of the great difficulties for the treatment of this type of industrial waste is the fact that it is very refractory to conventional treatments, persistent and carcinogenic, besides being bactericidal, which makes its treatment very difficult. An alternative to conventional methods of treatment of effluents is the process of electroflotation (EF) and electrocoagulation (EC), an example of an electrochemical process. This technique is based on the formation of the coagulating agent that occurs due to the electrolytic dissolution of sacrificial anodes, aluminum or iron. Gas bubbles - O_2 and H_2 - are formed in parallel with the electrolysis of the water molecules, and thus the electroflotation is coupled to the electrocoagulation process. Thus, the objective of this study was the investigation of the influence of functional parameters of electrocoagulation, such as pH, amount of electrolyte and applied potential, in the removal of dye color of aqueous solution. All solutions investigated were produced in order to simulate a textile industrial wastewater. For this purpose, it was prepared samples containing the dye black eriochrome, and All experiments were performed in order to evaluate the color removal efficiency CR (%) using the formula: CR (%) = {Abs_0 – Abs / Abs} x 100, where Abs_0 is the initial absorbance of dye and Abs is the absorbance after electrocoagulation/electroflotation process. The experiments were monitored by an UV/VIS spectrophotometer Shimadzu model UV3600 (maximum absorbance λ= 537 nm). In studies where the initial concentration of the dye was varied, the values used were 0.20 to 1.00 $g.L^{-1}$. The results showed that the electroflotation time process is a very important parameter for electrocoagulation process and, in this study, it was observed that 60 minutes were sufficient for a satisfactory color removal. It was not observed, at higher values of pH, satisfactory results with respect to decolourization. The optimal investigated values of pH are 2, 5 and 7. With respect to the applied potential, the better EC results were obtained with 7.0 V, beyond which no real improvement may be observed. The lower is the dye concentration the better is the decolourization efficiency. A low concentration of NaCl (1.0 $g.L^{-1}$) is sufficient for the color removal process to be efficient. After all experiments, it was concluded that the electrocoagulation process was quite efficient for removing the color of the black eriochrome dye, reaching values of CR 98.5% with optimized parameters.

Keywords: electroflotation, electrocoagulation, textile dyes, aqueous effluents and water treatment.

Financial support: UFSJ; FAPEMIG and CNPQ.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student ( ) Graduate Student (x) Professional

Impact of fish farming on dissolved organic matter (DOM) in the Furnas Hydroelectric Power Plant Reservoir

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Dissolved organic matter (DOM) can be an important source of nutrients in aquatic ecosystems and play important roles in the nutrient dynamics of natural and impacted environments. Fish farming in net-cages produces a significant amount of organic waste by fish excretes and non-consumed fish feed and may cause eutrophication due to the high nutritional quality of exported organic matter. Here, we hypothesize that fish farming alters the quality of dissolved organic matter in reservoir bays containing fish farms. This study was conducted in the reservoir of the Furnas Hydroelectric Plant (Federal State of Minas Gerais, Brazil). Sampling sites were located in the two major branches of the reservoir (Sapucaí river and Grande river). Samplings were performed in nine periods between April 2013 to December 2016 along horizontal and a vertical gradients starting at net cage sites. Fluorescence excitation emission matrices (EEMs) of DOM were measured using a scanning spectrofluormeter (HORIBA, AQUALOG-UV-800, USA). A total of 417 samples were analyzed. Fluorescence indices showed alterations in DOM quality caused by the presence of net-cages. The freshness Index (β/α) indicated a prevalence of recently produced DOM in sites closest to fish cages in comparison to reference sites of the Grande river along the longitudinal sampling gradient (impacted site, GTA=1.10; 10m and 25m distant sites, GTB and GTC=1.00; sites in reference bays, GRef=0.94). For the Sapucaí river, the Freshness Index (β/α) also showed decreasing values from the most impacted sites, nearest to the fish cages towards reference sites in the reservoir (STA and STB= 1.02; STC and SRef= 0.96). The fluorescence Index (FI) indicate if DOM is from more microbial and/or terrestrial origin. This index did not differ among sampling sites for both Grande and Sapucaí river. For the Grande river, values were GTA = 1.59; GTB, GTC and GRef= 1.58. For the Sapucaí river the values for this index were STA = 1.61; STB, STC and SRef= 1.60. In summary, our results showed that fish farming with net-cages have the potential to alter DOM quality and result in ecological, and possibly economical and social impacts in the reservoir.

Keywords: Dissolved organic matter; Fish farming; net-cages; Fluorescence indices; Furnas reservoir.

Financial support: Capes, Eletrobrás-Furnas, FAPEMIG, CNPq

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

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Effects of water-level fluctuations on the environmental integrity of a tropical reservoir (Furnas, SE Brazil)

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Water-level fluctuations of lentic systems are a natural phenomenon caused mainly by climatic and hydrological variations. However, when water level fluctuations exceed natural limits, e.g. due to human impacts or climatic extreme events, they may affect the environmental integrity and sustainability of lakes and reservoirs. From 2014 to 2016, reservoirs in Brazil went through massive fluctuations in response to a severe drought, and the Furnas Hydroelectric Reservoir (UHE-Furnas) was one of them. The aim of this work was to evaluate the impacts of water-level fluctuations in the Furnas Reservoir on its water quality (physical and chemical indicators). We tested the hypothesis that the strong reduction in the reservoir level resulted in a deterioration of the physical and chemical quality of the water, which could affect the planktonic community and lately cause homogenization of the environmental characteristics between the two rivers that form the reservoir – Rio Grande and Rio Sapucaí. Water samples were taken from sampling sites located in both river braches during 2014, 2015 and 2016, corresponding to the period of the largest water level fluctuations recorded for the reservoir. Chemical water quality was assessed by the concentrations of dissolved inorganic and organic nitrogen, soluble reactive and total phosphorus. Negative relationships were found between nitrogen nutrient concentrations of nearly all parameters analyzed (NTD, NID, NOD) and reservoir water levels (Spearman correlation, $p < 0.05$, $n=31$) for both river branches, suggesting that water level reduction indeed caused a general increase in nutrient concentrations, as expected. Changes in the spatial distribution of primary producers, changes in temperature and, consequently, in thermocline position and stratification, as well as water quality decrease are impacts associated to significant water-level fluctuations. Since most hydroelectric reservoirs in Brazil serve to purposes other than electric power generation as well, such as aquiculture, recreation, and water supply, changes in water chemistry and water quality caused by extreme water level fluctuations may directly impact human health and human well being. This scenario may become particularly alarming in the next years, if we assume extreme events to become more frequent due to climatic changes.

Keywords: Water-level fluctuation; reservoir; water quality.

Financial support: Furnas Centrais Elétricas, FAPEMIG, CNPq

Choose the Thematic Area: (x) TA1 ( ) TA2 ( ) TA3 ( ) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Microbiological Quality of the Water from SAC's Urbans of Divinópolis-MG

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Water is an essential element for life on Earth and the relevance of its countless applications demonstrates its vital importance. Access to a safe and sufficient source of drinking water is a fundamental requirement for human survival, well being and socioeconomic development. Brazil concentrates approximately 13.7% of the total fresh water of the planet. In Divinópolis/MG the majority of the population has adequate sanitation and access to treated water. Nevertheless, many urban residents make use of water from alternative collective supply solutions (CSS) in different parts of the city. This work intends to analyze the presence of total coliforms and thermotolerant coliforms in CSSs of Divinópolis MG. For the microbiological analyzes (presence of total or thermotolerant coliforms), the Enzymatic Chromogenic Substrate (ONPG-MUG) technique was carried out. For a qualitative diagnosis of the selected water sources a validated survey was applied in order to access information on the presence of garbage, animals, vegetation or sewage in the surroundings, as well as information on uses, water color, among others. Based on previous utilization surveys, twelve CSSs in the urban perimeter of Divinópolis were selected: Bela Vista, Canto da Mina 1, Canto da Mina 2, Olhos D'água, CSU Interlagos, Martins Cyprien, Sest / Senat, Cachoeirinha, Santo Antônio dos Campos, Itaí and Lava Pés (mine and well). Except for Bela Vista, all analyzed CSS showed absence of total coliforms and thermotolerants coliforms. The study allowed for a microbiological diagnosis of water samples collected in springs frequently used by residents of the urban area of Divinópolis. The evaluation of total and thermotolerant coliforms in water samples collected from the main CSS of Divinópolis will add to the existing data and passed on to the board of Health Surveillance of the municipality. The aim is to establish a partnership in order to promote actions needed to the improvement of the observed bad microbiological condition of the CSS in the city.

Keywords: Water quality, CSS, microbial indicators, water and human health

Financial support: Universidade Federal de São João del Rei.

Choose the Thematic Area: ( ) TA1 ( ) TA2 (x) TA3 ( ) TA4

Presenting author: (x) Undergraduate Student ( ) Graduate Student ( ) Professional

Degradation of paracetamol in aqueous medium by means of photocatalysis using CX / TiO_2 carbon xerogel based composites.

