Editorial
Prof. Dr. Martin Aznar

Nesta edição destacamos um fato importante: a procura pelo curso de engenharia química nunca foi tão alta. Segundo divulgado pela Comissão Permanente para os Vestibulares (Comvest), a relação candidato/vaga para o curso diurno de engenharia química foi de 31,9 no vestibular de 2010. O Prof. Dr. Osvaldir Taranto, Diretor da FEQ, analisa o fato como muito positivo, impulsionado pelas recentes descobertas de petróleo na camada pré-sal e os desenvolvimentos em biocombustíveis, áreas nas quais o engenheiro químico deve assumir um papel de liderança.

Mencionamos também duas importantes palestras (leia texto abaixo) e o grande destaque dado por veículos como o Jornal da UNICAMP e a revista Pesquisa FAPESP a pesquisas desenvolvidas na FEQ.

Palestras na FEQ

No dia 08 de julho, o Dr. Philippe A. Tanguy, Vice Presidente de Pesquisa e Desenvolvimento, TOTAL (França), ministrou a palestra “Energy-Environment Nexus: Issues and Challenges”. O Dr. Tanguy é também o presidente do comitê organizador do 8th World Congress of Chemical Engineering, realizado em Montreal, Canadá, nos dias 23 a 27 de agosto (www.wcce8.org). A visita do Dr. Tanguy foi organizada pelo Prof. Dr. José Roberto Nunhez.

Evaluation and application of the extended TBP curves in processing and refining of heavy oil fractions

Oil reserves in Brazil are characterized by heavy and ultra heavy petroleum. This type of oil is relatively difficult to process. In fact, it is necessary to upgrade such kind of oil in order to increase productivity of light fractions, mainly diesel. An important step in the definition and set up of suitable process to deal with this is the oil characterization. This is made with the aid of the True Boiling Point (TBP) curve through ASTM standard test methods until 565°C and its extension obtained from molecular distillation for heavy oil and residues. In this work, it is proposed a refining evaluation making use of the extended TBP curves. The conceptual process was implemented in HySys Process Simulator through a novel procedure for the generation of pseudocomponents for characterizing the feeding of distillation columns. It was developed a simulation methodology in order to evaluate the petroleum residues extended TBP curves in the process separation after the FCC (Fluid Catalytic Cracking) reactor, for producing liquefied petroleum gas, gasoline and diesel.

Experimental study in a short circulating fluidized bed riser
Castilho, G.J.; Cremasco, M.A. Particulate Science and Technology, 27 (2009), 210-221. ISSN: 1548-0046. doi:10.1080/02726350902921715

Experiments were performed with gas and solids flow in a 2.42 m high circulating fluidized bed (CFB). This equipment has both solids and gas fed into the downer section. Local solids holdup was measured using an optical fiber probe. By the axial solids concentration distribution, it was verified that (1) the curve that precedes the entrance into the riser provides further acceleration to the flow and (2) the abrupt exit causes an increase in solids concentration in the top zone. Results of radial distributions in the bottom zone show that the flow is more concentrated near the wall. For the exit zone, the distributions show high values of solids holdup both near the wall and on the axis.

A LabVIEW-based intelligent system for monitoring of bioprocesses

The application presented in this study illustrates the usefulness of an automated monitoring system carried out in LabVIEW environment. The results obtained have show that it is possible to infer into a real-time basis the key variables in bioethanol fermentation using pH, turbidity, CO₂ flow rate and temperature on line measurements and a MLP-based Software Sensor. On-line monitoring system provided accurate online predictions of the concentrations during the fermentation process even when the secondary variables measurements were noisy. This study also will illustrate the usefulness of an automated monitoring system carried out in graphical programming environment.

Anhydrous bioethanol production using bioglycerol - simulation of extractive distillation processes

Bioethanol has been increasingly used as fuel in the anhydrous form, mixed with gasoline. In this work, two configurations of the extractive distillation process using bioglycerol as a solvent for anhydrous bioethanol production were investigated. Simulations results show that bioglycerol is a suitable agent for the separation of ethanol-water mixtures, with low energy consumption on the column reboilers and the production of high quality anhydrous bioethanol.
Modeling of the nitroxide-mediated radical copolymerization of styrene and divinylbenzene
A mathematical model for the copolymerization kinetics with crosslinking of vinyl/divinyl monomers in the presence of nitroxide controllers has been developed and validated using experimental data of TEMPO-mediated copolymerization of styrene (STY) and divinylbenzene (DVB). Polymerization rate, molecular weight development, gelation point, evolution of sol and gel weight fractions, crosslink density, and copolymer composition, as well as concentrations of the species participating in the reaction mechanism can be calculated with the model. Diffusion-controlled effects were assessed and found unimportant. The presence of nitroxide controllers seems to favor the production of more homogeneous polymer networks, but this effect decreases as the initial fraction of crosslinker is increased.

Simulation and optimization of the continuous vacuum extractive fermentation for bioethanol production and evaluation of the influence on distillation process
In this work, the use of a vacuum extractive fermentation reactor, which allows the production of wine with higher ethanol concentration, as well as its effects on the distillation stage, were studied for bioethanol production. Energy consumption was evaluated and compared to the conventional process, showing that the proposed configuration provides a significant reduction in energy consumption, so it seems an interesting option for process intensification.

Development of a computational tool for simulating falling film molecular design
In a previous work, a software named DISMOL was developed in order to simulate molecular distillation (MD). However, due to the restricted access to this tool, and to the importance of having a computational tool available for future investigations of operational policies in oil refinery, in the present work, it is proposed the development of a general procedure for this highly specific process in the commercial simulator Aspen Plus®. Since no single unit operation is available in the commercial simulator that can appropriately simulate a falling film distillator, the proposal, in a preliminary approach, makes use of a sequence of flash vessels corrected with process efficiency, in order to accomplish the task of MD simulation. Experimental data of a binary system distilled in a falling film molecular distillator are used for the validation of the developed procedure. The results indicate the potential of the proposed procedure to represent a MD equipment for the system evaluated, making possible the study of different operational policies in conducting this high vacuum distillation operation for high-value products, such as the derived from oil refining.

Computational fluid dynamics simulation of the water - sugar cane bagasse suspension in pipe with internal static mixer
A comprehensive CFD model was developed to gain insight into flow characteristics of water-sugar cane bagasse suspension in pipe with and without internal static mixers. Two different modeling approaches were used: Eulerian-Eulerian and Lagrangian Particle Tracking, both with the k- turbulence model. Local solid volume fraction distribution was studied for three mean velocity suspension; 0.10, 0.15 and 0.20 m/s. The mass volume fraction studied were 49.6 and 10 W/V of water-swollen particles. The predicted flow indicates the presence of loop flow pattern in the pipe with internal static mixers as a function of mean velocity suspension.

