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Poster Session: Pan American Biofuel and Bioenergy Sustainability

Wednesday, July 23, 2014: 04:30 PM - 06:30 PM – Meeting Foyer

Chair: David R. Shonnard, Michigan Technological University, MI, USA

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16	Polymeric Membranes and Gas Separation: Homogenous Blends of Matrimid®5218 and P84 . **J. Carson**
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Session Overview:

This session will include all relevant topics pertaining to the sustainability of biofuels and bioenergy development in Pan America. Abstracts are welcome from academia, industry, government agencies, and non-governmental organizations.

Posters:

1. Effects of Maize Weevil Infestation on Corn and Utilization of Infested Corn for Ethanol Production
G. Adolfo Corrêa, Kansas State University, Manhattan, KS

Abstract:
The maize weevil, *Sitophilus zeamais* (Motschulsky) (Coleoptera: Curculionidae), is a cosmopolitan pest of stored cereal grains, especially maize in tropical and subtropical regions. The focus of our laboratory study was to characterize physical and chemical damage caused by *S. zemais* to corn over a six month period, and to determine ethanol yield from infested corn.

Clean, certified organic whole yellow corn (5 kg) of 11.9% moisture in 20-L round plastic with ventilated lids was infested with 20 unsexed adults of mixed ages of *S. zeamais*. There were a total of 36 buckets, of which 18 were infested and 18 were uninfested (controls). It was stored for periods of 1, 2, 3, 4, 5 and 6 months. The moisture content, test weight, dead and live insects, and proximate analysis were conducted using the AOAC (Association of Official Analytical Chemists) and Ankom methods, were measured monthly. The ethanol production was evaluated using two procedures, the enzyme digestion and fermentation processes, to measure the amount of glucose at initial time of the experiment and evaluated the glucose complete conversion into ethanol and its amount, respectively. The amount of glucose and ethanol was analyzed using the High Performance Liquid Chromatography (HPLC) technique.

The corn moisture content of uninfested corn fluctuated between 10.6 and 11.9% during the six-month study period, whereas that of infested corn increased from 11.9 to 14.8% at the end of the study. The number of live insects increased exponentially in infested corn and reached a maximum of 6,985 by the end of the study. Dockage in 1000 g of uninfested corn was 1.2 to 2.2 g but steadily increased in infested corn from 1.2 g to a maximum of 154 g at the end of six months. The weight of 100 uninfested corn kernels normalized to 11.0% wet moisture basis remained unchanged (35.8 g) but this weight in infested corn decreased gradually to 22.6 g at six months. However, dry matter losses were marginal for both uninfested and infested corn over the study period. The crude protein, crude fat, crude fiber, and ash of uninfested and infested corn over time showed minor variation that are not biologically significant. The starch content of uninfested and infested corn ranged from 58 to 61%, and these values were lower by about 10%, probably due to the official standard method used (glucoamylase method) or use of aged enzymes. It was demonstrated that during the first four months with a high level of infestation it was possible to obtain a profitable level of ethanol production, and it begins to decline after the fifth month, and over the sixth month it was not profitable because the amounts of glucose declined dramatically. In conclusion, it was possible to obtain profitable levels of ethanol from infested corn even under a high density of infestation by maize weevil, and it will optimize the use of corn as raw material for worldwide ethanol production.

2. Assessment of an Power Generation Industrial Unit from Vinasse Treatment in Uasb Reactor
André Felipe de Melo Sales Santos, Cetrel, Recife, Brazil, Maurício Alves da Mota Sobrinho, Department of Chemical Engineering, UFPE, Recife, Brazil and Adrianus Cornelius van Handel, Department of Civil and Environmental Engineering, UFCG, Campina Grande, Brazil

Abstract:
The UASB reactors (upflow anaerobic sludge bed) represent the type most widely disseminated and applied in the world of high rate anaerobic system. They have the advantage of treating wastewater diluted or concentrated, dissolved or particulate material, and simple or complex, with high efficiency under conditions of relatively simplified operation.Are applicable to sanitary sewers and industrial effluents that have organic nature, biodegradable, with low concentrations of oil and grease, and toxic compounds. Their cost/benefit ratio make it attractive for industrial uses with advantages of high biomass retention, low sludge production, high efficiency and the biogas exploitation possibility.The anaerobic digestion of vinasse, particularly in the case of Brazil, represents great opportunities for expanding the national energy matrix,taking views of the large volumes produced alcohol. Each liter of alcohol produced can generate from 10 to 18 L of vinasse with a BOD of around 15,000 to 50,000 mg O_2/L. Cetrel, from a research project in its program of Technological Innovation in 2009 startedthe project Energy appreciation of vinasse for the generation of decentralized electricity obtained from biogas through anaerobic biodegradation. The project has evolved from the laboratory scale, pilot reaching an industrial unit currently operating in the state of Pernambuco, in Vitória de Santo Antão. The project consists of a modified anaerobic UASB reactor for the treatment of vinasse, with capacity of 1000m^3, with organic loading volume (COV) projected in the range from 16 to 20 kg COD/m^3.d, and maximum flow rate of 60m3 / h of raw vinasse. The production of electricity is approximately 0.87 MWh using a power generator biogas GUASCOR, SFG-LD 480, which connects directly with the local utility.The plant started operation at the end of the year 2012, with the data presented in this article concerning the 2012-2013 and 2013-2014 harvests. At the beginning of the operation was necessary to inoculate anaerobic flocculent sludge originating from UASBused in urban sewage treatment, but this was not appropriate to the high organic loads applied, especially when applied loads above 4 kg COD/m^3. In this case it was necessary to acquire industrial granular anaerobic sludge of high activity (0.44 kg COD/kg TSS.d) to increase the treatment capacity.The unit began operating with low VOC of approximately 1 kg COD / m3.d in increments of 0.5kg COD / m3.d to promote the process of acclimatization of the anaerobic biomass. The performance of the unit in the second harvest has exceeded expectations of project reaching about 91% in COD removal (daily average), reaching levels of 71% methane in biogas. However, when using the vinasseoriginated from the dilution of molasses, there was great difficulty in their treatment compared to vinasse coming directly from sugar cane juice.This problem was due to the presence of sulfatewith concentrations in the range of 700-900 mg / L, which may interfere with the microbiological equilibrium of the system. Sulfate is used in control of indigenous bacteria in the fermentation of the must, and when in an anaerobic environment, the sulfidogenesis competes with methanogenesis interfering with the balance of alkalinity and volatile fatty acids (ratio AT / AGV) leading to operating instability. The vinasse broth does not present as great challenges.Another drawback of the sulfate is your anaerobic degradation leads to H_2S, which is highly toxic and corrosive. Were detected sulphate content of the order of 2000-5000 mg/L in the biogas removal system is required to prevent deterioration and shortening the life of equipment. The technology proved to be technically feasible even requiring optimization step.Challenges of economic viability also point to the energy market taking into view that this type of sustainable energy is not encouraged by the government, and the amounts paid by the MWh currently prohibitive to enable the business. However in other applications such as generating isolated systems or other applications can be economically viable.