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In recent years, a variety of drug residues have been detected in the environment, especially in drinking water, natural waters and household effluents. Paracetamol, classified as one of the top three most commonly used drugs, was found even after treatment of surface and groundwater. One solution to this problem is the use of Advanced Oxidative Processes (POAs), with photocatalysis being one of the most used. Photocatalysis can be defined as a catalytic process involving the absorption of light by a catalyst / semiconductor, the most used semiconductor being TiO_2. However, an important issue is the adsorption of the pollutant to the catalyst, which is essential for the process to be effective. For this, the association of TiO_2 with carbon materials has been extensively studied. Within this Carbon Xerogels (CXs) represent a promising class of nanostructured materials. These materials are used as support for the catalysts and, in addition, have a high adsorbent capacity that favors the contact of the substrate with the catalyst. In this work we investigated the photocatalytic power of TiO_2 doped CXs in paracetamol degradation. The sol-gel method was used for the introduction of semiconductor oxide nanoparticles into the CX pore structure. The CX standard, obtained from the reaction of resorcinol-formaldehyde, called CX-P and modified with the Ti (IV) salt, was evaluated, which, in the end, was evaluated in relation to the sorption and degradation capacity of said drug. The materials were investigated by Brunauer, Emmett and Teller (BET), scanning electron microscopy (SEM) and transmission (TEM) by thermogravimetric (TG) and X-ray diffraction (XRD) analyzes. CXs doped with TiO2 exhibited nanocrystals of the oxide in the anatase phase, smaller than 20 nm, immersed in an amorphous carbon matrix. The surface of the material was also evaluated by the FTIR technique, where it was possible to observe the adsorption of the drug and, subsequently, the degradation of the surface. The photodegradation was accompanied by Molecular Absorption Spectroscopy. The nanocomposites produced degraded more than 90% of the drug in approximately 4 hours. The presence of intermediates was observed through High Efficiency Liquid Chromatography, proving that degradation of the drug occurred. In addition, the analysis of Total Organic Carbon (TOC) was performed, where it was observed the disappearance of approximately 90% of the organic pollutants in the solution using the nanocomposite. It was possible to reuse the CX where a small loss of efficiency is observed in approximately 9%.

Keywords: Water, Paracetamol, TiO2, CX, Photocatalysis.

Financial support: CNPq, Capes, Fapemig.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

THE "ONE HEALTH" CONCEPT APPLIED TO THE ASSESSMENT OF ANTIMICROBIAL RESISTANCE IN ISOLATED CULTURES OF SAMPLES OF SUINOCULTURE

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Swine farms have an important role in the Brazilian economy and ranked fourth among the world's largest producers in 2017. Antibiotics, as growth promoters, are used to improve swine performance, however, it may stimulate resistance to antibiotics in bacteria (RABs). The concept of "one health", among other approaches, involves the recycling of waste and sanitary effluents which, once misused, becomes a source of pollution and RABs. The objective of this work was to evaluate the presence of RABs in sludge and swine effluent. Water is one of the forms of dissemination, between human and animal populations, BRAs to the most diverse antibiotics existent. The objective of this work was to evaluate the presence of BRAs in slurry and swine effluent. The samples were collected at a swine farm located in the state of Minas Gerais, Brazil, which has a waste treatment unit composed of an anaerobic biodigestor followed by a facultative lagoon. Samples were collected at five points along the treatment system. Afterwards, they were inoculated in selective media (EMB, hypertonic mannitol and Bile esculin plus sodium azide). The isolated colonies were submitted to the antibiogram by the disc-diffusion method. To verify the efficiency of the system, suspended solids and COD were analyzed according to the APHA standard. The swine manure presented high suspended and total suspended solids contents, however, the effluent treatment system was efficient in the removal of the same, the biodigestor unit being the most efficient in this removal, while for COD the facultative pond was the most removal efficiency. A total of 465 colonies were isolated, with n = 138 Staphylococcus, n = 147 Enterococcus en = 180 Enterobacteriaceae. The biodigestor proved to be an important unit in the removal of resistant bacteria, mainly for ampicillin, cefatzidine, gentamicin and tetracycline resistant Enterobacteriaceae and resistant to Staphylococcus tetracycline, cefoxitin, penicillin, clindamycin, sulfazotrim, gentamycin, rifampicin and ciprofloxacin. While for Enterococcus only for nitroforantoin resistant. Enterobacteriaceae had a higher proportion of multiresistance, with 90%, followed by Staphylococcus, with 80% and, finally, Enterococcus with 54%. The isolates tested showed a higher susceptibility profile than most of the comparative studies, which shows a latent risk associated to the use of sludge or effluent as biofertilizer. The presence of ARBs in environmental compartments is a risk to animal and, especially, human health due to the compromise of antibiotic therapy and the spread of bacteria and resistance genes in the environment. It has already been proven that some antibiotics for animal use are associated with resistance to antibiotics for human use, such as the case of avoporcina reflecting on vancomycin therapy. The ease of dissemination of BRAs is a worrying factor due to the ease of leaching, runoff and erosion of the soil that received the biofeedant or even the release of the treated effluent. Swine effluent treatment systems do not envisage the removal of metabolites or antibiotics, much less reduce BRAs, but they allow a greater interaction between bacteria favoring the multiresistance and the acquisition of resistance genes of other bacteria.

Keywords: Resistant bacteria, susceptibility profile, swine manure, disk-diffusion, one health.
Financial support: CAPES
Choose the Thematic Area: ( ) TA1 ( ) TA2 (x) TA3 ( ) TA4
Presenting author: (x) Undergraduate Student ( ) Graduate Student ( ) Professional

Isolation of phenol-degrading microorganisms from the activated sludge of a steel industry and a study of degradation of phenol in a synthetic medium

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Phenols are recalcitrant compounds of high toxicity, which can have serious environmental impacts if they are inadequately disposed of in ecosystems. The steel effluents present high levels of phenol and the activated sludge process employed in these industries present great efficiency in the removal of phenols after the acclimation of the microorganisms. Thus, activated sludge from steel industry is an important source of phenol degrading microorganisms that can be isolated and studied. Given this, this work aims to isolate and select species of microorganisms from the activated sludge of a steel industry, which present great potential in the removal of phenol and conduct a study, identifying the best conditions of phenol biodegradation by these microorganisms. For this, isolation was made using classical microbiology techniques, where initially the activated sludge sample was prepared, diluted and later plated on nutrient agar. The microorganisms cultured on the plates underwent phenol degradation tests on Petri plates and then in liquid medium, and those that best developed in phenol-containing media were identified by the MALDI-TOF mass spectrometry technique and further selected for the studies of phenol kinetics and biodegradation. A statistical experimental planning was carried out, where the phenol concentration and pH were varied to identify the best phenol biodegradation conditions. From the bioprospection, three bacteria capable of growing in the presence of phenol were isolated. These bacteria were identified as being *Pseudomonas aeruginosa*, Acinetobacter sp. and *Stenotrophomonas maltophilia*. In the kinetic assay, with an initial phenol concentration of 250 mg L^{-1}, the bacterium *P. aeruginosa* removed 100% of compound in approximately 72h. The bacterium Acinetobacter sp. removed 68.71 (±0.51) % of the phenol, the strain *S. maltophilia* removed 68.55 (±0.58) % of the compound and the mixed culture formed by the three bacterial strains studied removed 71.92 (±0.33) % of the phenol in 96 hours. Thus, all bacteria and the mixed culture presented interesting results in the removal of phenol, especially *P. aeruginosa*. In the experimental planning, it was observed that the optimum pH of *P. aeruginosa* was 6.4, of Acinetobacter sp. was 7.0 and *S. maltophilia* was 7.3. Removal of phenol by the three bacteria was better when the initial phenol content was lower. This is because, in the presence of toxic compounds such as phenol, microbial growth is affected, and the higher the recalcitrant compound content, the greater the inhibitory effect on the microorganism tends to be. This work brings the possibility of a process of great environmental interest, since phenol is a recalcitrant compound of great environmental impact and these bacteria prospected from the activated sludge of a steel industry are suitable for the biodegradation of phenolic compounds.

Keywords: phenol, recalcitrant compound, biodegradation, bacteria, effluent treatment.

Financial support: CNPQ, FAPEMIG, UFSJ.

Choose the Thematic Area: ( ) TA1 (x) TA2 ( ) TA3 (X) TA4

Presenting author: (x) Undergraduate Student ( ) Graduate Student ( ) Professional

USE OF OZONE FOR CONTAMINATED WATERS TREATMENT WITH DYES

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The large installed industrial park of the textile sector has generated large volumes of effluents that can cause serious problems of environmental contamination. It is estimated that more than 50% of the world's organic dyestuff production is used in the staining of tissues and that in the textile industry approximately 20% of the dyes are lost to the environment. This industry has employed effluent treatments based on physical and biological processes that have limited efficiency in effluent remediation. As alternative, the chemical processes that use ozone present the most promising for the degradation of chemical pollutants in aqueous solution. Ozone is known as the second strongest oxidizing agent that can be used in industrial scale and has been adopted for applications in water treatment by several countries. In this study was evaluated the decolorization and degradation of methyl orange, methylene blue and malachite green using bubbling ozone. For this, it was used air ozonation system with power of 40 W based on corona effect. A batch reactor filled with 2.5 L of dye solution was used. Aqueous solutions containing 10 mg/L of dye were prepared. The absorbance measurements were performed on a UV spectrophotometer using 1 cm cuvettes and wavelengths of 470 nm, 664 nm and 618 nm for methyl orange, methylene blue and malachite green, respectively. The degradation of the dyes was carried out by the organic oxidation using chemical oxygen demand (COD). The results showed that the ozonation system was very efficient for decolorization (> 96%) of solutions of methyl orange, methylene blue and malachite green. The effect of the air flow variation (2.5-7.5 mL / min) at the inlet of ozonator showed that the discolouration increased with increasing flow. However, after one hour no significant difference in color removal was observed. The COD results showed degradation of 99% of methylene blue and 40% of methyl orange.

