Kansas State University

Center for Sustainable Energy

2015 Energy Symposium

Research Abstracts - April 8-9, 2015

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Poster # 1

Enhancing droplet removal and heat transfer on a vertical surface during external condensation

Andrés Martínez

The purpose of this research is to experimentally study how mini-fins affect the heat transfer coefficient on a vertical surface under external condensation conditions. Filmwise condensation is a major concern when designing steam condensers for thermoelectric power plants. These plants currently account for 40% of freshwater withdrawal and 3% of freshwater usage in the United States. Filmwise condensation averages ten times lower heat transfer coefficients than those present in dropwise condensation. Currently, filmwise condensation is the dominant condensation regime in thermoelectric power plants due to their prolonged usage. The film thickness is directly proportional to the condenser's overall thermal resistance. This investigation focuses on optimizing mini-fins to reduce film thickness and maximize filmwise condensation heat transfer. The experimental setup allows us to control the cooling load, pressure, and steam quality in order to measure the steam-side surface temperature under steady state conditions. The surface temperature is determined by extrapolating the temperature measurements across the test sections using seven thermocouples. The heat flux across the test section is determined by using Fourier's Law with the temperature gradient across the test section. Finally, the heat transfer coefficient is calculated by dividing the heat flux over the difference in temperature between the steam and the wall. By comparing the heat transfer coefficients across a range of heat fluxes, we can find the optimal surface geometries. This experiment will use square mini-fins of 0.25mm, 0.50mm, and 1.00mm to determine the optimal mini-fin dimensions, and compare it to a plane surface with no alterations.

Poster # 2

Gas Phase Infiltration of Carbon Nanotubes in Nickel Nanofoam for Improved 3D Electrode Performance in Lithium-Ion Batteries

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Next generation Li-ion batteries (LIBs) require higher energy and power densities. The use of 3D nanostructured electrodes can significantly increase the rate of Li insertion and removal due to the short transport distances for Li ion within the 3D nanostructure. Further, the higher surface area associated with 3D nanostructured electrodes permits a high contact area with the electrolyte and consequently increases the Li-ion flux, while the improved porosity decreases volumetric stresses during cycling. Ni nanofoams are the state-of-the-art current collectors in LIBs due to their high stability, mechanical robustness, porosity, and the highly conductive 3-D framework that can be coated with high capacity active materials such as SnO_2. However, their extremely high porosities (> 99%) and limited specific surface areas (< 5 m^2/g) limits the amount of active electrode material that can be deposited, consequently reducing the maximum achievable areal energy density. Here, we show, for the first time, a scalable gas-phase liquid injection chemical vapor deposition (LI-CVD) process for the infiltration of arrays of high-quality CNTs in Ni nanofoam. Importantly, the new process allows for the improvement of the BET specific surface area of Ni nanofoam by a factor of over 20 without compromising the structural integrity of the foam. Upon deposition of SnO_2 on CNT-infiltrated Ni nanofoams by atomic layer deposition, the new nanocomposites show improved areal capacity and excellent rate capability as well as high capacity retention.

Poster # 3

Novel Fe/Fe_3O_4-based Nanocatalyst for Cellulose-to-sugar conversion

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Introduction: Use of homogeneous catalysts such as enzymes and mineral acids for large-scale cellulose degradation in biofuel industry is challenging because of the difficulty of product isolation and necessity of specific effluent treatments. Magnetic nanocatalysts would be ideal as they, being heterogeneous, can easily be separated from the reaction mixture (with a permanent magnet) and have a minimal environmental impact. Straightforward synthesis of considerably large amounts and recyclability further enhance the value of this catalyst. Against this background, we synthesized sulfamic acid-functionalized Fe/Fe_3O_4 magnetic nanoparticles (MNPs) and evaluated their effectiveness as catalysts for the aforementioned process.