An evaluation of a multi-method tool for real-time implementation of two-layer optimization
In this work, an optimization tool based on Sequential Quadratic Programming (SQP), Levenberg-Marquardt (LM) and Genetic Algorithm (GA) is presented. For the matter of possible alternative
computational platforms, it is convenient to have an open toll easily implemented with softwares at low costs. The tool evaluation is carried out in real-time optimization with the concept of two-layer approach. The tool is applied to a three phase catalytic slurry reactor, represented by a deterministic dynamic heterogeneous mathematical model. The kinetic law considers the hydrogenation reaction of o-cresol to obtain 2-methyl-cyclo-hexanol, in the presence of the catalyst Ni/SiO2. The advanced controller, which is based on the Dynamic Matrix Control with constraints (QDMC), is used. The present implementation aims to maintain the conversion at the exit of the reactor and to maximize the conversion. The challenge is then to conciliate better results of the optimization and less effort and computational time in the real-time process integration. The results presented showed that LM, SQP (local deterministic methods) and GA (stochastic method) algorithms were able to optimize the process both for the case of maintaining and maximizing o-cresol conversion, when perturbations are introduced into the process. The simulations showed that GA could optimize the process after perturbations were inserted but demanded a CPU time not applicable in real-time optimizations. LM and SQP, on the other hand, optimized successfully the process, both in terms of achieved conversion and CPU time, presenting potential to be used in real-time applications for the studied three-phase catalytic reactor.

An approach to calculate solid-liquid phase equilibrium for binary mixtures
An approach is presented to calculate solid-liquid phase equilibrium for binary mixtures, using expressions for the temperature as a function of the molar fraction. For Margules model the expression gives explicitly the temperature, while for other liquid phase activity models an iterative procedure is required to calculate the temperature. The method is very easy to apply and it can be used for mixtures that have peritectic and eutectic points, or just a eutectic point. The approach was applied to five case studies with binary mixtures of fatty acids and triglycerides. The results were in good agreement with experimental data.

Approach model for simulation of the starch hydrolysis by α-amylase and alcohol production from manioc root starch
This work shows optimal conditions to use the amylases from A. niger in starch hydrolysis and alcohol production from manioc root starch. Bioreactors contained 10-20 g/L of manioc starch concentration, on 35-55°C, and at pH 4.8; they were made for the evaluation of the effects of starch concentration and temperature on hydrolysis yield. New models for starch hydrolysis kinetics were compared for substratum dependence ([S]) to the hydrolysis time (t) and hydrolysis conversion rate (V) dependences with the substratum concentration ([S]). Results showed that exponential models fitted better than other models. The appropriate models were [S] = e^{k.t} and V = e^{V_{max} / [S]^n} K_M, while k, V_{max} and K_M are the kinetic, maxim velocity and Michaelis-Menten constants, respectively. Models proposed in this work have been compared to experimental data, and it may be possible to simulate the starch hydrolysis process by amylases and its scale-up. Results showed that exponential models were more appropriate to use than Michaelis-Menten model for V values higher than 0.3 g/L.min. At a V range lower than 0.3 g/L.min, both models were satisfactory predictives. For starch hydrolysis, the exponential models perceived that, at optimal conditions, the mean yield was 70%. After fermentation, an alcohol yield above 45% was obtained (the theoretical is 51.1%).

Alginate and pectin composite films crosslinked with Ca^{2+} ions: effect of the plasticizer concentration
The manufacture of composite biofilms of alginate and LM-pectin crosslinked with calcium ions requires a two-step contact with Ca^{2+}: initially a low-structured pre-film is formatted which is further crosslinked in a second contact with a more concentrated Ca^{2+} solution containing plasticizer. This research evaluated the influence of the plasticizer (glycerol) concentration (1-15% w/v) in this finishing reticulation step on final films characteristics. The results indicated that the extent of the simultaneous Ca^{2+} crosslinking and plasticization with glycerol was determined by the level of structural organization obtained in the pre-reticulation. Increasing the glycerol concentration of the crosslinking solution increased film solubility in water, moisture content, volumetric swelling and flexibility and decreased the resistance to tensile stress.
Transparent alginate and pectin composite films with acceptable mechanical properties, low solubility and limited degree of swelling were obtained with 10% glycerol in the second contact solution.

**Design of a high-efficiency hydrofoil through the use of computational fluid dynamics and multiobjective optimization**


A computational fluid dynamics (CFD) model is proposed, based on ANSYS-CFX tools coupled to optimization models inside the commercial optimization software modeFRONTIER in order to obtain an optimal design of a high-efficiency impeller for solids suspension. The analysis of impeller shape performance was carried out using the shear-stress transport (SST) turbulence model with streamline curvature correction. This turbulence model combined the advantages of the \( k \cdot \varepsilon \) and \( k \cdot \omega \) models, ensuring a proper relation between turbulent stress and turbulent kinetic energy, allowing an accurate and robust prediction of the impeller blade flow separation. The multiple frames of reference and the frozen rotor frame change models were used for the rotor/stator interaction inside the mixing vessel. The optimization procedure used seven design variables, two nonlinear constraints and two objective functions. The objective functions chosen (among many other possible options) to evaluate the impeller performance were the maximum solid distribution throughout the vessel (homogeneous suspension) reflected by a low variance between local solid concentration and average solid concentration inside the vessel and the higher pumping effectiveness, which was defined as the quotient of the flow and power numbers. The first objective function searches for impeller configurations able to provide good solid suspension, since it aims to achieve homogeneous suspension. The second objective function aims to reduce power consumption for a high-pumping capacity of the impeller. These criteria were considered enough to characterize the optimized impeller. Results indicated that the optimized impeller presented an increase of the pumping impeller capacity and homogeneous solid suspension with low-power consumption, especially when compared with the PBT 45° impeller.

**Phase equilibria for salt-induced lysozyme precipitation: effect of salt type and temperature**


The salt-induced precipitation of lysozyme from aqueous solutions was studied through precipitation assays in which the equilibrium compositions of the coexisting phases were determined. Lysozyme precipitation experiments were carried out at 5, 15 and 25 °C and pH 7.0 with ammonium sulfate, sodium sulfate and sodium chloride as precipitating agents. In these experiments a complete separation of the coexisting phases (liquid and solid) could not be achieved. Nevertheless it was possible to determine the composition of the precipitate. The enzymatic activity of lysozyme in the supernatant phase as well as in the precipitate phase was also determined. The activity balance suggests that there is a relationship between the composition of the true precipitate and the total activity recovery.

**Agosto**

**Study of kinetic parameters in a mechanistic model for bioethanol production through a screening technique and optimization**


The accurate description of the kinetics and robust modeling of biotechnological processes can only be achieved by incorporating reliable methodologies to easily update the model when there are changes in operational conditions. The purpose of this work is to provide a systematic approach with which to perform model parameters screening and updating in biotechnological processes. Batch experiments are performed to develop a mechanistic model, considering the effect of temperature on the kinetics, and further experiments (batch fermentations using sugar cane molasses from a different harvest) are used to validate the effectiveness of screening before parameters updating. The reduction in the number of kinetic parameters to be re-estimated enabled by the screening procedure reduces significantly the complexity of the optimization, which makes the updating procedure to be significantly quicker, while resulting in accurate performance of the updated model.
Production and characterization of amylases from Zea mays malt

In this work the α and β-amylase enzymes were obtained from maize (Zea mays) malt and were biochemistry characterized. A germination study to obtain the maize malt with good amylase activity was made. The maize seeds were germinated in laboratory and the enzymatic activity was measured daily. Activity dependence to germination time were fitted to an exponential model ($A=A_0e^{kt}$), which showed that the behaviour of enzymatic activity in the germination process was similar to the growth of the microorganism. Its model could be applied to describe the mechanism of α-amylase production for each maize varieties and others cereals. Maize malt characterization showed that α and β-amylase had optimal pH between 4-6.5, optimal temperature 50 and 90ºC, and molecular weight of 67.4 and 47.5kDa, respectively. This work contributed with the advances in biotechnology generating of conditions for application of a new and of low price amylases source.