Keywords: Dyes; ozone; wastewater; effluents treatment.

Financial support: UFSJ.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Synthesis and application of material based on polyaniline, cigarette filters and carbon nanotubes in studies of adsorption of anti-inflammatory drug as aqueous contaminant

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Water is essential for the life of living beings and its contamination becomes worrying as this can affect the health of the population and the environment for a long period of time. The increase in consumption of cosmetics, cleaning supplies and medicines has worsened the situation. Currently, little is known about the effects of these contaminants in natural waters, so it is important to acquire new knowledge as the creation and development of methods for the elimination of drugs in aqueous solution, for example. Adsorption is one of the options for extracting pharmaceuticals from low cost, efficient, simple, fast. Then, three adsorbent materials were developed based on polyaniline (PAni), with cigarette filters (PAni-CFs) and carbon nanotubes (PAni-CNTs) for adsorption of the anti-inflammatory meloxicam (MLX) indicated for the treatment of rheumatic diseases, this is an analyte model. The PAni material was sintetized using distilled aniline in acid medium and ammonium persulfate as the oxidant reagent; in the synthesis of PAni-CFs and PAni-CNTs, macerated commercial cigarette filters and carbon nanotubes respectively and separately were added in a solution acid containing aniline and ammonium persulfate. The synthesis occurs at low temperatures (± 5 ° C) and lasts for 5 hours. In this way, the materials synthesized was characterized by different techniques and applied in adsorption studies, evaluating the pH of the aqueous solution, the contact time between the analyte and the adsorbent and the analyte concentration, and the data were analyzed by the kinetic and isothermal models. The kinetic model that presented the best fit for all materials was the pseudosecond order ($R^2 \geq 0.999$), as evidenced by the Elovich model and intraparticle diffusion, suggesting that the adsorption mechanism occurs by chemical interaction of the MLX both on the outer surface and in the pores of adsorbent materials by the diffusion process. By the results of the isothermal models, the Langmuir-Freundlich dual-site model showed the best fit due to the determination coefficient values being greater than or equal to 0.9317 for all materials, suggesting that adsorption occurs in heterogeneous sites, with different energies. In addition, the PAni-CFs and PAni-CNTs composites showed to be better adsorbents of the drug than PAni, due to the presence of CFs and CNTs that have excellent adsorptive characteristics.

Keywords: polyaniline; cigarette filters; carbon nanotubes; adsorption; drug.

Financial support: CAPES, CNPq, FAPEMIG, FQMat e UFSJ.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: (x) Undergraduate Student ( ) Graduate Student ( ) Professional

Copper adsorption by the aquatic macrophyte *Eichhornia crassipes*

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Industrial activity is responsible for the generation of large amounts of effluents, which may include a variety of compounds and potentially toxic metals. The majority of these metals may be part of natural cycles and are necessary for vital processes of living organisms. However, in concentrations higher than required by the organism, metals can be extremely toxic. Copper is essential for vitamin absorption but can cause serious damage when concentration exceeds optimal conditions. The present work investigates the potential of biochar (600 ºC) from the aquatic plant *Eichhornia crassipes* to adsorb Cu^{2+} ions in aqueous solutions. To perform the adsorption tests, the biochar was used as a biosorbent and Cu^{2+} containing solutions were used as adsorbate. Tests considered pH variation, mass of biomass and the concentration of the metal in solution to determine the influence of these variables in the process, as well as to define optimal adsorption conditions. The remaining metal concentration after the tests was measured by means of atomic absorption and the results were statistically evaluated using a factorial design. The results showed that pH was the most significant parameter affecting Cu^{2+} adsorption, whereby alkaline pHs promoted the best removal of Cu^{2+} ions. As already reported in the literature, a solution with high pH allows the adsorption of the metals by the ion-exchange mechanism, which promotes the decrease of the hydroxyl ion concentration of the medium and allows cations to be attracted by the hydroxyl groups of the adsorbents, culminating in exchange of the ions in equivalent amounts. In contrast to alkaline pH, acidic pH solutions turn the adsorbents' surface charge positive, due to the high concentration of H^+ ions. The protonation of active sites promotes low adsorption rate due to the electrostatic repulsion between the charges, causing a competition for the adsorbent sites. pH and zero-point load (pH_{zpc}) analyses were performed to evaluate the surface characteristics of the adsorbent material. For the pH test, a result equivalent to 8.27 was obtained and for pH_{zpc} the value was 8.24. According to literature, when the pH value is higher than the pH_{zpc} the surface of the material is negatively charged, providing a favorable environment to the adsorption of cationic molecules, such as the Cu^{2+} ion. This result corroborates data obtained by the adsorption tests, which indicates optimal adsorption under alkaline conditions.

Keywords: adsorption; heavy metals; *Eichhornia crassipes*; biochar.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Industrial reuse water generation by reverse osmosis

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Gold mining contributes to the development and maintenance of the population's life quality. In order to this metal recovery exceed 80%, it is necessary to adopt pre-treatments, such as oxidation under pressure (POX), which requires a water's large volume and generates a high effluent's amount. This effluent is characterized by an elevated acidity and metals concentration, which even after neutralization and precipitation processes can be solubilized causing water contamination. In this scenario, an alternative treatment is reverse osmosis (RO), which can achieve retentions greater than 99% for dissolved organic salts and molecules with low molar mass generating a high physical chemical permeates quality. Therefore, this study presents as hypotheses that the BW30 membrane will be able to achieve retentions greater than 95% to ensure that the permeate is used as industrial reuse water. However, expected that the permeate flux will be negatively impacted by the fouling phenomenon but that the chemical cleaning will be efficient to recover 90% of the initial flux. This work presents as objective the reuse water generation for use in the mining company. For this study, the POX effluent from a gold mining, located in the state of Minas Gerais, was used. Tests were done in bench scale at 25° C, 10 bar of transmembrane pressure applying the RO BW30 membrane, which was supplied by Dow Filmtec. 2L of the POX effluent was used as feed, in a flow rate of 2.4 L / min, and permeate was collected while the concentrate was recirculated. For chemical cleaning, both citric acid and sodium hydroxide were applied, and each of them remained in contact with the membrane for 30 min. As results, the BW30 membrane achieved greater retentions efficiencies (99%) for Al and Ni since these atoms are larger than the RO interstices. However, BW30 reached only 72% and 85% of Mn and acid solution rejection, respectively. This fact may be related to the interaction between the membrane surface and these solutes, which allowed the diffusion of these compounds to the permeate. In relation to the permeate's flux, it was observed the reduction of approximately 63% comparing to the initial flux. The chemical cleaning met the expectations guaranteeing the recovery of more than 90% of the flux in relation to the initial one, conferring that most of the fouling was of a reversible nature. Analyzing the results, it can be seen that using only RO BW30 is not sufficient to guarantee the reuse water quality. In addition, it was observed the significant fouling occurrence, which compromised the permeate flow and required a constant chemical cleaning reducing the membrane lifetime. In this context, it is suggested to adopt pretreatments such as ultrafiltration in order to retain the macro molecules and nanofiltration to achieve higher acid solution retention, leaving the RO stage to the metals removal only.

Keywords: Reverse Osmosis; Treatment; Water Reuse.

Financial support: Capes, CNPq and Fapemig

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Electrochemical studies based on V_2O_5 thin film for detection of azithromycin in water supply

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Azithromycin is a 15-cyclic lactone antibiotic and semisynthetic erythromycin derivative. The antibiotic exhibits better oral bioavailability, higher tissue concentrations, and fewer effects. Azithromycin is active against some Gram-positive and Gram-negative microorganisms and plays its role by binding to the 50S subunit of the bacterial ribosome. This action influences the microbial protein synthesis by preventing transpeptidation and translocation processes. Thus, azithromycin has been used to treat respiratory infections, skin and soft tissue infections and some sexually transmitted diseases. Due to its high use, this antibiotic is found in water supply since there is no previous treatment. The aim of this work is to detect azithromycin present in water supply using electrochemical studies based on V_2O_5 thin film as a sensing material. The V_2O_5 thin film was prepared by sol-gel route and dipped on polyethylene terephthalate/indium tin oxide (PET/ITO) electrode. Electrolytes contained PBS, pH = 7 and azithromycin ($1x10^{-3}$ mol/L and $1x10^{-4}$ mol/L) in 20 mV/s. A SCE and platinum were used as reference electrode and counter electrode, respectively. Through the technique of square wave voltammetry, it was possible to note that the electrode is extremely sensitive to the presence of azithromycin as well as the amperometric response is linear and proportional to the concentration of the antibiotic in the investigated medium. The potential of -0.5 V (SCE) was chosen for the amperometric studies due to its better response as a function of azithromycin concentration, demonstrating that possibly the redox transitions occurring in this region are responsible for the oxidation of the substrate and, consequently, its detection. Then, it was possible verify that the V_2O_5 thin film presented a sensing surface for detection of azithromycin in different concentrations. Therefore, the evaluation indicated that material can be a candidate as sensing component in disposable for azithromycin detection in water supply.