Method: Fe/Fe_3O_4 MNPs were prepared via thermal decomposition of pentacarbonyliron(0), and were coated with tetraethoxysilane followed by 3-aminopropyltrimethoxylsilane. These amino-coated MNPs were then reacted with chlorosulfonic acid to introduce strongly acidic groups. The catalytic activity of the resulting sulfamic acid functionalized-MNPs was probed with respect to their ability to break down cellulose at higher temperatures and pressure in aqueous medium. Temperature and the amount of catalyst required were optimized by using Experimental Design (Doehlert) methodology.

Results: Under optimal conditions, more than 30% (by weight) of cellulose is transformed into sugars (glucose, fructose, and others). After 10 consecutive runs, more than 70% of MNPs could easily be recovered. Hence, this technology has a great potential for the conversion of cellulosic biomass to ethanol *via* sugars.

Acknowledgements: This material is based upon work supported by the National Science Foundation under Award No. EPS-0903806 and matching support from the State of Kansas through Kansas Technology Enterprise Corporation and Department of Chemistry, Kansas State University.

Poster # 4

Bioenergy crop impacts on soil carbon sequestration, soil biophysical properties and N_2O emissions in Manhattan, Kansas

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Background: The 2007 Energy Independence Security Act mandates the production of 60 billion liters per year of cellulosic biofuel by 2022, which will be required to have life cycle assessment greenhouse gas (GHG) emissions at least 60% below those of gasoline/diesel. Careful management and selection of bioenergy crops could reduce GHG emissions from ethanol production by encouraging soil organic carbon (SOC) sequestration and reducing nitrous oxide (N_2O) emissions in soils. The objectives of this study were to evaluate the impact of perennial and annual cellulosic ethanol crops on soil physical and biological properties, changes in SOC stocks and N_2O emissions.

Methods: Plots containing switchgrass, miscanthus, big bluestem (perennial grasses), corn, photoperiod sensitive sorghum, sweet sorghum and grain sorghum (annual crops) were established in Manhattan, Kansas, USA in 2007. In 2013, root stocks and water-stable aggregates (WSA) were measured. Phospholipid fatty acids (PLFA) were also measured to assess microbial community structure between crops. SOC stocks were measured after the 2009 and 2013 growing seasons. Annual N_2O emissions were measured from soils in a subset of the crops from 2011 through 2014 using static chambers.

Results: No consistent differences were found in N_2O emissions between crops, though miscanthus tended to have the lowest emissions. Several soil properties suggested that carbon sequestration may be occurring in the perennial grasses. Evidence of greater fungal biomass, increased formation of soil macroaggregrates and higher root stocks were found in the perennial grasses. Over 4 years, miscanthus and big bluestem sequestered SOC at 0 – 15 cm while annual systems lost or maintained SOC stocks. When 3 years of N_2O emissions and SOC stock changes were combined, it was found that miscanthus was a GHG sink, while switchgrass and the annual crops were GHG sources. These results demonstrate the high climate mitigative capacity of perennial grasses for bioenergy.

ACKNOWLEDGEMENT: *This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.*

Poster # 5

Direct and Indirect Impacts of Agricultural Land-Use Due to Increased Production of Grain-Based Ethanol in Kansas, USA

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Applied economists have dedicated much literature to the design and specification of acreage allocation models for land use decisions. These models can play an important role in understanding how acreages might shift in the event of new policy, especially with the increasing demand for biofuel production. Furthermore, the increase in ethanol production over the past two decades has impacted markets for corn and grain sorghum in Kansas, especially with the prospect of grain sorghum being classified as an advanced biofuel feedstock. The increased production of the ethanol within Kansas has had an impact on local markets. The presence of an ethanol plant can impact the prices of crops in the local market and the intensity of crop production in the vicinity of the plant. The direct changes in land-use production from a stronger ethanol industry in the state will likely lead to indirect changes in the use of agricultural land, as well.