Cromatografia de afinidade por ions metálicos imobilizados (IMAC) de biomoléculas: aspectos fundamentais e aplicações tecnológicas

Immobilized Metal Ion Affinity Chromatography - IMAC - is a group-specific based adsorption applied to the purification and structure-function studies of proteins and nucleic acids. The adsorption is based on coordination between a metal ion chelated on the surface of a solid matrix and electron donor groups at the surface of the biomolecule. IMAC is a highly selective, low cost, and easily scaled-up technique being used in research and commercial operations. A separation process can be designed for a specific molecule by just selecting an appropriate metal ion, chelating agent, and operational conditions such as pH, ionic strength, and buffer type.

High pressure phase behavior of carbon dioxide in 1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide and 1-butyl-3-methylimidazolium dicyanamide ionic liquids
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The acidity/basicity of the reaction media has a substantial influence on the efficiency of many reactive processes; therefore, a new class of acidic or basic ionic liquids is gaining special attention due to the possibility of increasing the efficiency of many processes by a wise manipulation of their properties. The absorption of sour gases is one of the processes that can be enhanced by the basic character of the ionic liquid. The fluorination of the cation or anion can also contribute to the gas solubility enhancement. In this work, these two characteristics are evaluated and compared through the study of gas-liquid equilibrium of two ionic liquids, 1-butyl-3-methylimidazolium dicyanamide ([C₄ mim][DCA]) and 1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide ([C₄ mim][Tf₂N]), with carbon dioxide (CO₂) at temperatures up to 363 K and pressures up to 74 MPa. A thermodynamic model based on the Peng-Robinson equation of state with the Wong-Sandler mixing rule, using the UNIQUAC model for the activity coefficients, was used to describe the experimental data and for the estimation of the Henry's constants. The solubility of CO₂ in 1-butyl-3-methylimidazolium dicyanamide is much lower than anticipated on the basis of the reported pKa of the anion when compared with the acetate anion. No chemisorption is observed and the solvation enthalpy is quite low, ruling out any Lewis acid/base interaction between the anion and the CO₂. The 1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide ionic liquid, known to present one of the highest solubilities towards CO₂ due to the presence of fluoroalkyl groups, showed a much larger solubility for CO₂ than 1-butyl-3-methylimidazolium dicyanamide.

Experimental study of the excess molar enthalpy of ternary mixtures containing water + (1,2-propanediol, or 1,3-propanediol, or 1,2-butanediol, or 1,3-butaneediol, or 1,4-butaneediol, or 2,3-butaneediol) plus electrolytes at 298.15 K and atmospheric pressure

Excess molar enthalpies (H_m⁰) of ternary mixtures containing water+(1,2-propanediol or 1,3-propanediol or 1,2-butaneediol or 1,3-butaneediol or 1,4-butaneediol or 2,3-butaneediol)+(sodium bromide, or ammonium
bromide, or tetraethyl ammonium bromide, or 1-n-butyl-3-methylimidazolium bromide at 0.1 mol dm\(^{-3}\) at 298.15 K and atmospheric pressure have been determined as a function of composition using a modified 1455 Parr mixture calorimeter. The \(H_n^E\) values are negative for all mixtures over the whole composition range. The influence of the electrolyte on the hydrophobic and hydrophilic effects as well as on the behavior of \(H_m^E\) is discussed.

**Measurements of excess molar enthalpy and excess molar heat capacity of (1-heptanol or 1-octanol)+(diethy lamine or s-butylamine) mixtures at 298.15 K and 0.1 MPa**


Experimental data of excess molar enthalpy \((H_n^E)\) and excess molar heat capacity \((C_p^m)^E\) of binary mixtures containing (1-heptanol or 1-octanol)+(diethy lamine or s-butylamine) have been determined as a function of composition at 298.15 K and at 0.1 MPa using a modified 1455 Parr solution calorimeter. The excess molar enthalpy data are negative and show parabolic format over the whole composition range; however, the excess molar heat capacity values, whose curves show a S-shape, are positive in the 0.0 to 0.7 molar fraction range and negative between the molar fraction values 0.7 to 1.0. The applicability of the ERAS-model to correlate the excess molar enthalpy data was tested. The calculated data values are in good agreement with the experimental ones. The experimental behavior of \(H_m^E\) is interpreted in terms of specific interactions between 1-alkanol and amine molecules.

**The solid-liquid phase diagrams of binary mixtures of consecutive, even saturated fatty acids**


For the first time, the solid-liquid phase diagrams of five binary mixtures of saturated fatty acids are here presented. These mixtures are formed of caprylic acid \((C8:0)\) + capric acid \((C10:0)\), capric acid \((C10:0)\) + lauric acid \((C12:0)\), lauric acid \((C12:0)\) + myristic acid \((C14:0)\), myristic acid \((C14:0)\) + palmitic acid \((C16:0)\) and palmitic acid \((C16:0)\) + stearic acid \((C18:0)\). The information used in these phase diagrams was obtained by differential scanning calorimetry (DSC), X-ray diffraction (XRD), FT-Raman spectrometry and polarized light microscopy, aiming at a complete understanding of the phase diagrams of the fatty acid mixtures. All of the phase diagrams reported here presented the same global behavior and it was shown that this was far more complex than previously imagined. They presented not only peritectic and eutectic reactions, but also metatectic reactions, due to solid-solid phase transitions common in fatty acids and regions of solid solution not previously reported. This work contributes to the elucidation of the phase behavior of these important biochemical molecules, with implications in various industrial applications.

**Neural network based control of an absorption column in the process of bioethanol production**


Gaseous ethanol may be recovered from the effluent gas mixture of the sugar cane fermentation process using a staged absorption column. In the present work, the development of a nonlinear controller, based on a neural network inverse model (ANN controller), was proposed and tested to manipulate the absorbent flow rate in order to control the residual ethanol concentration in the effluent gas phase. Simulation studies were carried out, in which a noise was applied to the ethanol concentration signals from the rigorous model. The ANN controller outperformed the dynamic matrix control (DMC) when step disturbances were imposed to the gas mixture composition. A security device, based on a conventional feedback algorithm, and a digital filter were added to the proposed strategy to improve the system robustness when unforeseen operating and environmental conditions occurred. The results demonstrated that ANN controller was a robust and reliable tool to control the absorption column.

**Hydroxyapatite deposition study through polymeric process on commercially pure Ti surfaces modified by laser beam irradiation**


Many techniques have been used to coat metallic substrate with bioceramics. The aim of this study was to study the physical-chemical characteristics of polyvinylidene fluoride (α-PVDF)/hydroxyapatite (HA) composite coating, obtained by casting method, on commercially pure titanium (α-CP Ti) substrate
Surface modified by laser beam irradiation. The preparation of coating was done for mixing α-PVDF pellets shape dissolved in dimethylacetamide (DMA) with HA/DMA emulsion. The mixture was poured onto the α-CP Ti sample and left to dry in an oven. CP Ti plates were coated with α-PVDF/HA composite film, in proportions of 100/00 and 60/40 in weight, and characterized by particle size analysis, scanning electron microscopy, energy dispersive spectroscopy (EDS), X-ray diffractometry, thickness measurement and contact angle. Uniform coating with a small thickness variation along the coated surface was successfully obtained.