Keywords: V_2O_5 thin film; azithromycin; Square Wave Voltammetry; detection; electro-oxidation.

Financial support: FAPEMIG, CAPES, CNPq.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student ( ) Graduate Student (x) Professional

Sensitivity evaluation of sensor based on chitosan/V2O5 for electrochemical detection of 17-α-ethinylestradiol in water supply

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The presence of endocrine disruptors in the environment is considered the new emerging challenge of environmental chemistry, since these compounds, even in low concentrations (order of µg·L-1 and ηg L^{-1}) present a potential risk to human health and animal. The hormone 17-α-ethinylestradiol (EE_2), present in the composition of almost all formulations of oral contraceptives, in animal excrement that is used as fertilizer and in the production of monosexual populations in aquaculture has been pointed out as the main compound responsible for the observed changes in the populations. It is because this hormone is a compound resistant to biodegradation and with high estrogenic potential. The aim of this work is the use of chitosan and vanadium pentoxide (V_2O_5) as sensing material by electrochemical detection of EE_2 in water supply. The electrochemical cell had as its composition: working electrode containing V_2O_5 and chitosan, prepared by the layer-by-layer technique in PET/ITO support; auxiliary platinum electrode; reference electrode containing saturated calomel electrode (SCE); electrolyte composed of PBS solutions, EE_2 in different concentration and pH = 7. The electrochemical techniques of cyclic voltammetry (CV) and square wave voltammetry (SWV) were used. It was verified by the cyclic voltammogram a variation of CVs in different concentrations of EE_2 (10^{-4} to 10^{-12} mol·L^{-1}), which generated anodic peak, in 20 mV/s. The oxidation signal was well defined in the range of 0.6 to 0.8 V vs SCE. It was observed a current in high concentration of EE_2 due to the greater amount of hormone to be oxidized by the sensing materials of the electrode. Parameters such as electrolyte concentration, frequency and potential increase were studied in order to optimize the conditions of SWV. Considering the higher current value and the better peak resolution of the voltammogram, the potential range was chosen, with the established optimum parameters ($2x10^{-5}$ mol·L^{-1}, 10 Hz and 3 V). It was observed in SWV results a decrease of current in function of decrease of EE_2 concentration corroborating with CV results. According to the results, both techniques identified peaks in the same potential range, which proved the oxidative activity of the materials used and gave high sensitivity of the sensor in question. Thus, the use of V_2O_5 and chitosan in the electrochemical detection of EE_2 was promising, since it is a simple preparation, low cost and excellent performance.

Keywords: electrochemical; detection; ethinylestradiol; V_2O_5; chitosan.

Financial support: FAPEMIG, CAPES, CNPq.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student ( ) Graduate Student (x) Professional

Water loss management through smart water systems

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The pressure on water resources will increase worldwide along this century due to the increase of population and economic development. Population levels are expected to increase at the fastest rate in emerging regions that are already undergoing a strong urbanization process. Investing in the water system's efficiency should be the first option to allow the cities avoiding water scarcity, as traditional water resources will no longer be guaranteed in enough quantity and quality. In that context, water utilities will have to be as efficient as they can to avoid any waste of water and energy. Water networks will be increasingly complex and may also treat and supply non-drinkable sources such as reclaimed wastewater. The good news is that recent technology breakthroughs such as the Internet of Things and artificial intelligence will allow achieving that higher standard of efficiency. In this work, it is first discussed the water loss control in distribution systems. Related concepts such as sectorization, water audits, pressure management and proactive leak detection programs are addressed. Then it is assessed the transition of water networks toward truly smart water systems. Thus, the architecture and functionalities of a smart water network are described with the aim to explain how such technologies can increase resilience against extreme climate events, improve the asset managing of water infrastructure, and operate the network efficiently to reduce leakages, pipe bursts and energy waste.

Keywords: smart water systems; water loss; leak detection; water networks; pressure management.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

International Symposium on Water Crisis: Challenges and Solutions
São João del Rei, MG, Brazil, April 7th to 10th, 2019

Seasonal variation of the removal efficiency of pharmaceuticals in conventional Drinking Water Treatment Plants

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The presence of pharmaceuticals in environmental waters has become a major issue and concern for the scientific community as numerous studies have reported their occurrence and there is a lack of information about its risks and impacts to the environment and public health. In Brazil, a country considered the 8th largest drug consumer in 2016, many cities do not have Wastewater Treatment Plants and sewage is often thrown directly into the rivers. This sanitation condition affects the water quality in the rivers and drinking water production, since Drinking Water Treatment Plants (DWTPs) mainly draw water from these sources in which many authors have reported the occurrence of these compounds in drinking water. The behavior of pharmaceuticals in full-scale conventional DWTPs remains less-known, especially in Brazil, since most of the studies were developed for a few samples on a laboratory scale. Thus, the objective of this study was to investigate if there is a seasonal variation of the removal efficiency (RE) of the pharmaceuticals Prednisone (PRE), Atorvastatin (ATO) and Fluconazole (FLU) in three Brazilian conventional DWTPs. Samples were collected for twelve months (ago/16 to jul/17) in three DWTPs of Minas Gerais state. DWTP1 employs a combination of chlorination, coagulation, flocculation, sedimentation, sand filtration, and post-chlorination. DWTP2 adopts direct filtration and does not include neither sedimentation or flocculation. DWTP5 uses dissolved-air flotation as an alternative to sedimentation and periodic powdered activated carbon due to algae-laden. The analytical methodology was based on solid phase extraction (C18 cartridge) followed by High-Performance Liquid Chromatography (Prominence DGU/20A3 – Shimadzu) coupled with Mass Spectrometry (Microsoft-QII – Bruker). The monitoring results showed the presence of the pharmaceuticals FLU, PRE and ATO in both source and drinking water. Over the year, the RE of FLU varied from 3% (DWTP2) in June to 100% (DWTP1 and DWTP2) in January. The RE of PRE varied from 11% (DWTP2) in December to 100% in DWTP1 (October and December) and DWTP2 (September, October and May). In addition, the RE of ATO varied from 11% (DWTP2) in February to 100% in DWTP1 (August), DWTP2 (October, November and July) and DWTP3 (August, September and Jun). The average RE of FLU was 59% ± 21% in DWTP1, 48% ± 27% in DWTP2 and 43% ± 24% in DWTP3. The average RE of PRE was 69% ± 25% in DWTP1, 56% ± 38% in DWTP2 and 45% ± 23% in DWTP3. Lastly, the average RE of ATO was 57% ± 23% in DWTP1, 55% ± 38% in DWTP2 and 61% ± 32% in DWTP3. The RE varied between the pharmaceutical compound and DWTP. Besides, it was observed the greater temporal variation of RE in the different DWTPs. This seasonal variation of the RE in conventional DWTPs was also reported by other authors, suggesting that the source water quality may impact the RE of the DWTPs and that conventional DWTP are inefficient in completely removing pharmaceutical compounds.

Keywords: Drinking water; Conventional Treatment; Pharmaceuticals removal; Emerging Pollutants; Water quality.
Financial support: FUNASA, CAPES, CNPq, FAPEMIG.
Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4
Presenting author: (x) Undergraduate Student ( ) Graduate Student ( ) Professional

Dispersive magnetic solid phase extraction (d-MSPE) with activated carbon/Fe_3O_4 nanocomposite for the determination of Bisphenol A and ethinylestradiol by HPLC.

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Concerns toward the pollution of water by synthetic or natural contaminants have been increasing in last years. BPA, 2,2-bis(4-hydroxyphenyl) propane, is largely used as intermediate in the manufacture of polycarbonate plastics, epoxy resins, food can liners, others. It is an endocrine disruptor and several studies have revealed links between BPA exposure and hormone-related cancers. Ethinylestradiol (EE2) (17α-ethinylestradiol) is used in oral contraceptives and, in medicine, - in hormone replacement therapies. This compound also belongs to group of endocrine-disrupting chemicals, that is, it interferes in the equilibrium of the endocrine system by mimicking or antagonising the effects of endogenous hormones. Some authors appointed the incidence of feminization in fish as a consequence of EE2 exposure. On the other hand, the dispersive magnetic solid phase extraction (d-MSPE) is a sample preparation technique for extraction, clean-up and preconcentration of analytes of interest, including the endocrine-disrupting. In this work, we used an activated carbon/Fe_3O_4 nanocomposite as magnetic adsorbent for extraction of BPA e EE2 in water matrices. In this sample pretreatment step, the standards of analytes are adsorbed onto magnetic material, followed by desorption using appropriated eluents. An Agilent HPLC model 1220 system (Agilent Technologies Palo Alto, CA, USA) compost for a quaternary pump (G1311 B), automatic injector model 1260 HiP ALS (G1367E) and a column oven model 1290 TCC (G1316C) 1260 TCC (G1316A) was used for chromatographic analysis. The pollutants were separated on an analytical column Phenomenex® Germini C18 (250 mm × 4,6 mm, 5 µm) at 25°C. The mobile phase consisted of a mixture of methanol:acetonitrile (87.5:12.5 v/v) at a flow rate of 1,0 $mL.min^{-1}$. The injection volume was 20 µL for standards and the chromatographic data were acquired at 290 nm using an ultraviolet-visible detector. The optimization of sample preparation was carried out and the obtained parameters were: 20 mg of magnetic adsorbent; sample volume of 750 µL with pH adjusted for 10.5, volume and type of eluent methanol:acetonitrile (50:50 v/v), adsorption/desorption times of 60s. The method was efficient with recoveries of (80.65 ± 2.07)% and (55.35 ± 10.35)% for BPA and EE2, respectively. The used methodology offers some advantages when compared to others SPE devices such as: reagents economy, reduced analysis time and facility on the separation of target analytes due to magnetic proprieties of adsorbent.