3. Energy-Water Nexus: An Optimal Control Model

Geraldo A. de Oliveira, DASE, IFPE - Instituto Federal de Educação, Ciência e Tecnologia de Pernambuco, RECIFE, Brazil and **Fernando M. Campello de Souza**, PPGEE, UFPE - Universidade Federal de Pernambuco, Recife, Brazil

Abstract:

One may say that economics is the study of the allocation of scarce resources between competing uses. Scarcity is a characteristic of exhaustible resources.

Most of the world's energy sources known today are finite i.e., exhaustible, or limited.

In the global energy matrix, oil comes first, followed by coal and natural gas. These sources together account for approximately 80% of the world's energy supply. Coal is the source most used to generate electricity. It accounts for generating 41% of the world's electricity supply. The United States and China are examples of countries that are highly dependent on this resource. In Brazil, water is the resource most used to generate electricity and is followed by biomass. These resources, although renewable, are limited.

What oil, coal, natural gas, water and biomass have in common is that they are conventional. Conventional resources, represent stored energy; are found in specific and unchangeable locations; and offer a limited supply. Their scarcity and high demand create a capitalizable commodity and an avid and impatient market, i.e., these sources are goods with high marketability in the international market and thus subject to price variations.

The issue is that these natural resources are allocated both for producing energy and for producing non-energy goods. Therefore, they are used as an input for production and as an input to produce a different kind of input, namely power.

Energy and water are at the heart of any country's economy and way of life. National defense, food production, human health, manufacturing, recreation, tourism, and the daily functioning of households all rely on a clean and affordable supply of one or both of them.

It is known that the production and consumption of energy and water are closely intertwined. They are diversified. Energy includes electric energy, and fuels like gasoline, diesel, nafta, kerosene, alcohol, fuel oil, uranium, and the like. Water includes drinkable water (potable), water for irrigation, water for cooling, water for industrial processes, and so on. The end users of both, energy and water, are many. There are also several producers of both.

Energy and water are, for their turn, intrinsically related to the production and consumption of food and transport.

Keeping electric power plants cool requires lots of water. Keeping water safe takes lots of energy. Apparently this potentially forces a choice between the two.

Water is needed to generate energy. Energy is needed to deliver water. Both resources are limiting the other --- and both may be running short. Is there a way out? What would be the rational to deal with this problem?

In some countries, the two greatest users of freshwater are agriculture and power plants. Thermal power plants --- those that consume coal, oil, natural gas or uranium --- generate more than 90 percent of U.S. electricity, and they are water hogs. The sheer amount required to cool the plants impacts the available supply to everyone else. In other countries, like Brazil, for example, hydroelectric energy plays a major role, and it has been found that water to be used directly as water, as in agriculture, industrial processes, and human consumption, for example, worths twice the economic value it has after it has been transformed into electricity in a hydroelectric power plant.

At the same time, one uses a lot of energy to move and treat water, sometimes across vast distances. Health standards typically get stricter with time, too, so the degree of energy that needs to be spent per gallon will only increase.

A mathematical model is proposed here formulated in terms of an optimal control problem representing an evolving economy; an optimal economic growth model. It is written as a maximization of an intertemporal social welfare function, subject to constraints defined by income and investment identities, production technologies, the reserves consumption dynamics, the labor force growth dynamics, the energy balance and the labor force balance. The policy instruments are the investments in each sector, the consumption rate for the energy resources, the water usage rate, and the labor force growth rate. The model is treated via the Pontryagin maximum principle. The results obtained from the model are useful in the understanding of the sector as a whole, and as a support in establishing integrated policies in the context of the energy-water nexus.