The purpose of this paper is to examine the direct and indirect impact on agricultural land-use from increased ethanol production in Kansas. The study uses acreage allocation models and builds on previous acreage allocation studies by correcting for spatial autocorrelation; spatial proximity to ethanol refineries, and by incorporating changes in agricultural land-use in neighboring counties to capture potential indirect land-use changes. This study uses a 1996-2009 Kansas county level dataset for analysis. Models will be estimated for dryland corn, wheat, sorghum, and soybean. The methods in this paper will follow methods proposed by Wu and Brorsen (1995). Results from the paper will help to assess the agricultural land-use impacts from the expansion of the ethanol markets in the U.S. and the impacts of U.S. bioenergy policies.

ACKNOWLEGDEMENT: *This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.*

Poster # 6

Three-phase Hydrogenation of Hydroxymethylfurfural and Levulinic Acid using a Catalytic Membrane Reactor

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Catalytic membrane reactors afford an alternative and potentially more efficient method for performing three-phase heterogeneous chemical reactions. Traditional three-phase reactors often present mass transfer limitations, namely relatively large diffusional distances to reach catalytic sites exacerbated by low gas solubility in the liquid phase. Membrane reactors can alleviate the inherent mass transfer limitations by directly and abundantly supplying gas to the catalytic sites located on the membrane surface, which acts as a gas/liquid phase contactor, and thus lessening the necessity for higher gas phase pressures. The reactions investigated in this work include the hydrogenation of 5-hydroxymethylfurfural (HMF) in an alcohol solvent and the hydrogenation of levulinic acid (LA) in an aqueous solvent.

Polyimide polymers are used in this work for membrane synthesis because of their good chemical and high temperature resistance. The polymer solutions are cast as asymmetric integrally-skinned flat sheet membranes and are then coated with a ruthenium catalyst on the non-porous surface. The completed membrane is positioned in a flow over configuration maintaining liquid contact on the metal coated surface while allowing hydrogen gas to permeate from the porous support side to the catalytic sites on the non-porous surface. The multi-functionality of the membrane reactor/contactor has allowed several areas to be investigated, including catalytic activity and reaction kinetics, membrane performance and characterization, and solvent/polymer interactions. This work has demonstrated quantitative hydrogenation product formation with reaction kinetics similar to or better than more traditional three-phase reactors. The membrane reactors are shown to be stable and catalytically active for several days of continuous operation. Continued efforts to improve membrane reactor performance such as increasing hydrogen permeance, increasing catalytic site availability, and decreasing liquid phase permeance should yield a favorable comparison to traditional reactor systems.

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE- 0903701.

Poster # 7

Alternative Excitonic Structure in the Baseplate (CsmA–BChl *a* Complex) of the Chlorosome from *Chlorobaculum tepidum*

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In the photosynthetic green sulfur bacterium *Chlorobaculum tepidum*, the baseplate, i.e., CsmA–bacteriochlorophyll *a* (BChl *a*) complex, mediates excitation energy transfer (EET) from the light harvesting chlorosome to the FMO complex and subsequently towards the reaction center (RC). Literature data suggest that the unit cell of the baseplate is most likely a 2D lattice of CsmA protein dimers binding two BChl *a* molecules. However, recently it has been proposed, using 2D electronic spectroscopy (2DES) at 77 K [J. Dostál et al., *J. Phys. Chem. Lett.* **2014**, *5*, 1743–1747], that at least four excitonically coupled BChl *a* are in close contact within the baseplate structure. This finding is tested in this work via hole burning (HB) spectroscopy (5 K). Our results indicate the following: *i*) there is a large static diagonal disorder of baseplate BChl *a* (Γ_{inh} ~ 625 cm^{-1}); *ii*) excitation is transferred to a localized trap state near 818.3 nm (fwhm ~ 240 cm^{-1}) via exciton hopping, which leads to emission near 825.7 nm; and *iii*) the four excitonic states identified at 77 K via 2DES [J. Dostál et al., *J. Phys. Chem. Lett.* **2014**, *5*, 1743–1747] most likely correspond to contamination of the baseplate with the FMO antenna and possibly the RC; which cannot be resolved at 77 or 295 K. HB spectra show that EET from BChl *c* → BChl *a* and BChl *a* → BChl *a* occurs in 2.9 ± 0.1 and 2.0 ± 0.1 ps, respectively.