Keywords: endocrine-disrupting chemicals; d-MSPE; sample preparation; magnetic activated carbon

Financial support: CAPES, CNPq and FAPEMIG.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Water crisis in Pará de Minas, MG, Brazil: a novel challenge after a mining disaster

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Pará de Minas (Minas Gerais, Brazil), is a city that belongs to the sub-basins of Paraopeba and Pará rivers, both into São Francisco River basin. In the past few years the municipality has been suffering from water supply. Climate change caused significant hydrologial transitions all over the globe. During 2013-2015, because of a flow reduction in the sources responsible for its water supply, the city underwent a period of rigorous rationing. The situation of water scarcity resulted in the conception of a water system in Paraopeba river, in October/2015, which brought robustness to the municipality's water supply. In January/2019 the rupture of a mining dam in Brumadinho/MG generated an environmental impact in the Paraopeba River, deteriorating its water quality and making it unfit for consumption by indefinite time, which places Pará de Minas in a novel water crisis situation. The objective of this work is to analyze the water deficit generated by the disruption of the Paraopeba River abstraction, and to discuss possibilities of water supply alternatives. Based on information from IBGE and the Municipal Basic Sanitation Plan (MBSP), the water demand was estimated for the municipal urban population. Using public databases maintained by entities responsible for water management in the country, the current water deficit and some possible viable alternatives to mitigate it were analyzed. The urban population supplyed in 2019 by the municipal water network is 87,500 inhabitants, consuming 243 liters per inhabitant per day. Thus, the average flow demanded is 246 L/s (295 L/s for the maximum daily consumption and 442.5 for the peak hourly consumption). Once the water catchment of the Paraopeba River has ceased, the system is supplied by Paivas and Paciência rivers, which together reach a maximum adduction capacity of 222.4 L/s. Thus, the water deficit can reach up to 220 L/s for the maximum consumption. In a first analysis, the best possibility to fill the lack of water is to use the Cova D'anta river. This source, being a tributary of the Paraopeba River, was not affected by mining tailings and was available for granting up to 204 L/s in 2014, according to the MBSP. This abstraction would have the advantage of being quickly activate, since it is close to the existing catchment structure in the Paraopeba River. As there is lack of information about Cova D'anta river's flow during all seasons, it cannot be a definitive solution. In this way, there is also the possibility to build an adductor in the Pará River, which presents a flow capacity similar to the Paraopeba River and is located 30 km west of the city. A supply system counting on the Pará River would bring back the water security to the municipality. Pará de Minas scenario is challenging. It is not known if Paraopeba river will return to its potable water, nor if the rainfall regime during the year will help to maintain the necessary flows, while the construction of a new water catchment system will require high costs of time and money.

Keywords: Water crisis; Dam rupture; Supply alternatives
Financial support: CAPES (Coordenação para o Aperfeiçoamento de Pessoal de Nível Superior); à FAPEMIG (Fundação de Amparo à Pesquisa do Estado de Minas Gerais) e ao CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico).
Choose the Thematic Area: ( ) TA1 (x) TA2 ( ) TA3 ( ) TA4
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Viability evaluation of a rainwater harvesting system

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Water is fundamental for the conservation of life, being responsible for several functions that are essential to the ecosystems and human activities. Although considered renewable, quality water has become a scarce resource, and cause for conflict in some parts of the planet. Due to the reduction of water reserves, it is desirable to search alternative solutions to reduce these impacts. The present work evaluates the viability and applicability of a rainwater harvesting system in the building belonging to the Department of Exact and Biological Sciences (DECEB) of the Federal University of São João del-Rei, in Sete Lagoas city – MG. The climate of the region is defined as tropical semi-humid, with two distinct seasons: 1) rainy and hot summer; 2) mild and dry winter. Considering the last 60 years, we calculate that the average annual precipitation of the region was 1,320 mm., However, the rainfall distribution is not homogeneous, presenting periods of 5 months of drought. These characteristics are pointed as desirable for the implementation of the evaluated technology. In addition, limitations regarding to the local water supply besides the DECEB's building configuration (coverage area of 4,300 m²), are positive characteristics for the implementation of the rainwater harvesting system. The following analyses were carried out: analysis of rainfall rates using a historical series (1961-2015) obtained at the Brazilian National Institute of Meteorology (INMET); evaluation of the characteristics of the building, through *in loco* surveys; identification of the main demands and uses of water in the *Campus* considering the last three years; design of the reservoirs using the Practical Brazilian, Practical English and Rippl methods, which are described in the ABNT 15,527 standards. The values of 1,192 m³, 283,8 m³ and 365 m³ were obtained for the volume of the reservoirs according to the Brazilian Practical, English Practical and Rippl methods, respectively. It was concluded that the Brazilian Practical Method tends to oversize the reservoirs, considering the entire drought period in the calculation. The English Practical method obtained the lowest value for the volume of the reservoir because it considers only 5% of the total rainwater for storage. As a result, the Rippl method is presented as the most accurate, because it considers the demand of water consumed in the *Campus* and the roof runoff coefficient. Using the Rippl method, we observed a potential water consumption reduction of 4,951 m³ per year.

Keywords: harvesting system; sustainability; rainwater; conservation water, technology.

Financial support: CAPES, CNPq and FAPEMIG

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Pharmaceutical compounds removal from surface water by reverse osmosis

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The emerging pollutants presence in aqueous matrices has gained focus by scientific community due to the potential risks that these elements offer to human health and to the ecosystem equilibrium. Among these pollutants, stands out the pharmaceutical compounds, which occurrence in aquatic environment is facilitated by their ingestion, since part of these compounds are eliminated through feces and urine following the sewage collection network up to the municipal waste water treatment plant (WWTP). This conventional treatment is not sufficient for these compounds complete removal. Moreover, cities that are deprived of this treatment are more exposed to this kind of contamination. In this context, in order to guarantee the water quality, the advanced treatment techniques use have been increasing. Among these techniques, reverse osmosis (RO), which presents the capacity to retain low molecular weight elements such as pharmaceutical compounds, stands out. In spite of the RO high selectivity, its application faces one of the biggest challenges which is the fouling occurrence that interferes with the permeate flux as well as its chemical physical quality. This study bring as hypothesis that surface water collected from a city that does not have sewage treatment will present pharmaceutical compounds and that the RO membrane will be able to retain 100% of these elements, as well as reduce the turbidity, color, nitrogen and phosphorus. The main objective is to retain the pharmaceutical compounds by applying RO. For this, 2L of water from the Doce river, collected in the Governador Valadares city, was used as system feed. The membrane used for the bench scale tests was SG supplied by GE Osmonics. The entire test was carried out by applying a 10 bar transmembrane pressure at 25 ºC, continuously collecting the permeate and recirculating the concentrate. Pharmaceutical compounds were analyzed using a micrOTOF-QII mass spectrometer (Bruker) equipped with a Prominence DGU/20A3 HPLC system (Shimadzu) using a Shim-pack XR-ODS column (50mm x 2 mm; 2 µm particle size) also from Shimadzu. As results, Loratadine has been detected which has been retained by the membrane in a concentration below of the method detection limit (8.0 $ng \cdot L^{-1}$) since the molecular size of the compound is greater than the free interstices of the SG membrane. Thus, RO proved to be efficient in the Loratadine retention inferring that it can be used to complete the water and sewage conventional treatment in what concerns the pharmaceutical compounds retention. But studies that contemplate different pharmaceutical compounds are suggested to endorse this finding.

Keywords: Reverse Osmosis; Treatment; Water; Pharmaceutical Compounds.