4. Comparison of Anaerobic Reactors for Electricity Production in PILOT Scale from Vinasse

André Felipe de Melo Sales Santos, Cetrel, Recife, Brazil, **Mauricio Alves da Motta Sobrinho Sr.**, Universidade Federal de Pernambuco, recife, Brazil and Adrianus Cornelius van Handel, UFCG, Campina Grande, Brazil

Abstract:
Among the liquid effluents of the sugarcane industry, the vinasse is which has higher pollution potential. In terms of BOD value ranges can range from 15,000 to 50,000 $mg.L^{-1}$, and its production in conventional distilleries can reach 10-18 L of vinasse per liter of ethanol produced, according to the process and quality of sugarcane. The high amounts of biodegradable organic matter in the raw vinasse indicate its potential for use in biological processes using more rationally this energetic potential. One of the most promising technologies is the anaerobic digestion, which produces methane that can be applied in decentralized generation of electric power or burning processes in the unit. In this work three models of anaerobic reactors were evaluated in pilot scale, verifying the increase of the volumetric organic load on the stability of the reactor in its ability to withstand shock loading and its repercussion on the quality of the biogas generated. Were compared to the UASB reactor (R-11) two other models of anaerobic reactors: reactor IC (internal circulation) (R-21) and reactor (external settler) (R31) that present changes in concept and design in relation to reactor UASB.The reactors were built in fiberglass, in a cylindrical shape with a diameter of 1 m and 4m height (working volume 3.5 m^3). Was utilized industrial granular anaerobic sludge of high activity (SMA = 0.7 $kg.COD.CH_4/kg.VTS.d$) as inoculum to reduce the adaptation time of the anaerobic microbiotafor vinasse. As alkalizing, was made use of agronomic urea in aqueous

solution, dosed at the entrance of the reactor by a metering pump. Recirculation of treated effluent (of the order of 1:3) was also used to reduce the consumption of alkalizing the use of alkalinity generated in the reactor.The criterion of stability and load increase was the maintenance of the relationship TA/VFA around 3.5 -. 4.0 with load increments of 0.5 to 1.0 kg.COD/m^3.d until it reaches the design load of 20 kg COD.m^3/d. The reactors operated continuously for 2 consecutive harvest seasons, with the first harvest (January 2011) the maximum load was reached only after 6 months for the three reactors, which presented similar behavior. In the first harvest the average removal efficiencies of COD were respectively 75%, 79% and 79% and the concentration of methane in the biogas on average 88%, 84%, 84% for R-11, R-21 and R-31 reactors, respectively. In the second harvest (August 2011 to April 2012) the maximum load was achieved in only 1 month.This rapid staggering load is due, probably,the adaptation of anaerobic sludge to the vinasse,reducing by one sixth the time required in the previous harvest. The average removal efficiencies of COD were respectively 85%, 87% and 88% and the concentration of methane in the biogas was on average 82%, 65%, 77% for R-11, R-21 and R-31 reactors, respectively in the second harvest. It was found that, in terms of applied load,that the second season the R-21 and R-31 reactors exceeded the design load reaching 30 kg COD.m^3/d,however for the reactor R-11 reached only the load of 25 kg.COD.m^3/d.Despite this load shedding, the reactor R-11 proved to be robust shown very satisfactory performance with respect to COD removal efficiency, stability and quality of the generated biogas (high methane content). Compared to the other two models tested, although these present technological improvements over contact sludge-substrate and sludge retention, the UASB technology was adequate for the treatment of vinasse, with lower cost to other models of anaerobic reactors studied.

5. Switchgrass Genotype Study As a Bioenergy Crop in Kansas, USA
Doohong Min and Vara Prasad, Agronomy, Kansas State University, Manhattan, KS

Abstract:
Due to increasing fuel costs and uncertainty of fossil fuel supply on the planet, developing bioenergy crop such as switchgrass might play an important role in terms of diversifying energy sources and increasing energy sustainability. There are many potential bioenergy crops and switchgrass is one of them. Switchgrass is a native warm-season grass and once it's established, it can last several years with low inputs and maintenance. The objectives of this study were to: 1) assess the best performing switchgrass genotype suitable for Kansas soil and climatic condition in the USA, and 2) determine the correlation between plant height or tiller numbers per plant and dry biomass of various switchgrass genotypes. Seeds of twenty accessions of switchgrass were sown in trays under greenhouse conditions and transferred into cones after emergence. Twenty two different genotypes (i.e., Alamo, Cave-in-Rock, Kanlow, SL 93 C2-1, SL 93 C2-2, SL 93 C2-3, SL 93 C2-4, NL 94 C2-1, NL 94 C2-2, NL 94 C2-3, NL 94 C2-4, NSL 2009-1, NSL 2009-2, NSL 2009-3, NSL 2009-4, SWG 2007-1, SWG 2007-2, SWG 2007-3, SWG 2007-4, SNU 98 LMBP C1-1, SNU 98 LMBP C1-2, SNU 98 EMBP C1-1) of seedlings were allowed to grow in cones for 30 days under controlled environments. Thereafter, the seedlings were transplanted into the field at the Kansas State University North Research Farm in Manhattan, Kansas, USA. The growth and yield components of various switch grass genotypes were measured. Plant height and number of tillers per plant was measured in five randomly selected plants from each replication. Single plant was harvested and dried in oven at 50°C for a week and dry weight was recorded and expressed as g $plant^{-1}$. Plants in a meter square were hand harvested and dried in oven at 50°C for a week and dry weight was recorded and expressed as g m^{-2}. Significant difference in plant height was observed among the genotypes. The genotypes, SL 93 C2-2 was the tallest (193.9 cm) and there was no significant difference between SL 93 C2-2 and NL 94 C2-1, NL 94 C2-2, NL 94 C2-3, NL 94 C2-4, NSL 2009-1, NSL 2009-3, NSL 2009-4, SL 93 C2-