**Precipitation of porcine insulin with carbon dioxide**


Recent works have pointed to the use of volatile electrolytes such as carbon dioxide (CO₂) dissolved in aqueous solutions as a promising alternative to the precipitating agents conventionally used for protein recovery in the food and pharmaceutical industries. In this work we investigated experimental and theoretical aspects of the precipitation of porcine insulin, a biomolecule of pharmaceutical interest, using CO₂ as an acid-precipitating agent. The solubility of porcine insulin in NaHCO₃ solutions in pressurized CO₂ was determined as a function of temperature and pressure, with a minimum being observed close to the protein isoelectric point. A thermodynamic model was developed and successfully utilized to correlate the experimental data. Insulin was considered a polyelectrolyte in the model and its self-association reactions were also taken into account. The biological activity of insulin was maintained after precipitation with CO₂, although some activity can be lost if foam is formed in the depressurization step.

**Setembro**

**Crystallization behavior of mixtures of fatty acid ethyl esters with ethyl stearate**


In spite of their interest to understand the low-temperature behavior of biodiesel, data on the crystallization behavior of fatty acid esters mixtures are scarce. To overcome this limitation, the melting points of seven binary mixtures of saturated and unsaturated fatty acid ethyl esters with ethyl stearate were measured by differential scanning calorimetry (DSC) and are here reported. The Predictive UNIQUAC model, developed for the prediction of cloud points of diesels and previously applied to fatty acid methyl esters, is shown to produce an excellent prediction of the experimental data measured in this work. It is shown that, alternatively, a simple ideal solution is able to describe the melting points with identical accuracy to the Predictive UNIQUAC model and may prove to be able to describe cloud points of real biodiesel.

**Separation of L-tryptophan present in an aromatic amino acids mixture in a four-column simulated moving bed: experimental and simulation studies**


An experimental and theoretical study is presented for the fractionation of L-Tryptophan (Trp) from L-phenylalanine (Phe) and L-tyrosine (Tyr). A Simulated-Moving Bed (SMB) with four-column system was tested, and the results are presented as effluent histories of the raffinate and extract ports. L-phenylalanine and L-tyrosine were recovered as major products in the raffinate, while L-Tryptophan was recovered at the extract. To simulate the L-Tryptophan separation, a general rate model was used to represent the mass transfer phenomena that occur in each individual column of the SMB, for each solute present in the multicomponent system. A hybrid method was used to solve the model. An analytic solution was used for the intra-particle concentration, and was correlated to the liquid bed concentration by Duhamel's theorem. The results from simulation are compared with the experimental data presented in this work.
Production of bioethanol and other bio-based materials from sugarcane bagasse: Integration to conventional bioethanol production process
Ethanol may be produced using sugarcane bagasse as raw material through the Organosolv process with dilute acid hydrolysis, thus increasing ethanol production with the same cultivated sugarcane area. In this work simulations of bioethanol production from sugarcane juice and bagasse are carried out using software UniSim Design. A typical large scale production plant is considered: 1000 m³/day of ethanol is produced using sugarcane juice as raw material. A three-step hydrolysis process (pre-hydrolysis of hemicellulose, Organosolv delignification and cellulose hydrolysis) of surplus sugarcane bagasse is considered. Pinch analysis is used to determine the minimum hot utility obtained with thermal integration of the plant, in order to find out the maximum availability of bagasse that can be used in the hydrolysis process, taking into consideration the use of 50% of generated sugarcane trash as fuel for electricity and steam production. Two different cases were analyzed for the product purification step: conventional and double-effect distillation systems. It was found that the double-effect distillation system allows 90% of generated bagasse to be used as raw material in the hydrolysis plant, which accounts for an increase of 26% in bioethanol production, considering exclusively the fermentation of hexoses obtained from the cellulosic fraction.

Effect of fatty acid addition on the properties of biopolymer films based on lipophilic maize starch and gelatin
In the present work, composed layer films based on lipophilic starch and gelatin were produced containing different amounts of fatty acids (palmitic, lauric, myristic, capric, caproic and caprylic); i.e., 5, 15, 25 and 50%, using sorbitol as the plasticizer. All films were prepared by casting in an acrylic plate and their barrier properties (vapor permeability), as well as their mechanical (tensile strength and elongation), physicochemical (water solubility) and physical (opacity and thickness) properties were measured. The addition of fatty acids to the biopolymer films increased their thickness, opacity and elongation. On the other hand, the addition of fatty acids decreased the tensile strength and water vapor permeability of the biopolymer films for all formulations studied. The fatty acid concentration found to be effective in reducing the biopolymer film permeability varied between 15 and 25%.

Efeitos da massa molar e do pH sobre o equilíbrio termodinâmico do sistema bifásico aquoso PEG/fosfatos
Sistemas bifásicos aquosos têm sido muito utilizados, em pesquisas, na separação e purificação de biomoléculas. São formados pela mistura de dois polímeros hidrofílicos, ou de um polímero e um sal. O objetivo principal deste trabalho foi caracterizar um sistema bifásico aquoso (SBA) a partir da preparação de soluções estóquicas de PEG com massas molares de 1500, 4000 e 6000 e tampões fosfato variando de 6 a 8, em condições normais. Nos diagramas de fases PEG/fosfato, foi observado um deslocamento da binodal para os valores de menores concentrações dos polímeros e com o aumento do peso molecular do PEG. Por outro lado, a variação do pH não mostrou um deslocamento significativo da binodal. Em relação às linhas de amarração, os valores das composições não se alteram muito, mesmo quando os polímeros são comparados entre si e a diferentes pHs.

Microalgae as feedstock for biodiesel production: carbon dioxide sequestration, lipid production and biofuel quality
The objective of this paper was to evaluate the carbon dioxide sequestration capacity, biomass production, lipid content, lipid productivity and biodiesel quality of six microalgal strains cultivated photosynthetically in a bubble column photobioreactor. Lipid productivity was the criteria for selection species; for the best specie, carbon dioxide sequestration rates, biomass productivity, lipid content and lipid productivity of 17.8 mg/L min, 20.1 mg/L hour, 27.0% and 5.3 mg/L hour were obtained. Qualitative
analysis of the fatty acid methyl esters demonstrates the predominance on saturated (43.5%) and monounsaturated (41.9%) fatty acids. The crucial parameters for quality properties of biodiesel evaluated (ester content, 99.85%; cetane number, 56.73; iodine value, 65.00 gI/100 g; degree of unsaturation, 74.07% and cold filter plugging point, 4.54°C) comply with the US Standard (ASTM 6751), European Standard (EN 14214), Brazilian National Petroleum Agency (ANP 255) and Australian Standard for biodiesel. The novelty of this paper is the estimation of the fuel properties of the microalgal biodiesel and the comparative study of conventional sources used as feedstock for biodiesel manufacture, facilitating worldwide advances in this research area.