Financial support: Capes, CNPq, Fapemig and FUNASA

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: (x) Undergraduate Student ( ) Graduate Student ( ) Professional

Etheramines degradation in aqueous waste from iron mines

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Iron ore is the second most important product in Brazilian exports. The process most used to increase the iron concentration in the ore is the reverse cationic flotation. In this process depressants, such as etheramines, are used which are discarded in the aqueous wastes. As these compounds present high toxicity to aquatic organisms it is necessary to know their stages of degradation to minimize the impact generated by the use of these compounds. In this context, the objective of this work was to study the degradation process of etheramines in aqueous waste from iron miners. For this, the factors that can influence the degradation of the etheramines were determined by means of a factorial design 2^4 with four central points. As variable were considered, waste mass (2,0 a 8,0 g), stirring time (5 a 25 min), stirring velocity (500 a 1500 rpm) and temperature (25ºC a 35ºC). For each system, 30 mL of etheramine solution 100 mg L^{-1} was added to the residue and the experimental conditions varied according to the design planning. At the end, each sample was centrifuged and filtered and a 10 mL aliquot of each experiment was taken to determine the etheramine concentration by Dispersive Liquid-Liquid Microextraction (DLLME), which consisted of the extraction of the etheramine using 700 µL of methanol and 220 µL of chloroform as dispersant and extractor solvent, respectively. The extract was analyzing for gas chromatography to determine etheramine concentration. After this process, samples of mud doped with etheramine solution were evaluated for the concentration of these species, as well as nitrate, nitrite and ammonium for thirty-two days. The results of the factorial design showed that only temperature influences the degradation of etheramine, being favored at higher temperatures, which can be justified by the thermal sensitivity of the covalent bonds that form these molecules. Although it has not been shown to be significant for degradation, time is a parameter that exercise a strong influence in the process and therefore studies with larger time intervals were done in degradation tests. The results showed that after thirty-two days the etheramine concentration decreased sharply and the nitrate concentration increased during this period. Intermediate concentrations of ammonia and nitrite were observed during the experiment. Therefore, it is concluded that these compounds are degraded in a period of thirty-two days and the temperature has a great influence on the degradation. During the process are formed compounds such as ammonia, nitrite and nitrate, but it is still necessary to determine the possible intermediate organic compounds which are generated in the process, so that all impacts related to their use can be quickly minimized.

Keywords: Cationic flotation; Chemistry degradation; Environmental Impact.

Financial support: CNPq.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student ( ) Graduate Student (x) Professional

Water Retention Capacity of Litter from *Eucalyptus* Species

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Transformations of natural landscapes cause negative impacts to the environment, including increasing habitat fragmentation and increasing water scarcity, due to the misuse of land. To identify and propose actions to mitigate such degrading actions to the environment represents a great concern among social agents responsible for nature conservation. Eucalyptus monocultures, from the point of view of geoecology, can reduce biodiversity in the region where it occurs and induces soil degradation, due to the high rates of water absorption. Here we intended to understand the influence of Eucalyptus cultivation on the available surrounding water resources by testing the hypothesis that litter samples from eucalyptus areas would present a greater water holding capacity (WHC) than litter samples from other areas. We collected litter samples from Eucalyptus plantations located in the São João del-Rei surroundings in order to test their water retention capacity. Litter samples from *Eucalyptus urophylla* and *Eucalyptus citriodora* (treatment samples) as well as from mixed species and common occurring species, such as *Calophyllum brasiliense* from natural / spontaneous vegetation areas (control samples) were collected. For determining water retention capacity, the methodology proposed by Blow (1955) was used. In the laboratory, litter samples were immersed in water for 90 minutes, weighed and dried at 100ºC until reaching constant dry weight. The WHC was calculated as a function of the final dry weight of the material. Litter from *E. citriodora* areas had the highest WHC (173%), followed by the litter collected from *E. urophylla* areas (119%), and litter from *C. brasiliense* areas (73%) (One-way ANOVA< $p<0.05$). Thus, litter from Eucalyptus species did show higher WHC than litter from natural vegetation areas, confirming our initial hypothesis. The results are important to help us understanding the dynamics of water retention capacity of the vegetation in Eucalyptus plantation areas, which are increasing in Minas Gerais in the last decades. It can also contribute to our understanding of the dynamics of forestry hydrology.

Keywords: Forest Hydrology; Water Holding Capacity; Water retention of litter; Water Cycle; functions of the litter.

Financial support: National Council for Scientific and Technological Development (CNPq); Foundation for Research Support of the State of Minas Gerais (FAPEMIG), Coordination for the Improvement of Higher Education Personnel (CAPES) and Federal University of São João del-Rei (UFSJ).

Choose the Thematic Area: (x) TA1 ( ) TA2 ( ) TA3 ( ) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Industrial Water Clarification Using Tannin-Based Coagulant

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Water is used in most process industries for a wide range of applications. Industrial processes and systems using water are being subjected to increasingly stringent environmental regulations relating to the discharge of effluents. However, industrial water can be reused on-site, or at an alternative industrial site, for many industrial processes, including the following: material washing, process rinse water, crate and pallet washing, hardstand and vehicle washing, industrial fire protection, cooling, in production line, pH adjustment and boiler or cooling tower feed water supplement. In this way, an industrial plant can make the reuse of industrial water contributing for the productive process and the environmental. The water clarification for reused using coagulants chemicals has been widely used. However, coagulants chemicals based in iron and aluminum salts are not biodegradable and contributes to the sludge generation composed by substances harmful to human health and the environment. Alternatively, a natural coagulant (tannin) is suggested to replace the iron and aluminum salts. Tannins are found in the leaves, fruits, barks, roots and wood of trees. Another benefit is its operation in pH near the neutral. In this scenario, the objective of this work was to evaluate the performance of tannin-based and ferric chloride coagulants for the wastewater clarification from the rolling process. The effluent characterization was carried out according to the Standard Methods. The quantification of turbidity, color, suspended solids, pH and the concentration of iron, chloride and phosphate was used as a base to define the ideal dosages of ferric chloride and tannin coagulants. The jar test was performed using 1L of effluent in each jar. After dosing the coagulants, it used a rotational speed of 150 rpm during 1 min, followed by the speed of 400 rpm during 15 min. After stirring, the jars were left standing during 15 min. The aliquots were collected for analyses. The results showed that it was necessary to use 20 mg/L of ferric chloride for to reduce the turbidity of the rolling process effluent to below 10 NUT. It was observed the increase of 6.7% of chloride content in relation to the crude sample. Combined use of 30 mg/L of tannin reduced 75% of ferric chloride dosage, promoting the reduction of 88.8% turbidity, 26.9% color, 88.4% suspended solids and 77.8% phosphate. These results show that the tannin is a promising alternative for the ferric chloride reduction in of industrial water clarification process. In addition, it acts in the fine particles removal and the sludge is biodegradable.

Keywords: Water reuse; coagulant; tannin; wastewater; turbidity.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Dual chamber microbial fuel cell in the treatment of industrial wastewater - evaluation of the use of agar plates as a separator

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Technologies that seek the recovery of waste are increasingly promising and imperative for sustainable development. Thus, bioelectrochemical systems have been gaining notoriety because they allow the treatment of contaminated water and the concomitant direct generation of electric energy. However, the cost of these systems is still high, mainly due to the need to use cationic or anionic exchange membranes as separators between negative (anode) and positive (cathode) compartments of the microbial fuel cell (MFC). The objective of the present work is to evaluate the performance of MFC using agar plates, added or not of KCl, as an alternative to cationic or anionic exchange membranes, for the treatment of wastewater containing sulfate, common species in the mineral and metallurgical industry. As these effluents are deficient in organic matter for the growth of microorganisms, it has to be added to the systems, and the proposal is to use an effluent from the food industry to meet this need, essentially effluent from the dairy industry, which the system still more dynamic for the treatment of wastewater of different origins in the same process. Laboratory-scale MFC were constructed using 40 mm diameter pvc cylinders with a useful volume of 150 mL, graphite bar electrodes and, as a separating membrane, 5 mm thick agar plates were produced, containing or not KCl 3 mol L^{-1}. The external circuit was closed by a 10 kΩ resistor. Cells were constructed in duplicates. Modified Postgate C medium was used, with lactose being the main carbon source, with 4000 mg L^{-1} of initial COD and 2000 mg L^{-1} of SO_4^{-2}. The reactors were inoculated with mixed cultures of sulfate reducing bacteria. The potential of the cells was monitored daily using a multimeter and after 40 days of experiment the COD and SO_4^{-2} removal was evaluated. The agar plate separators showed to be promising for this type of reactor, and the plate in which KCl was not added showed better performance for both electric energy production and removal of COD and SO_4^{-2}. For the reactor constructed with the agar plate, a maximum potential of 281 mV was reached, equivalent to 53 mW m^{-3}, reaching 90% COD removal and 40% SO_4^{-2} removal. The sulfate removal in this system was compatible with batch systems described in the literature, these values can be improved in continuous or intermittent feeding systems. For the reactor whose agar plate contained KCl 3 mol L^{-1}, the maximum potential obtained was 168 mV, equivalent to 19 mW m^{-3}, reaching 84% COD removal and only 23% sulfate removal. In this case, the chloride may have been solubilized in the reactor and thus presented toxicity to the microbiota. These results indicate that it is possible to construct microbial fuel cells of low cost, with excellent application in the treatment of industrial liquid effluents.