1, SL 93 C2-3 and SWG 2007-2. The genotype Cave-in-Rock was the shortest (124.2 cm) among the genotypes. Significant difference in number of tillers per plant was observed among the genotypes. The genotypes Alamo recorded the highest numbers of tiller plant^{-1} (24.4) which was on par with NL 94 C2-1, NL 94 C2-4, NSL 2009-2, NSL 2009-3, SL 93 C2-1, SL 93 C2-2, SL 93 C2-3, SL 93 C2-4, SWG 2007-1 and SWG 2007-2. The genotype Cave-in-Rock had the lowest numbers of tiller plant^{-1} (14.3) compared with other genotypes. The genotypes Alamo, NL 94 C2-2, NL 94 C2-3, NSL 2009-1 and NSL 2009-1 had increased above ground biomass compared with other genotypes. The genotypes SWG 2007-3, SNU 98 LMBP C1-2, SNU 98 EMBP C1-1, Cave-in-Rock and SWG 2007-4 had lower above ground biomass than other genotypes of switchgrass. The correlation study indicates that there was a significant positive correlation between number of tillers per plant and per plant dry weight (R^2=0.93), number of tillers per plant and plant height (R^2=0.94), and plant height and per plant dry weight (R^2=0.82). This study might help bioenergy crop breeders develop certain genotypes that can have high biomass with both high number of tillers per plant and taller plant characteristics.

6. Utilization of Crab Shells As Heterogeneous Catalyst in the Synthesis of Methyl and Ethyl Biodiesel

Gustavo Reis[1], Felipe da silva Medeiros[2], Joyce Bianca S. Costa[3], Alexandre S.Moura[3], Ricardo Oliveira DA Silva[4], Vânya M.D. Pasa[5] and Claudia C. C. Bejan[3], (1)department of chemistry, universidade federal de minas gerais, Belo Horizonte, Brazil, (2)Universidade Federal de Minas Gerais, Belo Horizonte, Brazil, (3)UNIVERSIDADE FEDERAL RURAL DE PERNAMBUCO, Recife, Brazil, (4)UNIVERSIDADE FEDERAL DE PERNAMBUCO, Recife, Brazil, (5)Universidade federal de Minas Gerais, Belo Horizonte, Brazil

Abstract:
Biodiesel is biodegradable and renewable fuel obtained through a chemical process called transesterification in which vegetable oil or animal fat (triglycerides) is reacted with an alcohol in the presence of a catalyst, and glycerin as a major co-product (Figure 1) is removed by decantation. Biodiesel has emerged as an alternative to replacing diesel oil by presenting similar combustion properties[1] and minimize environmental pollution.[2]

Among the catalysts, the mostly used in homogeneous phase is alkaline due to faster reaction and higher yields, requiring lower pressures, temperatures and molar ratio alcohol: oil.[3] Nevertheless, the presence of free fatty acid (over 1.0 mg KOH/g) and water in the oil feedstock implies in soap formation, reducing the ester yield and inhibiting the biodiesel purification.[3]

As an alternative method of biodiesel production, the use of heterogeneous catalysts presents some advantages, such as easy separation from the reaction medium and reusability. The heterogeneous catalyst is separated by a filtration process instead of exhaustive washing, when homogeneous catalysis is used, reducing the volume of residual water and environmental impact.[4] Nevertheless, heterogeneous catalysts have been proposed as a high operating cost.[3, 5] Due to that, the biggest challenge in this area is to search for catalyst with a high performance and lower costs.

High interest has been shown regarding the use of CaO due to its economic advantages, high alkalinity, low solubility and easy handling.[6] Despite recent and few numbers of papers published in this area, some of them presents as sources of CaO, the waste of natural products such as egg shells, bones, oyster shells of molluscs,[7-9] resulted from a calcination process since the bark of these species are composed of about 40-55% of $CaCO_3$.[10]

Another challenge given to the productive sector of biodiesel takes place regarding the use of alcohol used in the transesterification reaction. On an industrial scale, methanol is the alcohol used for presenting a lower cost, and improved handling of the final product because of its low homogeneity biodiesel, thus allowing easy separation by settling.[3] However it is a toxic alcohol, lethal, non-renewable, offers high risk of explosion and needs to be handled with great caution. Alternatively, ethanol has been studied as a promising possibility for not presenting these unwanted properties of methanol, furthermore ethanol is a renewable, providing greater environmental benefit to biodiesel.[11]

According to that, in this work we propose an environmentally friendly alternative for biodiesel production sector, studying the use of CaO obtained from food residue from crab shell as heterogeneous catalyst. A study of the kinetic of the reaction while using this catalyst in the synthesis of biodiesel, is done comparing both methyl and ethyl alcohol.