**Biotransformations of carbon dioxide in photobioreactors**


Laboratory experiments were performed to study the capacity of CO₂ sequestration and carbon fixation into biomass during the cultivation of the cyanobacteria *Aphanathece microscopica Någeli* in refinery wastewater. The influence of the photoperiod (day/night) on the rates of CO₂ sequestration and O₂ release was also determined. Rates of CO₂ sequestration were measured both in the liquid and gaseous phases. The results showed that the capacity of CO₂ sequestration and O₂ release during the day/night experiment was about one-fourth less than that achieved in the continuously illuminated experiment. Equivalence was found between rates of CO₂ sequestration measured in the two phases. Despite large amounts of CO₂ that were sequestered during the cultivation, it is demonstrated that only a small fraction (about 3%) was effectively fixed as microalgae biomass, indicating the existence of other routes of CO₂ conversion in the photobioreactor.

**Fuzzy model-based predictive hybrid control of polymerization processes**


This paper presents a fuzzy model-based predictive hybrid controller (FMPHC) for polymerization processes based oil Takagi-Sugeno models and moving horizon methodology. Such processes are characterized by strongly nonlinear behaviors, which may either require significant effort to tune model-based controllers or render them ineffective. The proposed FMPHC is a promising integrated approach to handle nonlinearities and control issues. An industrial copolymerization process of ethylene and 1-butene is adopted to validate the proposed approach and to compare it to the most widespread advanced multivariable control.

**Aerobic biodegradation of butanol and gasoline blends**


This work aimed to assess the aerobic biodegradation of butanol/gasoline blends (5; 10; 15 and 20% v/v), being the latter compared to the ethanol/gasoline blend (20% v/v). Two experimental techniques were employed, namely the respirometric method and the redox indicator DCPIP test. In the former, experiments simulating the contamination of natural environments (addition of 50 mL of fuel kg⁻¹ of soil from a non-contaminated site and 20 mL of fuel L⁻¹ of water from a river) were carried out in biometer flasks (250 mL), used to measure the microbial CO₂ production. The DCPIP test assessed the capability of four inocula to biodegrade the blends of 20%. The addition of butanol at different concentrations enhanced the biodegradation of gasoline in soil. However, no practical gains were observed for concentrations of butanol above 10%. Ethanol showed to have a much faster biodegradation rate than butanol, particularly in water, and the following order of biodegradability was found: ethanol > butanol > gasoline. The addition of the alcohols to the gasoline resulted in positive synergic effects on the biodegradation of the fuels in soil and water matrices. Furthermore, results suggest that, in soil, butanol better enhanced the biodegradation of gasoline than ethanol.

**Identification of defluidization region in a gas-solid fluidized bed using a method based on pressure fluctuation measurements**


Industrial applications that involve fluidized bed operations must prevent the undesirable phenomenon of partial or complete bed defluidization. Defluidization can be avoided by increasing the gas velocity.
and/or, in some cases, changing the solid feed conditions in the system, provided that the changes in the hydrodynamics of the flow are detected early enough. The use of a technique that can perform an early detection of the defluidization condition in industrial applications is important, in order to avoid the loss of efficiency or even an undesirable shutting down of the process. The objective of this work is to show the application of a method for early detection of the condition where the bed is tending to the defluidization, in a gas-solid fluidized bed flow. The method is based on pressure fluctuation measurements. Experimental tests are carried out using two solid particles: microcrystalline cellulose and sand. Results show that the proposed method is efficient in detecting the fluidization condition in a conventional bubbling bed regime. The potential of application of the technique is also shown for the control of the defluidization phenomenon in industry.

One-pot synthesis of a chitosan–based hydrogel as a potential device for magnetic biomaterial
This describes the cross-linking/co-polymerization reaction of chitosan (CS), acrylic acid (AAc), and N, N’-methylenebisacrylamide (MBA) in presence of citrate covered-γ-Fe₂O₃ nanoparticles. A gelling process was verified by means of spectroscopic methods; FT-IR and solid-state ¹³C-CP/MAS NMR. The corresponding signals of the gelling process, in the ¹³C NMR spectra, for the magnetic hydrogel were shifted to lower values due to embedding of the citrate covered-γ-Fe₂O₃ nanoparticles. XRD confirmed that the crystallinity of the magnetic hydrogel exhibited a different crystalline structure to that without magnetic properties. The Mössbauer and magnetization analysis revealed that the magnetic hydrogel displays a high lattice strain due to bonded iron atom covalence and superparamagnetism. From SEM micrographs, no separation phase coexists between the magnetic nanoparticles and cross-linked hydrogel, indicating an excellent dispersion throughout the hydrogel. The swelling rate was dependent on the cross-linking degree of the hydrogel and ionic strength of the aqueous solution.

Factorial design applied to concentrate bioactive component of Cymbopogon citratus essential oil using short path distillation
*Cymbopogon citratus* (DC.) *Staff* (Gramineae) is the scientific name of a plant known as lemongrass. It is characterized by the high concentrations of citral. This work aimed to analyze the influence of short path distillation process variables (evaporator temperature (EVT), volumetric feed flow rate (Q) and interactions between them), on the concentration of citral in the distillate stream of the process. Factorial design experiments were carried out, starting with a 22 design trials at experimental range from 60 to 80 ºC for EVT and from 1.5 to 6.0 mL/min for Q, followed by 22 with central point design trials at experimental range from 60 to 120 ºC for EVT and between 1.5 and 4.5 mL/min for Q. The concentration of citral in the distillate (CCD) was analyzed by gas chromatography-mass spectrometry (GC-MS). The effect of each variable studied on the dependent variable (CCD), is indicated by influence of EVT and Q on CCD. The increase of EVT increases CCD to 2.048 × 10³ mg citral/g sample, when compared with the initial sample of essential oil, which presented a CCD of 9.908 × 10² mg citral/g sample. The linear model, statistically significant, describes the dependence of the variable CCD with the variables of the process inside the experimental range.

Rheological behavior of alginate solutions for biomanufacturing
Rezende, R.A.; Bártolo, P.J.; Mendes, A.; Maciel Filho, R. *Journal of Applied Polymer Science*, 113 (2009), 3866-3871. ISSN: 1097-4628. doi:10.1002/app.30170
The rheological behavior of alginate solutions were investigated for the optimal design of a biomanufacturing system to produce alginate structures for tissue engineering. Its rheological properties were determined by a rheometer through rotational and oscillatory tests. Experimental results were used to model the alginate solutions characteristics. The findings suggest that alginate solutions undergo shear-thinning effects with increasing shear rates. It is also possible to observe that its loss modulus is higher than the storage modulus ones being both modulus dependent upon the frequency, which is a typical characteristic of dilute solutions.
Fluorometric quantification of green fluorescent protein in tobacco leaf extracts
The main utilization of green fluorescent protein (GFP) is as a reporter system, where the existence of the protein is usually determined visually using fluorescent microscopy. Although fluorescence-based quantification of GFP is possible, background fluorescence in plants and in plant extracts was observed by our group. Another phenomenon we observed, that makes quantification difficult is the increased level of GFP fluorescence in Nicotiana benthamiana leaves extracts, probably the result of dimerization of GFP molecules promoted by interaction with some component(s) of tobacco extract. In the present work the background fluorescence was minimized and the enhancement of GFP fluorescence in tobacco extract was eliminated with the addition of urea to the measured solution so that a simple quantification assay for the GFP in the tobacco extracts could be established.