Keywords: bioeletrochemical systems; sulfate; COD; sulfate reducing bacteria.
Financial support: Fapemig.
Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4
Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Determination of 2,4-dichlorophenol in environmental waters using magnetic activated carbon in sample preparation

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2,4-Dichlorophenol (2,4-DCP) is an important compound used in the manufacture of herbicides for the control of large and perennial plants in the world. Minimal concentrations of this substance can cause health problems for humans, animals and various environmental disturbances. Some environmental protection agencies such as the US Environmental Protection Agency (EPA) and the National Environmental Council (CONAMA) 357/2005 established even smaller concentrations of these compounds present in water. Thus, the increasing search for efficient, selective and inexpensive methods for quantification of compounds at low concentrations is evident. Therefore, the objective of this study was to synthesize an activated carbon / Fe_3O_4 based composite to apply in magnetic solid phase extraction (MSPE) for the quantification of 2,4-DCP in water. Water samples were collected near the plantations that use pesticides in the municipality of Lavras-MG. The experimental parameters such as adsorbent mass, pH, contact time, volume and type of desorbent, sample volume and desorption time were optimized with the objective of obtaining maximum percentages of adsorption and recovery of the analyte using small amounts of organic solvent. The MSPE process consisted in dispersing 5 mg of the magnetic activated carbon in a flask containing a 20 mL volume of the sample to be analyzed (pond water and water from the cistern) for 1 hour under constant stirring. Subsequently, the material loaded with the analyte was separated from the solution by the action of an external magnetic field and the desorption was carried out. For this, 5 mL of methanol was used, with stirring, for 15 minutes. Finally, after each sample preparation, 3 $\mu g\ mL^{-1}$ of 2,4-DCP was added to the solution and led to HPLC for determination of the herbicide. It is noteworthy that the presence of 2,4-DCF was not detected neither in the water sample of the pond nor in the cistern water. The method showed good linearity in the investigated concentration range of 1 $\mu g\ mL^{-1}$ - 6 $\mu g\ mL^{-1}$ (R^2 = 0.999). The detection limit (LOD) and the quantification limit (LOQ) were 0.293 $\mu g\ mL^{-1}$ and 0.890 $\mu g\ mL^{-1}$, respectively. The recoveries for the water samples ranged from 50.0% to 55.0% and the relative standard deviation (RSD) was less than 4.8%. In this sense, it can be concluded that the magnetic activated carbon presented application to the MSPE in the determination of 2,4-DCP in water by HPLC analysis. The proposed method was safe and environmentally friendly, due the minimal consumption of organic solvents. In addition, the incorporation of magnetite into the activated carbon assisted the removal of the same, also reducing the sample preparation time.

Keywords: chlorophenols; real water samples, magnetic solid phase extraction; magnetic activated carbon; pesticides.

Financial support: **CAPES** (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), **CNPq** (Conselho Nacional de Desenvolvimento Científico e Tecnológico) and **FAPEMIG** (Fundação de Amparo à Pesquisa do Estado de Minas Gerais).

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Women's role in the efficient management of water resources

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Access to water and sanitation is not available in the same way for men and women. Women were considered by the United Nations (UN) as the most affected in situations of water scarcity. Farther, they assume secondary activities in participatory spaces related to water resources, not being effective actors in decision making. This study aims to demonstrate the importance of women participation in decision-making processes on water. The study was carried out as a bibliographical survey, in the databases Scielo, PubMed and Google Scholar. The descriptors water, gender and water resources management were used. Brazilian papers published between 2008 and 2019 were selected, with a total of 27 studies. It was possible to conclude that the differences of social roles attributed according to gender, influence the access to water. The term gender refers to the relationship between the different roles, rights and responsibilities established between men and women as a result of the socialization process, and influenced by historical, religious, economic and cultural realities. For a long time, the concept of being a woman has been established as the obligation to establish a family relationship, based on the culture that women should be mother and wife. On the other hand, the patriarchate was delegated for man, that is, the family provider. In most countries, especially the least developed, women are still responsible for caring for the family, especially in terms of food preparation and basic needs. And in regions where water is scarce, women are charged of domestic water supply, spending hours on this task. In the Brazilian's northeast, women, during the dry season, travel great distances to access water, reaching up to 10 km, and carrying up to 18 liters of water over the head. Besides, poor water quality imposes health risks and increases the burden on women, who are often responsible for caring for the sick. The lack of water in bathrooms exposes women to health risks and other threats. The availability of potable water guarantees safety for their health, and also more available time to carry out other activities, improving women's quality of life. Women may have a great productive role, not only in the domestic environment – in the labor market there are excellent professionals, very competent and sensitive to water issues. They have significant knowledge about water resources (location, quality, storage) and are motivated to protect this resource by recognizing their vital need. It is their interest to be represented in decision-making processes on water, since the lack of water effectively affects their daily lives. Women's participation in water decisions would ensure more equal access and sustainable use to this resource, allowing their interests to be taken into account. Equitable participation of men and women in water management is needed, sharing decisions, tasks and responsibilities.

Keywords: water; gender; women; decision-making; water resources management.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

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Adsorption of EDTA in aqueous medium using CX-TiO_2

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Ethylenediaminetetraacetic acid (EDTA) is a chelating agent widely used by industries because of its wide commercial application. However, all its applications generate a large amount of residues containing this molecule, which are released into the aquatic systems. An alternative for the removal of EDTA are processes involving adsorption. In this sense, carbon xerogels (CXs) represent promising materials for such studies. Thus, the objective of this work was to investigate the adsorption capacity of the EDTA molecule in CXs, considering parameters such as adsorption temperature and pH, adsorption isotherms and experimental kinetics. In the experimental methodology, the synthesis of the CXs involved the polycondensation of resorcinol with formaldehyde by means of the sol-gel process, using sodium carbonate as catalyst and water as solvent. TiO_2 (CX-TiO_2) was incorporated into the precursor solution. In addition, some characterizations such as X-ray diffraction (DRX), scanning electron microscopy (SEM) and thermogravimetric analysis (TG) were essential to study the synthesized material. The CXs doped with TiO_2 showed intense peaks that characterize the anatase crystalline form and smaller peaks showing the presence of the rutile form, both immersed in an amorphous carbon matrix. In the adsorption studies of EDTA in CX-TiO_2, parameters such as temperature, pH, adsorption kinetics and isotherms models were evaluated. The results show that the temperature favors the adsorption, being possible to obtain up to 70% of efficiency at 70 °C and that the increase of the pH implies in the reduction of the sorption capacity of the material. The equilibrium time was considered 5h, obtaining an adsorption of 89%. In addition, the Langmuir Freundlich dual-site isotherm model was the one that best described the adsorption process with Q_{max} = 459.7 mg g^{-1} closest to the experimental one (456.0 mg g^{-1}) and R_2 = 0.976. The adjusted kinetic experimental models suggest that the process is controlled by adsorption of a chemical nature and occurs at different binding energy sites. Therefore, by means of the presented results, it can be observed that the adsorption of the EDTA in the material used was promising for its removal in aqueous solutions.

Keywords: EDTA; xerogel; TiO_2; adsorption; aqueous.

Financial support: UFSJ, Capes, Cnpq, Fapemig

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

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The Atlas of mining tailing dams in Minas Gerais

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In the last years, the state of Minas Gerais has suffered with repeated ruptures of dams that receive mining tailings. These events have caused immense human, social, economic and environmental damages. Furthermore, the recurrence of these disasters suggests that the management of these reservoirs is flawed, imprecise and, probably, based on insufficient or even false technical premises. The planning and construction of reservoirs that may contain tens of millions of cubic meters of tailings obviously must take into account a number of factors, whether environmental or factors related to the different forms of land use in their catchment basins. Among these uses, urbanization must be treated as a limiting critical factor. In the state of Minas Gerais there are more than 400 dams that receive mining tailings. Official data show that a significant number of these structures present problems related to dam safety. Additionally, a great deal of data about these mining dams are inaccessible to the general public because they are presented in a highly technical way, without any kind of critical analysis and often incomplete or outdated. In this context, the objective of the atlas is to present in a clear, objective way and using a language accessible to the general public a representative set of "critical dams". The dams will be grouped in different categories representing their risks thanks to their location, morphometric features, the nature of the accumulated material or the degree of dam safety. Instead of focusing on mining activities, the atlas will classify the dams because of the proximity of cities and the population exposed to a possible rupture. The results will present a new typology of these structures considering above all the environmental and human risks they offer.

Keywords: Dam break; mining tailings; environmental disasters; reservoir management;

Financial support: CAPES, UFSJ, UNIFEI, UFMG.