7. Poverty in the Pirapama Basin: The Role of Management of Hydrological Resources

Jorge H. N. Viana, Economics, Universidade Federal de Perbambuco, Recife, Brazil and Márcia M.G.A. Moraes, UFPE – Pernambuco, Brazil

Abstract:
The sustainable use of water resources has become a very popular theme in scientific literature along with a broader discussion about the sustainable use of natural resources. More specifically, there is an increased interest in how climate change may affect water availability. The social and economic impact of different water allocation strategies has recently been modeled and measured (Bhatia et al, 2006, Moraes et al, 2009, CALZADILLAA et al, 2013). Many studies have shown that the anthropogenic emissions of greenhouse gases may be responsible for changes in weather conditions on the planet (IPCC, 2007 COMOU; ROBINSON & Rahmstorf, 2013). The economic impact resulting from these changes is likely to be strongly influenced by the increased water availability for agricultural production.

Water availability for agriculture is related not only to the natural conditions of the climate, but also to water resources management practices that define supply and demand conditions. Thus, the rational and efficient use of water mainly through demand management – using water allocation policies - becomes urgent. There are many benefits that can be derived from the application of adequate water allocation policies, such as: environmental, for example, an improvement in water quality; or economic, for example higher economic returns from activities that use water, such as agriculture.

The probable diminishing of rainfall rates, resulting from climate change, is potentially disastrous. This is true especially for individuals living in regions already in a socioeconomic context of poverty and whose incomes are closely linked to the availability of natural resources.

This study aims to develop an integrated framework to assess the effects of different management practices of water resources on the economy of the Pirapama Riverbasin, especially the effects on the poorest strata of the population.This will be done by joining the hydro-economic model for this region already developed at the Federal University of Pernambuco (UFPE) with a Computable General Equilibrium Model (CGEM) being formulated for the same hydrographic region.

Starting from the results obtained from the first model, concerning water allocation for agricultural users and their resulting crop production, the effects on all sectors of the regional economy including

possible changes in the condition of poor families will be measured . These results are expected to support decision-making about different allocation policies in the region.

The Pirapama River basin was mainly chosen as the area of study because of its economic importance for Pernambuco, since one hand is the most important water source for the metropolitan region of Recife, capital of Pernambuco and supplies water for others major users such as alcohol distilleries and sugar cane irrigation. Thus, there are already many existing conflicts between different uses in the region, such as electricity generation, irrigation, and human consumption.

Water quality is also a major concern in the Pirapama basin since throughout the length of the river most currently monitored water quality standards cannot be met, mostly because of sugarcane production together with fertirrigation, which is a process of irrigation and fertilization that uses water to carry and distribute fertilizers to the sugar cane. On top of that, two recently constructed reservoirs on the basin (the last one completed in 2010) might also contribute to further water quality deterioration through eutrophication processes (MORAES ET AL, 2010).

Furthermore, the region where the Pirapama River basin is located (*Zona da Mata*) is not associated with the climate variability and drought as the semi-arid regions in northeastern Brazil, therefore the basin is less used to extreme drought periods making it particularly vulnerable to future climate changes (ENGLE & LEMOS, 2010). These conditions make good water management practices in the region indispensable

Given the main goal highlighted above we have the following specific objectives:

- To build a Social Accounting Matrix for the Pirapama River basin;
- To develop and calibrate a CGEM for the Pirapama River basin with different types of representative families;
- To include the results from the hydro-economic model in the general equilibrium model;
- To simulate through the integrated framework how different decisions on water management might affect the Regional Economy, especially those areas with poorest population.

8. Maximizing Ethanol Production from Genetically Modified Cyanobacteria Grown Autotrophically

Claudio Delpino, Chemical Engineering, Planta Piloto de Ingeniería Química (PLAPIQUI), Universidad Nacional del Sur-CONICET, Bahía Blanca, Argentina, Vanina Estrada, Chemical Engineering, Planta Piloto de Ingenieria Quimica (PLAPIQUI), Universidad Nacional del Sur - CONICET, Bahia Blanca, Argentina and **Maria Soledad Diaz**, Chemical Engineering, Planta Piloto de Ingenieria Quimica (PLAPIQUI), CONICET - Universidad Nacional del Sur, Bahia Blanca, Argentina

Abstract:
In this work we address the optimization of ethanol production from a mutant strain of the cyanobacterium Synechocystis sp. PCC 6803 (Vidal Vidal, 2009), growing on carbon dioxide as carbon source. This modified strain harbors the genes pdc and adhB from Zymomonas mobilis under the control of the gene PetE promoter for ethanol production. We carry out dynamic flux balance analysis by integrating photobioreactor nonlinear dynamic models and metabolic network linear models. Basically, the model includes two major components: (a) a dynamic model with mass balances for biomass, ethanol, nitrate, phosphate, internal nitrogen and phosphorus, and (b) a steady state metabolic Linear Programming (LP) model. The biomass equation includes limiting functions for light, temperature and nutrients, kinetics of growth inhibition by ethanol toxicity and the decrease in the available light by

biomass concentration increase. The control variables of the dynamic optimization problem are batch temperature, light intensity and phosphate concentration in the culture medium.

The resulting dynamic optimization problem for ethanol production maximization is a bilevel optimization problem, with an embedded LP. The problem is reformulated to a single level one, by replacing the LP by its optimality conditions. The dynamic optimization problem is fully discretized by orthogonal collocation on finite elements, rendering a large-scale nonlinear programming (NLP) problem. Complementarity constraints associated to first order optimality conditions in the inner LP are efficiently dealt with the Interior Point algorithm within the IPOPT solver (Waechter & Biegler, 2006) in GAMS (Brooke et al., 2013). The discretized model has 88337 constraints and 58063 variables (73 finite elements and two collocation points). The model has been previously calibrated with experimental data (Laiglecia et al., 2013). In these experiments, performed over 73 hours, the runs have been carried out using the genetic modified strain, and activating the Pet promoter from the very beginning of the runs (with copper); i.e., enabling ethanol production path throughout the entire time horizon.