Kinetics of L-ascorbic acid degradation in pineapple drying under ethanolic atmosphere
Santos, P.H.S.; Silva, M.A. Drying Technology, 27 (2009), 947-954. ISSN: 1532-2300. doi:10.1080/07373930902901950
The kinetics of L-ascorbic acid degradation during drying of pineapple in normal and modified atmosphere was studied. Drying experiments were carried out in a tunnel dryer at two drying temperatures and air velocities. The drying atmosphere was modified by the addition of ethanol (0.5% v/v). The presence of ethanol in the drying atmosphere promoted a more intense water evaporation compared to the conventional process. Although the L-ascorbic acid degradation rate during the pineapple drying (final moisture content of 27% wet basis) under ethanolic atmosphere was higher, these samples retained higher amounts of L-ascorbic acid. Moreover, the Weibull model was applied to fit the kinetics data.

The intestinal permeation of didanosine from granules containing microspheres using the everted gut sac model
Silva, C.F.; Severino, P.; Martins, F.; Chaud, M.V.; Santana, M.H.A. Journal of Microencapsulation, 26 (2009), 523-528. ISSN: 0265-2048. doi:10.1080/02652040802466691
The aim of this research is to evaluate the intestinal permeation of a new formulation (NF) for the anti-retroviral didanosine (ddl) drug, using the everted gut sac model. The NF is composed by granules containing ddl incorporated in chitosan microspheres, plus free chitosan as an excipient. The permeation was evaluated across the three intestinal segments of adult male Wistar rats. The performance of ddl permeation from the NF was compared to the same granules without free chitosan and to buffered ddl tablets as control. The permeations across duodenum were higher than across jejun e and ileum. The ddl from NF presented higher permeation and a crescent-shaped profile in duodenum compared to the other formulations. Such effects are provided by the superior mucoadhesiveness to the intestinal membrane and potentialize sustained release properties for NF. These results lead one to consider the novel formulation to be promising for ddl administration by oral route.

Potencial biotecnológico de uma nova linhagem de Pseudomonas fluorescens na produção de biossurtactante utilizando petróleo como substrato
Os surfactantes químicos ou biológicos são compostos anfífilos que apresentam propriedades de redução das tensões superficial e interfacial pela acumulação na interface de fluidos imiscíveis, aumento da solubilidade e da biodegradabilidade de compostos hidrofóbicos. Nesse sentido, o potencial de produção de biossurtactante por Pseudomonas fluorescens foi investigado utilizando o meio de cultura Luria Bertani, contendo petróleo como substrato nas concentrações de 4 e 8%, sob agitação orbital de 150 rpm, à temperatura de 37°C, por 60 horas. Os resultados obtidos indicaram que P. fluorescens produziu um biossurtactante que reduziu a tensão superficial de 70 para 30,04 mN/m. Esses dados demonstraram também sua habilidade para remover e degradar petróleo, por meio da produção de agente surfactante, sugerindo uma possibilidade futura de aplicação nos processos de contaminantes hidrofóbicos como o petróleo.
Enzymatic esterification of d-fructose with acrylic acid in organic media

Esters derived from carbohydrates and acrylic acids (so-called acrylate of sugars) are promising by-products used in various branches of industry and in medicine. A wide variety of different procedures for their preparation have been reported. In this project, initial reactions rates and ester yields were affected by the solubility of the monosaccharide and tert-butanol, with higher reactions rates and yields with d-fructose. An experimental factorial design was used to study the effect of temperature (45-65°C), reactants ratio (1:1-1:5 (sugar:acrylic acid (AA)) and the amount of enzyme (0.7-2.1 g) on the production of d-fructose esters of acrylic acid. Application of the factorial design allowed the investigation of the esterification of d-fructose with AA catalyzed by Candida antarctica lipase B (CalB, Novozyme 435). However, a lack of fit was observed and the F-test regression was neither significant nor predictive. Therefore the experimental design was not capable to describe the influence of response factors. Thus analysis of reaction mixtures was determined esters products by thin layer chromatography (TLC), high-performance liquid chromatography (HPLC) and electrospray ionized mass spectrometry (ESI-MS). They showed that the main products are the monoacrylate and diacrylates, while higher esters are formed as minor products. The enzymatic esterification of free carbohydrates with acrylic acid is unprecedented. The fructose acrylate ester products could be separated and purified by flash silica gel chromatography and the fructose monoacrylate and diacrylates were obtained as the first, white powder and the last, viscous liquid. Unfortunately no one was reported for comparing to discuss.
Mestrado:


774. Não houve defesa.


Doutorado:


**Notas curtas**


**12ª SEQ**

A 12ª Semana de Engenharia Química (SEQ), que aconteceu nos dias 17-21 de agosto, trouxe uma programação voltada ao mercado de trabalho e sociedade. A divisão da programação em pilares (indústria, mercado e economia, tecnologia, educação e sustentabilidade) permitiu, segundo os organizadores, abranger todas as interfaces da vida profissional de um engenheiro químico. Entre os palestrantes, Mario Ponci Neto, executivo da Chilli Beans; Ozires Silva, ex-ministro e ex-presidente da Embraer; Eliane Cantanhede, colunista do jornal Folha de São Paulo; Gláucia Maria Pastore, diretora da Faculdade de Engenharia de Alimentos; e Wagner dos Santos Oliveira, professor do Departamento de Tecnologia de Polímeros da FEQ. A palestra de encerramento trouxe um dos maiores grupos de voluntários palhaços hospitalares do mundo, os Doutores Cidadãos; com 500 integrantes, o grupo atua em cerca de 40 hospitais da grande São Paulo levando alegria, motivação e informação aos pacientes, acompanhantes, visitantes e funcionários. Após a palestra, os estudantes visitaram um asilo de Campinas. A SEQ foi organizada pela empresa júnior Projeto e Pesquisa em Engenharia Química (Propeq), o Centro Acadêmico da Faculdade de Engenharia Química (CaFEQ) e a Associação Atlética Acadêmica da Faculdade de Engenharia Química (AAAFEQ).