Poster # 8

The Sustainable Curtain Wall

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A threat to the world's resources is North America's, and many other regions', most popular building façade, the curtain wall system. With high aesthetic value, this highly sought after façade is an extremely poor insulator, therefore, increasing the energy needs of a building. From this dilemma arose the question: How can we save the aesthetic value of the curtain wall system while also increasing its thermal efficiency, and in turn, save energy?

While glass technology has improved over recent decades, the framing system has not kept the same pace. The frame is the weakest part of the system. Therefore, we wanted to test the hypothesis that if we reduce the area of the framing system, we would be able to produce a more efficient curtain wall system that increases views and daylighting, and reduces resources used.

By replacing the horizontal mullion with our designed "aluminum shelf" and "structural spacer", our team has created a higher insulating curtain wall system. The structural shelf is attached to the vertical frame and supports the insulated glass unit (IGU). The structural spacer is located within two panes of glass. The steel spacer is thermally insulated by expanded rubber, also holding two convection control films in the air cavity within the IGU. The IGU is then filled with argon gas and sealed with hot butyl. Calculations of these new structural pieces were done to ensure structural stability.

After running computer generated and physical tests on a prototype of the new proposed curtain wall, we found that our innovative system increases views by 33.45% at 3' away and 6.70% at 20' away, increases natural daylighting by 19.86%, increase thermal resistance by 58.70%, and decreases heating and cooling loads of a typical building by 18%.

Poster # 9

Ethanol expansion in Brazil: The linkages between sugarcane producers and mills in the Cerrado region.

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PROBLEM: Increased demand for ethanol has stimulated the expansion of the sugarcane ethanol industry in the states of Goiás (GO) and Mato Grosso do Sul (MS), Brazil. This expansion has been attributed to state-level fiscal incentives, cheaper land, and infrastructure development. Since 2000, more than 40 mills have been constructed and over 20 million hectares of land zoned for sugarcane production. Sugarcane production in both states now accounts for 15% of total production in Brazil. The expansion of sugarcane produciton has involved complex relationships between farmers, land owners and mills. This study aims at characterizing the types of sugarcane producers; their contractual and working relationship with local sugarcane mills; and the perceptions they have about the mills in their local area.

DATA and METHODS: A survey was conducted in 2014 with 148 producers in GO and MS across 22 counties of which 104 produced sugarcane. The survey collected information on demographics; farm characteristics; land use; sugarcane production; contracts; and perceptions about mills. Results from this survey were analyzed using descriptive statistics.

RESULTS: Land used for sugarcane expansion comes primarily from agriculture and pasture land. Sugarcane is either supplied by independent producers via a contract with the mill or grown by the mill themselves on rented land. On average, contracts were for 6 to 7 years, the duration of a sugarcane planting cycle. Proximity to the mill increased bargaining power for producers. A large number of producers felt growing sugarcane is not viable without a contract. Producers indicated concerns with the financial health of the mills, as well. While some producers felt they had a good relationship with the mill, not all producers trusted the mill. But many producers agreed their profits have not declined since signing a contract with the mill.

ACKNOWLEDGEMENTS: This study is part of an NSF grant " Collaborative Research: Land Change in Brazil's Cerrado: Ethanol and Sugar Cane Expansion at the Farm and Industry Scale (NSF#1227451)."

Poster # 10

Switchgrass Genotype Study as a Bioenergy Crop

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Due to 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.

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE- 0903701.