Numerical results obtained in this work suggest modifications in the metabolic network during the fermentation, with the consequent increase in ethanol production. The optimal pdc pathway should be activated after 20 hours of fermentation, with a consequent 26% increase in ethanol production. Another important issue is that ethanol production increase does not affect biomass growth, as it has been previously shown in experiments carried out by Vidal (2009). Optimal profiles for light intensity, suggest keeping it constant at 80 µE/(m2.s) up to 40 h and increasing to double its value by the end of the fermentation. In this way, alternatives are suggested for the enhancement of ethanol production from a genetically modified cyanobacterium strain.

9. Water Allocation and Resources Management Using a Hydro-Economic Optimization Model: The Case Study of the Sub-Middle São Francisco Watershed

Gerald Souza da Silva, UFPE, Recife, Brazil and Márcia M.G.A. Moraes, Department of Economics, Universidade Federal de Pernambuco, Recife, Brazil

Abstract:
The Northeastern semiarid region of Brazil is known of its irregular rainfalls and water scarcity. Reservoirs and perennialized rivers are the only water source in the dry season. Water disponibility is limited, already causing several conflicts between different water users and uses, like hydropower, irrigation, human consumption, animal consumption, industrial and aquaculture. Furthermore efforts are taken to exploit this region economically with some irrigation sites using mainly crops with a high water need and high drought sensitivity, like sugar cane. Conflicts can get even more challenging with the Integration Project of the San Francisco River (PISF), where two lines of water channels are being built to deliver water to the north and the northeast of the region. Water allocation rules and decision making based on land use change and climate change becomes more important. The aim of the research, linked with the INNOVATE project, is the development of a hydro economic model which uses optimization algorithms to determine the hydro-economical optimum for water allocation in the middle São Francisco River Basin. The hydro-economic optimization model is written in GAMS. Expected results are optimal water storage in reservoirs and allocation rules for irrigated production under different scenarios of water transfers, land use and climate changes.

10. Considering Water Quality and Energy Efficiency to Define Optimum Operation of Integrated Systems of Water Supply and Value of Use of Water Quality

Lidia Rodella, Universidade Federal de Pernambuco, RECIFE, Brazil, Carlos Alberto Gomes de Amorim Filho, Núcleo de Gestão - Campus do Agreste, Universidade Federal de Pernambuco, Caruaru, Brazil and Márcia M.G.A. Moraes, Department of Economics, Universidade Federal de Pernambuco, Recife, Brazil

Abstract:

According to Gunkel et al. (2007), all rivers in the coastal region of Pernambuco´s state are influenced by sugarcane cultivation. Effects are often magnified as these same rivers supply cities as well and are generally heavily dammed for both urban water supply and electrical power generation. These reservoirs might also contribute to further water quality deterioration through eutrophication processes. Seeking to contribute with a decision support tool in the water supply area with this kind of problem, this study presents an optimization model that identifies the volume of water to be distributed from a set of integrated water supply systems monthly to each municipality in the Recife's metropolitan region (Pernambuco´s state), in order to minimize expenses with electric power and water treatment. The optimization problem presented uses the linear programming techniques with constraints on the maximum supply capacity of each integrated water system, the installed pipeline network and the minimum volume of water to be distributed to each city. The model results showed that the optimization leads to a reduction of 4.82% of the costs, particularly from an increase of 20.73% in volume produced by Pirapama system, the newest and largest supply system of the state of Pernambuco, the standstill in some months of the smallest integrated systems in the region (Caixa D'Água and Marcos Freire), which also have the m^3 of treated water more expensive in the region. At the same time requires a reduction of 15.38% in the activities of Tapacurá system, which suffers from eutrophication problems in the dam of the same name, its main source. By the reduced cost is possible to know how much the cost of the systems that do not operate at the optimal solution must be reduced so that they start to be considered as an option for use in catchment. Indeed, it may identify the opportunity cost of each of these systems, which is an important concept of economic theory. One of the scenarios studied considered the opportunity cost of Tapacurá system and the results showed a reduction in the value of the objective function of 6.98% (R$ 3,138,175.76) in relation to the optimal solution in scenario 1 (current conditions) and 11.47% (R$ 5,414,987.10) compared with that achieved by COMPESA in 2013. These results show the economy that the supply company would have for a year if invested in Tapacurá system to achieve lower energy and treatment costs, by installing more efficient pumps or policies to improve the water quality of the Tapacurá basin, for example. From the analysis of scenarios that consider different conditions of water quality of the main reservoirs of water catchment for integrated systems in the region, Pirapama and Tapacurá, the study estimates the direct use value of water quality for the company responsible for supplying water in the region, presenting a proposal for value the quality of water based on the avoided cost method. The direct use value of water quality from the Tapacurá system to the company responsible for the supply is R$ 3,874,662.18/year, which represents 8.21% of current expenses of the company on electricity and chemical products. The water quality of the dam Pirapama has a higher value, R$ 5,468,122.15/year, corresponding to 11.58% of the expenses of the company in 2013 with electricity and chemical products. The difference between these values results from the differentiated proportional share of them in the water supply of the metropolitan region of Recife.