**Proteção de alimentos através de biofilmes antimicrobianos**

As pesquisas desenvolvidas no Laboratório de Engenharia de Produtos e Processos em Biorrecursos da FEQ, coordenado pelo professor Theo Guenter Kieckbusch, foram objeto de matéria publicada no Jornal da UNICAMP (nº 440). O assunto destacado foi a proteção de alimentos, principalmente queijos, usando embalagens ativas ou inteligentes, feitas de biopolímeros com ação antimicrobiana. Este tipo de embalagens tem sido objeto de estudo por parte da indústria de alimentos nas últimas décadas, usando matérias primas renováveis, como os polissacarídeos, as proteínas e os lipídios. Ainda que esses filmes e coberturas não
As pesquisas dirigidas pelo professor Theo e pela doutora Mariana Altenhofen da Silva (foto) se concentram no uso de filmes compostos de alginato e quitosana, devido à possibilidade desses dois biopolímeros formarem complexos polieletrolíticos, por exibirem centros de cargas opostas, que permitem melhorar as propriedades dos filmes em relação aos obtidos através desses componentes quando utilizados isoladamente. Além disso, a quitosana apresenta atividade antimicrobiana inerente, o que poderia contribuir para o caráter ativo do filme. Os trabalhos foram desenvolvidos em parceria com o Instituto de Tecnologia de Alimentos (ITAL) e tiveram a participação direta das pesquisadoras Marta Hiromi Taniwaki e Beatriz Thié Iamanaka. Além de visar a otimização do processo de elaboração de filmes de alginato e de filmes compostos de alginato e quitosana, o trabalho visou determinar a eficiência de dois agentes antifúngicos - sorbato de potássio e natamicina - incorporados nos filmes, contra três microrganismos de alta ocorrência em queijos, com vistas a uma possível aplicação como embalagem antimicrobiana em alimentos de umidade intermediária. Segundo Mariana, “os resultados obtidos permitem afirmar que os filmes desenvolvidos contendo natamicina apresentam excelente perspectiva de atuação como filmes antimicrobianos para alimentos”. O professor Theo pretende na sequência obter filmes de alginato com outros polímeros, como a pectina, com vistas a contornar o problema do alginato, que gera filmes resistentes, duros, mas de pouca plasticidade, com o objetivo de conseguir propriedades adequadas quanto à resistência e solubilidade e que sejam capazes de liberarem antimicrobianos com a velocidade adequada.

Escalonamento de bioprocessos com nanopartículas

A tecnologia desenvolvida no laboratório de uma universidade ou centro de pesquisa só pode ser aplicada na indústria se houver escalonamento. Em outras palavras, os resultados obtidos na bancada devem ser reproduzidos de maneira eficiente em escala industrial. Trabalhos realizados no Laboratório de Desenvolvimento de Processos Biotecnológicos (LDPB) da FEQ, coordenado pela professora Maria Helena Andrade Santana e mostrados no Jornal da UNICAMP (nº 443), relatam o escalonamento de três tecnologias envolvendo nanopartículas que prometem trazer impactos positivos para a saúde e o bem-estar da população. Caso venham a se transformar em produtos comerciais, elas ajudarão a combater a leishmaniose cutânea, a tuberculose, a osteoartrite e até mesmo rugas de expressão, problemas que afligem milhões de pessoas no país.

De acordo com a professora Maria Helena, o objetivo dos pesquisadores é estabelecer processos e parâmetros operacionais eficazes para a ampliação da escala de produção dessas tecnologias, de modo que a indústria possa absorvê-los e aplicá-los. “Produzir algo em escala laboratorial é uma coisa. Produzir o mesmo em dimensão industrial é completamente diferente. Com frequência, temos que fazer adaptações ou promover alterações no processo laboratorial para alcançar a meta desejada”,

venham a substituir totalmente as embalagens plásticas tradicionais, podem contribuir significativamente para a redução de seu uso e, mais que isso, atuar como suportes na liberação controlada de substâncias ativas que evitem o desenvolvimento de microrganismos, além de limitar a migração de umidade, aromas e lipídios.
explica. Muitas vezes, detalha a docente, o aumento de escala torna-se necessário para a obtenção de material em quantidade adequada até mesmo para ensaios pré-clínicos (em animais) e clínicos (em humanos). Um dos projetos de escalonamento no qual a equipe está envolvida refere-se à produção de nanopartículas desenhadas para promover o transporte e a liberação controlada de um fármaco usado no tratamento da leishmaniose cutânea. Os testes realizados em laboratório com modelos animais, que contaram com a colaboração de pesquisadores da Universidade Federal do Rio de Janeiro (UFRJ), apontaram que a nanocápsula contendo a medicina consegue penetrar nas camadas mais profundas da lesão, sem, contudo, atingir a corrente sanguínea. “Os resultados dos ensaios foram excelentes e o processo é passível de escalonamento”, analisa a professora Maria Helena. Segundo ela, o principal desafio foi desenhar uma partícula que cumprisse as funções desejadas. A opção foi o uso de lipossomas, que são partículas lipídicas obtidas, nesse caso, a partir da lecitina de ovo. Entre as características dessas minúsculas cápsulas estão: elasticidade e capacidade de interagir com as células do organismo. Sem essas peculiaridades dos lipossomas não teria sido possível transportar e liberar controladamente o fármaco no ponto desejado. “Para se ter uma ideia, os lipossomas medem cerca de 100 nanômetros, mas os poros da pele têm somente 30 nanômetros de diâmetro. Ou seja, para atingir a área mais profunda da lesão e depois liberar o fármaco, o veículo teria que se deformar para passar pela superfície da pele. Nos ensaios que realizamos, nós vimos claramente que esse objetivo foi atingido”, afirma a pesquisadora. O processo já foi patentead. Segundo os dados mais recentes do Ministério da Saúde, em 2008 foram registrados no Brasil aproximadamente 20 mil casos de leishmaniose cutânea.

O segundo projeto de escalonamento executado pelo grupo está relacionado com uma nova vacina de DNA contra a tuberculose, desenvolvida por pesquisadores da FEQ e da Faculdade de Medicina de Ribeirão Preto, vinculada à USP. A ação atual está sendo realizada dentro do programa FAPESP denominado Pesquisa Inovativa em Pequenas Empresas. Este projeto é coordenado pela professora Lucimara Gaziola da Torre, que na sua tese de doutorado desenvolveu o veículo transportador da vacina. De acordo com a professora Maria Helena, os trabalhos estão se encaminhando para a fase final com sucesso. “Creio que em pouco tempo o processo já deva estar escalonado, com capacidade de produção para os ensaios clínicos e aplicação por parte da indústria”. O processo a que se refere a especialista envolve igualmente a produção de nanopartículas de lipossomas capazes de carregar e liberar o fármaco de forma controlada no organismo humano. Os testes laboratoriais, também realizados com modelos animais, mostraram que o biofármaco, que já foi igualmente patenteado, tem capacidade de prevenir a tuberculose, moléstia que atinge cerca de 130 mil pessoas a cada ano no Brasil. A vacina de DNA, conhecida como vacina gênica, é considerada mais eficaz e segura do que a vacina convencional, normalmente preparada a partir de uma parte atenuada do agente causador da doença. Em ambos os casos, o objetivo do fármaco é induzir o sistema imunológico humano a produzir defesas contra o bacilo da tuberculose (Mycobacterium tuberculosis), mais conhecido por “bacilo de Koch”, por ter sido identificado pela primeira vez em 1882 pelo cientista alemão Robert Koch.

O terceiro e último projeto de escalonamento está ligado à produção de ácido hialurônico, substância natural presente nos tecidos humanos. Uma das funções desse ácido é lubrificar as articulações. No LDPB, ele é produzido tanto a partir de meio de cultura a partir de meio de fermentação líquida e sólida. Segundo a professora Maria Helena, além de ser aplicado no tratamento de doenças reumáticas, como a osteoartrite e a artrose, através de infiltrações, o ácido hialurônico também serve para o preenchimento de sulcos da face provocados pelas rugas. Atualmente, o ácido hialurônico já vem sendo utilizado nessas duas abordagens, na
sua forma nativa e reticulada. A utilização do ácido em nanopartículas para as aplicações citadas e também para o transporte de fármacos e cosméticos é uma inovação. A vantagem das nanopartículas é a maior capacidade de adesão, interação com receptores celulares e liberação controlada dos princípios ativos. Porém, o ácido hialurônico é importado e tem um custo muito elevado, visto que o Brasil ainda não o produz em escala industrial. “Se conseguirmos produzir a substância em larga escala no Brasil, a partir de substratos baratos como o suco e o bagaço do caju, certamente estaremos abrindo a perspectiva para a redução do custo e a consequente ampliação do acesso a essas terapêuticas”, prevê a professora Maria Helena. Dados da Sociedade Brasileira de Reumatologia informam que a artrose, uma das doenças reumáticas mais comuns, responde sozinha por 7,5% de todos os afastamentos do trabalho no Brasil. Além disso, é quarta doença determinante de aposentadoria no país.