Choose the Thematic Area: ( ) TA1 (x) TA2 ( ) TA3 ( ) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student () Professional

Recovery of wastewater in industrial sludge using drainage bed

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The main residues generated in Water Treatment Plants (WTP) are decanter sludge and filter washing water. In Brazil is prohibited to release WTP sludge into bodies of water, according to national legislation. However, this practice is common in most WTPs, making the development of solutions for the proper disposal of this waste an urgent matter. The WTP sludge composition is very complex and composed of small particles with arrangement that can hinder its removal from water. In addition, the particles sedimentation which occupies the voids of the solid mass hinders the passage of free water. As the volume of sludge produced by WTPs is large, disposal in containment pond is dangerous, as seen in the accidents in Mariana and Brumadinho cities. In this sense, one of the most serious problems is the sludge reduction generated in WTPs. The recovery of wastewater from industrial sludge using drainage bed can be accomplished by natural volume reduction systems. It is worth noting that the use of natural waste treatment systems for WTPs has great potential for application, mainly due to the availability of the area, favorable climatic conditions and because it is a low-cost system that does not require chemicals and electricity. This work has the objective of evaluating the drainage bed performance for the dewatering of sludge from WTP of the Ouro Branco city. A drainage bed was built on a small scale using 20 mm PVC pipe, 4.5 mm thick geotextile blanket and gravel. 20 L of sludge sample was collected in the WPS decanters and total solids concentrations were determined. The initial and final volume of the sludge, color, pH, total solids content in the sludge, total solids content, turbidity, aluminum content in the residual water and the total sludge drying time were analyzed. The results showed that the drainage bed is a good alternative for the dewatering of sludge from the WPS of Ouro Branco city. Drainage bed shows efficiency of up to 99.91% of solids removal. These solids retained by the geotextile blanket are easy to remove, aiding in the process of conscious destination of the generated sludge. The values of aluminum concentration in the water after the drainage bed were lower than 0.05mg/L. In addition, the water presented excellent turbidity and color conditions, resulting in an efficiency of 99.36% turbidity removal and 99.91% solids removal.

Keywords: Water reuse; sludge; drainage; wastewater; turbidity.

Financial support: UFSJ.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

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Development of Chemically Modified Electrode with Magnetic Molecularly Imprinted Polymer for Determination of Estradiol in Water Samples

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The presence of environmental contaminants is due to the increasing number of artificial or natural compounds that are disposed of improperly into air, soil and water. In general, the environmental damage is highly relevant and can be irreversible. Steroid estrogens including estrone, estradiol and estriol, has been indiscriminately disposed of in water springs. These contaminants are chemicals that may interfere in the natural functioning of the endocrine system of animal species, including humans. In this work, we described the development of an electrochemical sensor modified with magnectic molecularly imprinted polymer for the estradiol determination in water samples. The magnetic molecularly imprinted polymers (MMIPs) bear selectivity due to its biomimetic receptor, and the facilitate pre-concentration, separation and manipulation of the analyte due to their magnetic properties. The MMIP was prepared on the Fe_3O_4@SiO_2 (nanoparticles of magnetite coated with tetraethyl orthosilicate). The estradiol was used as template and methacrylic acid as functional monomer. The electrochemical measurements were performed in an Autolab potentiostat/galvanostat (PGSTAT 12). A conventional three electrode cell was used. A carbon paste electrode modified (CPE-MMIP) was used as the working electrode. A platinum wire was employed as the counter electrode and Ag/AgCl/KCl (3.0 mol L^{-1}) electrode used as the reference electrode. The morphological and structural characterization of the obtained MMIP suggests that the synthesis of the material was effective. The sensor modified with MMIP showed higher current intensity in the oxidation of estradiol when compared to electrode configurations in the absence of this material. The electrochemical behavior of the CPE-MMIP on the oxidation of estradiol has been evaluated by employing cyclic voltammetry. The charge transfer coefficient, α, and the charge transfer rate constant, κ, for electron transfer between CPE-MMIP and estradiol were calculated as 0.49 and 19.09 s^{-1}, respectively. Under optimized conditions (pH 7.0 in 0.10 mol L^{-1} phosphate buffer) the best results were obtained by using differential pulse voltammetry and respond linearly to estradiol from 0.5 up to 14.0 µmol L^{-1} with limits of detection and quantification of 0.13 and 0.44 µmol L^{-1}, respectively. The developed method was successfully applied for estradiol determination in real samples of river water.

Keywords: Electrochemical Sensor; Magnetic Molecularly Imprinted Polymer; Estradiol; Water.

Financial support: CNPq, Fapemig, Capes and Rede Mineira de Química, Instituto Nacional de Tecnologias Alternativas para Detecção, Avaliação Toxicológica e Remoção de Contaminantes Emergentes e Radioativos (INCT-DATREM).

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

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Evaluation of fish farms impacts on water and sediment quality of the Furnas Reservoir

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The hydroelectric power plant reservoir of Furnas (Brazil) has a widespread activity of cage fish farming. *In situ* fish production can negatively impact the water-sediment system, causing nutrient enrichment, increases in turbidity and decreasing dissolved oxygen concentrations, which can promote eutrophication and contribute to changes in plankton community composition and physiology. In order to properly evaluate the impacts of fish farming to water quality and plankton communities, methodologies that combine impact identification and the detection of ecophysiological and compositional changes in plankton communities are promising, compared to single measurements of water quality or community taxonomic approaches. Here we used fatty acid analyses to investigate the impacts of fish farming on the suspended particulate organic matter of the Furnas reservoir. We hypothesized the fatty acid composition is a better descriptor of changes in aquaculture bays than traditional water quality chemical variables. Samplings were conducted in aquaculture and reference bays of the two rivers that form the reservoir, rio Grande and rio Sapucaí, between 2012 and 2016. Physical and chemical variables of water quality as well as the fatty acid profiles of SPOM were evaluated by espectrophotometric or gas-chromatographic techniques. Discriminant analyses were used to extract combinations of variables that best described the effects of fish farming activity in the reservoir. The results showed that the Sapucaí river bays had higher NH_4-N concentrations and lower concentrations of dissolved oxygen, possibly due to high discharge of urban and agricultural effluents, but no effect could be associated to the presence of fish cages. The fatty acid composition and concentrations in SPOM, on the other hand, showed a clear distinction between aquacuture and reference bays. Reference bays of both rivers were characterized by saturated fatty acids whereas aquaculture bays had high percentages of polyunsaturated fatty acids (18:3ω3, 20:5ω3 and 22:6ω3), monounsaturated fatty acids (18:1ω7cis and 18:1ω9cis) as well as a higher ω3:ω6 ratio, compared to reference bays. Such differences in the FA profile are probably caused by changes in the phytoplankton community structure. We conclude that fatty acids were better descriptors of fish farming impacts in the Furnas reservoir than tradition water chemistry variables.

Keywords: net cages; inorganic and organic nutrients; fatty acids biomarkers; reservoirs.

Financial support: Furnas Centrais Elétricas S.A., CAPES, FAPEMIG.

Choose the Thematic Area: ( ) TA1 ( ) TA2 ( ) TA3 (x) TA4

Presenting author: ( ) Undergraduate Student (x) Graduate Student ( ) Professional

Tubular LED photobiorreactor for nitrogen removal in wastewater

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Inadequate disposal of different forms of nitrogen from wastewater can cause eutrophication in rivers and lakes, in addition to contaminating groundwater, mainly due to the inadequate use of fertirrigation. Thus, treating wastewater with microalgae is a biological alternative for the removal of nitrogen, together with the sustainable production of algal biomass and co-product generation. This study investigated the different transformations of the nitrogen forms and the potential removal in the wastewater treatment with photobioreactor. Three red-wavelength LED-illuminated tubular photobioreactors (FBR_I; FBR_II; FBR_III) were operated in a batch mode with secondary effluent, from a wastewater treatment plant, as a culture medium with a useful volume of 3.35 liters.The photobioreactors operated under light flux of 224 ± 29 µmol m^{-2} s^{-1}, in photoperiods with 24 hours of daily illumination, for 96 hours and artificial injection of CO_2 every 12 hours, in order to provide the highest growth of algal biomass with inorganic carbon source and to control the pH so that less ammoniacal nitrogen was volatilized. Experiments results showed that 99% of N-NH_4^+ was removed from the culture medium at a removal rate of 10.6 mg N-NH_4^+ L^{-1} d^{-1}, together with a 5% increase in N-NO_3 concentration. In all photobioreactors removal of N-NH_4^+ was > 99%. Nitrate was completely removed in the FBR_I and FBR_II, while in the FBR_III there was a 201% increase in the concentration of N-NO_3^-. In all photobioreactors NO_3^- increases up to 84 hours of operation, because the culture medium is saturated with dissolved oxygen and ideal conditions for nitrification by bacteria. In addition, microalgae prefer to assimilate nitrogen in the form of NH_4^+, and assimilation of NO_3^- occurs only when the preferred form of nitrogen is depleted. Only in the FBR_I and FBR_II is the NH_4^+ depleted in the last 12 hours of batch, and in this remaining period, the algal biomass is responsible for assimilating the NO_3^-. Although FBR_III removed > 99% of N-NH_4^+, in the 84 hours of photobioreactor operation the NH_4^+ concentration is still high, and NO_3^- is not assimilated by microalgae and accumulates, which results in significant increase. With this, one source of inorganic nitrogen was transformed into another, the nutrients were not removed and the problem just changed shape. Thus, measuring only the NH_4^+ concentration in microalga-bacterial photobioreactors may present a false positive in the removal of nitrogen from effluent, because a fraction is converted to NO_3^- in the nitrification process. In addition, for the removal of NO_3^- it is necessary that limitation of NH_4^+ occur, which corroborates with the preference of the microalgae in the assimilation of nitrogen in the form of NH_4^+. However, if correctly operated, microalgae photobioreactors have a high rate of nitrogen removal from wastewater, and are a biological alternative for sustainable treatment.

Keywords: Microalgae; microalgae-bacteria consortium; wastewater treatment; tertiary wastewater treatment; nutrient removal.

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