11. Enhanced Pyrolysis Oil Properties through Pretreatment of Aspen with Controlled Torrefaction

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Abstract:
Pyrolysis oil produced from thermochemical conversion of woody biomass has great potential as renewable fuels and feedstocks in chemical production. Perhaps one of the most exciting ways to utilize biomass resources is in the production of transportation fuels through fast pyrolysis and catalytic upgrading. Pyrolysis oil, however, has several disadvantages such as high oxygen content, acidity, corrosivity, low storage stability, and high water content. Our results indicate that these problems can be, at least partially, addressed through the use of torrefaction as a pretreatment method. During torrefaction, mainly the hemicelluloses fraction of biomass degrades resulting in a more uniform and desirable feedstock for pyrolysis. This poster presents preliminary data demonstrating that through careful control of torrefaction conditions, the oils formed during a subsequent fast pyrolysis step of aspen have significantly improved acidity (>40% reduction), corrosivity, water content(>25% removal), oxygen content(chromatographic shift), and thus improved storage stability and energy content. Pyrolysis (500°C for 20 seconds) and torrefaction (300°C for between 5 to 90 minutes) experiments were carried out in a high purity helium atmosphere on a 5200HP Pyroprobe (CDS Analytical), and the chemical analysis performed with a Trace GC coupled with a DSQII mass spectrometer (both Thermo-Fisher Scientific).

12. Sorghum As an Advanced Biofuel: Price Effect on Wheat, Corn and Soybean Markets
Krishna Pokharel, Rulianda Purnomo Wibowo and Frank Nti, Agricultural Economics, Kansas State University, Manhattan, KS

Abstract:
BACKGROUND: The 2007 US Biofuel mandate requires total biofuel production to increase to 36 billion gallons by 2022. The Energy Independence and Security Act further specify that more than 55% of total biofuel production in 2022 must come from sources – grain, sorghum, wheat, etc – other than cornstarch. In 2012, the EPA announced that grain sorghum-based ethanol qualifies as a renewable fuel with more carbon credits than the corn-based ethanol. This may result in land use changing from the planting of wheat and other grains to planting grain sorghum. However, the problem of increasing sorghum production could cause a decrease in food supply leading to an upward pressure on grain prices. This study examines impact of the biofuel mandate on wheat, corn, soybean and sorghum prices considering the new situation where sorghum is considered an advanced biofuel feedstock.

METHOD: A stochastic partial equilibrium model is used to evaluate the short-run implications from demand and supply shocks from having grain sorghum approved as a advanced biofuel feedstock on corn, wheat, sorghum, and soybean prices in the USA. Different scenarios are simulated and compared to a counterfactual and the simulated results are compared with results obtained from the observed data.

EXPECTED OUTCOME: The use of sorghum as an input for biofuel production could alter grain prices in USA. With higher competitive prices from sorghum, the possibility of decrease production in wheat and other grains is inevitable. Since the USA is a leading wheat producer, any decline in its production will have effect on the global wheat market.

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13. A Prototype Methodology for Incorporating Sustainability Indicators in Biorefinery Process Design

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Abstract:
Biorefineries are industrial plants that integrate equipment and processes to transform biomass into a range of biofuels, platform chemicals, end-use products, and energy. The biorefinery concept rises to address two concerns, mainly: assuring energy security (by displacing fossil fuels usage, and adequate stewardship of biomass resources) and reducing greenhouse gases emissions (to meet well specified targets). Traditional methodologies for chemical processing plants are commonly used to design biorefineries, but these fall short on considering these basic criteria systematically during the design process. In this work, a methodology for including various sustainability indicators into the traditional design of biorefinery plants. The two main drivers of biorefineries are included, along with other sustainability indicators, so that a quantitative 'sustainability footprint' can be calculated for each design as a standalone evaluation. This methodology consists of 9 indicators for the design stage, and 5 more for the ex-post evaluation of existing biorefineries. For its application it requires performing a Life Cycle Assessment during the conceptual design stage, and a techno-economical pre-feasibility study during the basic engineering stage. A normalized scale is proposed for all the indicators, requiring the identification of the 'ideal sustainability' and 'critical' states for each one. A case study illustrating the resulting sustainability footprint is presented and discussed.

14. Optimal Control Strategies for Different Stabilization Pond Systems

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Abstract:
Wastewater generation is inevitable and its discharge into surface waters leads to environmental problems and health risks. To avoid this, standards for wastewater discharge have been enforced and are expected to become stricter, this resulting in a growing interest area of study [1]. Wastewater treatment in stabilization ponds mainly results from settling and complex symbiosis of bacteria and algae where the oxidation of organic matter is accomplished by bacteria in presence of dissolved oxygen supplied by algal photosynthesis and surface re-aeration [2].

In this work different configurations of stabilization ponds are considered. Dynamic modeling of each pond was implemented within a dynamic optimization environment and the whole system was simulated during a fixed time horizon. A detailed mechanistic model is constructed, based on first principles of mass conservation, of different types of systems of anaerobic, aerobic and facultative ponds in series.

We address the control problem of wastewater stabilization ponds of the differents systems by formulating an optimal control problem considering electrical motor power for mixers in the aereted pond and nutrient addition rate as control variables (degrees of freedom of the problem)[3]. Constraints are embedded in the DAE model and boundaries on the control variables. As the specification on chemical oxygen demand (COD) in the outlet stream is far from the target one, the objective is to minimize the offset between the desired value and the current one, along a time horizon of a year. As a result of the dynamic optimization problem the optimal time profiles of motor power and nutrient addition rates are obtained for the time horizon. The main objective of the work is to compare the performance of the different configuration pond system under different control strategies, by the amount of organic matter in the effluent of the treatment plant.