**Cresce procura pelo curso de engenharia química**

A UNICAMP registrou, nos dois últimos anos, um aumento de demanda pelos seus cursos de engenharia. Ao contrário do que ocorreu em meados da década de 90, quando houve queda na procura, seguida por um longo período de oscilação, tanto em termos absolutos quanto relativos, o interesse dos jovens por essas carreiras tem crescido nos períodos recentes. No Vestibular 2010, por exemplo, foram inscritos 18 candidatos por vaga. Em 2003, a proporção ficou abaixo de 15. Outro dado importante identificado pela Universidade foi a mudança na preferência dos jovens. Há 20 anos, eles optavam com maior frequência pelas Engenharias de Computação, Elétrica e Mecânica. “Atualmente, as mais demandadas são, pela ordem, as Engenharias Química e Civil”, afirma o coordenador da Comissão Permanente para os Vestibulares (Comvest), Prof. Renato Pedrosa. De acordo com ele, ainda não há razões absolutamente claras para explicar o recente aumento de demanda por essas duas carreiras em especial. Entretanto, infere que alguns aspectos podem estar influenciando na escolha dos vestibulandos. Um deles é o noticiário veiculado pela mídia em torno da possível ampliação do mercado de trabalho para profissionais qualificados, proporcionada pela execução de novos projetos nas áreas de infraestruutura, petróleo e biocombustíveis. “De alguma forma, isso pode estar contribuindo para orientar a opção profissional dos candidatos”.

Em se tratando especificamente de Engenharia Química, prossegue o coordenador da Comvest, há de fato alguns segmentos em expansão. Destaque, nesse sentido, para os setores de extração mineral, petroquímica, fertilizantes e energia. “O início da exploração do petróleo da camada pré-sal, a produção de novos biocombustíveis e o desenvolvimento de novos fármacos e materiais sem dúvida podem abrir boas perspectivas profissionais para o engenheiro químico”, analisa.

O Diretor da Faculdade de Engenharia Química, Prof. Osvaldir Pereira Taranto, concorda que o fator mídia possa estar levando mais estudantes a optarem pela carreira de engenheiro químico. Ele lembra que no Vestibular 2009 o curso em período integral registrou 30,5 candidatos para cada vaga. Este ano, a proporção subiu para 31,9. “A imprensa tem divulgado informações positivas sobre diversos setores que mantêm estreita ligação com a profissão, como a exploração de novos reservatórios de petróleo, a produção de novos biocombustíveis e a busca por soluções para a preservação do meio ambiente. Todas essas atividades exigem muita pesquisa e desenvolvimento, principalmente na nossa área de atuação”, explica. O Prof. Osvaldir acredita que o mercado de trabalho para o engenheiro químico deve manter a tendência de crescimento nos próximos anos em razão do surgimento de projetos tanto nessas quanto em outras áreas.

**Bioquerosene**

O desenvolvimento de um processo de produção de bioquerosene a partir de óleos vegetais, a cargo de uma equipe composta pelos professores Rubens Maciel Filho e Maria Regina Wolf Maciel e pelos pesquisadores César Benedito Batistella e Nívea de Lima da Silva, do Departamento de Processos Químicos, foi objeto de matéria
publicada no Jornal da UNICAMP (n° 442) e na revista Pesquisa FAPESP (n° 164). A tecnologia, já com patente depositada, objetiva um produto que poderá substituir com diversas vantagens o querosene usado como combustível de aviões. Além de ser mais barata, essa alternativa energética é menos poluente, pois não é emissora de enxofre, de compostos nitrogenados, de hidrocarbonetos ou de materiais particulados. Depois da patente, o próximo passo é o estudo da produção em escala industrial. O grupo pretende repassar a tecnologia para empresas interessadas em produzir o bioquerosene.

O processo é composto de duas etapas. Na primeira, depois de extraído da planta e refinado para a retirada de impurezas, o óleo vegetal é colocado em um reator, junto com o catalisador e uma quantidade pré-determinada de álcool, no caso etanol. A quantidade de etanol utilizada no processo foi otimizada através de extensivos estudos e é um ponto importante do processo. Dentro do reator ocorrem as reações de transesterificação e / ou esterificação que levam à formação do éster (bioquerosene).

O etanol foi escolhido para o processo por ter baixa massa molar e ser um reagente não-agressivo e renovável. Ele reage com o ácido graxo presente no óleo, dando origem ao bioquerosene. Além disso, o processo gera como subprodutos glicerina, água e o que sobra do etanol não consumido nas reações.

A segunda etapa, a mais importante, é a separação de todos os produtos da reação, ou seja, o isolamento do éster, do catalisador, da água e da glicerina. Reside aí a grande inovação do processo de produção do bioquerosene desenvolvido pela equipe da FEQ. O isolamento é feito em uma unidade de separação intensificada, em condições de temperatura e pressão que possibilitam a obtenção do bioquerosene de forma economicamente viável e que atende aos requisitos para o querosene de aviação estabelecidos pela Agência Nacional do Petróleo (ANP).

Esse último ponto foi confirmado por análises realizadas na UNICAMP e no Instituto de Pesquisas Tecnológicas (IPT). Na verdade, não existem, no Brasil, instituições que possam atestar se o produto obtido atende às especificações do querosene de aviação. “Contudo, os resultados das análises feitas na UNICAMP e no IPT foram comparados com a tabela de especificação do querosene de aviação da ANP”, explicam os pesquisadores. “Ficou demonstrado que o bioquerosene possui características semelhantes às do querosene de aviação.”

Embora haja uma série de pesquisas e diversos biocombustíveis sendo testados em várias partes do mundo, inclusive no Brasil, a equipe não identificou um processo/produto similar ao desenvolvido. Apesar de ser comentada a existência de experimentos e realizações de testes fazendo uso de bioquerosene, não foi identificada patente na literatura técnica que fizesse uso do mesmo processo, comenta o professor Rubens Maciel Filho. “Também não foi encontrado no mercado produto identificado como bioquerosene”. O professor ressalta que pode não haver um produto exatamente igual, mas já existem companhias aéreas com aviões voando experimentalmente movidos a biocombustíveis. É o caso da americana Continental Airlines, que anunciou recentemente a realização do primeiro vôo de demonstração, com o uso de biocombustível, realizado no dia 7 de janeiro de 2009 nos Estados Unidos. Assim, as pesquisas realizadas pelo grupo da UNICAMP podem contribuir com o desenvolvimento de processos de produção viáveis para a obtenção de biocombustíveis para a aviação, um segmento importante nos transportes, estando no âmbito do empenho mundial na redução da emissão de poluentes, avaliam os pesquisadores.