The model takes into account dynamic mass balances of biomass of algae, the main groups of bacteria: heterotrophic bacteria, autotrophic bacteria, fermenting bacteria, acetotrophicsulphate reducing bacteria and acetotrophicmethanogenic bacteria. Also, mass balances for organic load are formulated, such as slowly biodegradable particulate COD, inert particulate COD, fermentation products, inert soluble COD, and fermentable readily biodegradable soluble COD. For nutrients, ammonium and ammonia nitrogen, nitrate and nitrite nitrogen, sulphatesulphur and dissolved oxygen. Finally, molecular nitrogen and methane emissions are considered in the model.

The results provide useful information on the complex relationship among micro-organisms, nutrients and organic matter concentration, as well as information about the impact of modification in the pond system that can be used to improve the control of the effluent composition.

15. Analysis of the Solid Waste Management of the Sugarcane Industry in Pernambuco

Maiara Gabrielle Souza Melo[1], **Maria do Carmo Martins Sobral**[2] and Andre Luiz Nunes Ferreira[2], (1)Coordination Environment, IFPB, Cabedelo, Brazil, (2)Civil Engineering, UFPE, Recife, Brazil

Abstract:
The sugarcane agribusiness stands out due to the large amount of solid waste generated in their production processes. One of the main problems caused by industrialization is precisely the disposal of waste resulting from the production process, which affect the natural environment and human health.

Most of the sugarcane waste activity needs an adequate destination; it cannot be accumulated indefinitely at the site where it was produced. The disposal of waste in the environment, by means of matter and energy emissions released into the atmosphere, waters, or soil must occur after being treated and must be framed on standards established in environmental legislation in order not to cause pollution (AQUARONE, 1990 *apud* PELIZER, 2007).

On the other hand, the processes of production and processing of sugarcane have special features, because their residues are not considered as waste, but as byproducts and thus are valued by the industrial sector (BNDES, 2008).

In this sense, the purpose of this work is to describe the legislation on solid waste management in Pernambuco and analyze how it is being applied to the sugarcane sector of the state. The methodology consisted of both bibliographic and documentary research.

16. Polymeric Membranes and Gas Separation: Homogenous Blends of Matrimid®5218 and P84
Jared Carson, Chemical Engineering, Kansas State University, Manhattan, KS; Chemical Engineering, Kansas State University, Manhattan, KS

Abstract:
A study has been conducted to determine if a polymeric membrane consisting of a homogenous blend of the polyimides Matrmid® 5218 and P84 can be created, and if the H_2/N_2 selectivity of this membrane would compare to that of pure Matrimid® 5218. This research shows that by using NMP as a common solvent, a homogenous blend of both polyimides can be achieved. The experiment outlined in this report achieved a maximum H_2/N_2 selectivity of 50.4 using a 50/50wt% blended membrane, and a maximum H_2/N_2 selectivity of 51.6 for a pure Matrimid® membrane. Further investigation was conducted into the effects of annealing and cross-linking these membranes, though the results are inconclusive.

17. Incorporation of Sweet Sorghum Juice into Current Dry-Grind Ethanol Process
Kaelin Saul, Biological and Agricultural, Kansas State University, Manhattan, KS

Abstract:
With an increase in demand for ethanol as a source of biofuel, there are many different biomass solutions being explored, such as utilizing grain sorghum and sweet sorghum juice as opposed to corn and water, for the dry-grind process. This paper conveys the optimum conditions for flour loading as well as for the hydrolysis time that will result in high ethanol yield and high fermentation efficiency. Two sets of experiments were conducted. The first consisted of varying the quantities of grain sorghum flour of 6 grams, 9 grams, 12 grams, and 15 grams whiles maintaining a constant amount of sweet sorghum juice concentrate. The results of the first study showed that the best flour loading was 6 grams of flour added to 100 milliliters (mL) of sweet sorghum juice. With optimal flour to juice ratio, the hydrolysis time can be significantly reduced from 60 min to 30 min. Future research will study the effectiveness of different enzymes (e.g. Stargen 002, alpha-amylase, etc.) on the ethanol yield and the fermentation efficiency.

18. Biogas in the Brewery: An Exploration of Practice and Sustainability
Jaime Jurado, Abita Brewing Company, Abita Springs, LA

Abstract:
In recent years, more breweries in the USA have installed anaerobic waste water treatment plants as an alternative to traditional aerobic plants. The biogas byproduct can be used as boiler or CHP fuel, and one brewery evaluated its use in fuel cell electricity generation. Admittedly, a 'micro-' scale biofuel solution which, at best, supplies 20% of the energy required by the brewery... yet which is like PV and solar heating applications in that individual adaptation may seem to be inconsequential, but industry-wide, it is additive and helps change energy benchmarks. A challenge has been to deploy anaerobic treatment systems for the burgeoning artisanal breweries. Once this technological approach was only viable for very large breweries, but then smaller regional breweries had successes with their implementations. The proliferation of new, very small breweries suggests that there exists a genuine opportunity for small-scale anaerobic digester systems. An exploration of successful existing installations lends a framework of what makes sense for smaller, unitized systems that must be more affordable for the small brewery. ROI is the final determinant which will be discussed from the lens of the brewery owner.