Poster # 11

Develop Lignin-Protein Based Adhesives

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About 8 billion pounds of conventional petroleum-based adhesive such as phenol formaldehyde (PF)-based adhesives is used in wood-based industries. PF has high adhesion strength and water resistance property. However, it is toxic to human and causes environmental pollution. As nowadays, there are significant concern about health, environment and natural resource limitation, there are strong demands for safe and environment friendly adhesive. Soy protein-based adhesives (SPA) have been commercially available for partial replacement of urea formaldehyde-based adhesives due to their excellent adhesion performance on wood and other materials. However, water resistance of SPA does not measure up to phenol formaldehyde and isocyanate-based adhesives for exterior applications. Lignin, the most abundant aromatic polymer, is largely available as industrial residues or co-products from paper and biofuel production. Basic units such as phenols are building blocks for many polymers, which are currently obtained by synthetic chemistry from fossil-based feedstocks. Lignin is more hydrophobic and protein is more hydrophilic. Therefore, biobased adhesives derived from principal components of lignin and plant proteins could improve water resistance as well as reduced cost. The objective of this research is to develop lignin-protein based adhesive with improved water resistance properties. Kraft lignin was modified at 260 and 290 °C by hydrothermal degradation process and used to make lignin-protein adhesive. The primary result showed that the water resistance property of 20% blending of 260°C solid lignin, 260°C liquid lignin, and 290°C solid and liquid lignin with soy protein adhesive is better than that of standard soy protein adhesive.

Poster # 12

Effect of low Humidity on indoor air quality

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Residential and commercial buildings consume 40% of energy in the United States. In addition to minimizing energy consumption, buildings need to be healthy and comfortable for occupants. This work considers the effects of low humidity on the health, comfort, and Indoor Environmental Quality (IEQ) of building occupants. Humidity is simply vaporized water in the air. Relative humidity that is too high or too low can be problematic to home, health and the comfort. This paper aims to investigate the effect of low humidity on occupied buildings presenting case studies from the literature reviews. Exposure to low humidity can dry out and inflame the mucous membrane lining the respiratory tract. Reduced humidity combined with colder temperatures tends to wreak havoc on skin as well. Many suffer with dry, scaly, itchy skin during winter months even if they don't have a diagnosable skin problem like eczema. Also this paper attempts to present ways to manage the humidity levels in houses.

Poster # 13

Aqueous enzymatic oil and protein extraction in the microalgae *Chlamydomonas Reinhardtii* and the potential application of autolytic enzymes

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Economic and life cycle assessment studies of microalgae as a biofuel feedstock have shown that inefficient oil extraction and recovery limit the commercialization of microalgal-derived biofuels. Current methods include the use of solvents and energy-intensive mechanical processing which have environmental and cost disadvantages. Furthermore, other valuable compounds, such as proteins, may be degraded during extraction. The use of aqueous enzymatic extraction (AEE), a non-solvent and environmentally friendly recovery method, provides an opportunity to design an integrated process that allows oil and protein extraction. Nevertheless, enzyme costs and lower extraction efficiency compared to mechanical and chemical methods are current limitations on the AEE process. In addition, variables such as pH and temperature have to be adjusted in the culture media in order to promote enzyme activity. A potential alternative to address this issues is the use of autolytic enzymes. This enzymes are produced and secreted into the culture media by particular algae species under stress conditions. In this study, we evaluated the potential use of the microalgae *C. reinhardtii* as a feedstock for aqueous enzymatic oil and protein extraction, using its autolytic enzyme as part of the extraction process. First, we analyze lipid and protein accumulation kinetics in nitrogen depleted cultures. Second, we evaluate the lytic activity of different enzyme treatments. Finally, we compare lytic activity of the treatments above with the autolytic enzyme produced by *C. reinhardtii*. Results indicate a maximum recovery yield of 42% (w/w) for protein and 41% (w/w) for lipids on a dry weight biomass basis after 48 hours under nitrogen depleted conditions. Moreover, cell wall lysis was achieved after 2 hours of autolysin treatment at room temperature (25°C± 5) and an optimal pH between 7.5 and 8.2.

This material is based upon work supported by the National Science Foundation under Award No. EPS-0903806 and matching support from the State of Kansas through the Kansas Board of Regents.

Poster # 14

IN-SITU ATOMIC FORCE MICROSCOPY STUDY OF CATALYTIC SURFACES

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Heterogeneous catalysis is a commonly used process with applications in fields ranging from pharmaceuticals and petrochemicals to biomass conversion and food production. One such process, hydrogenation, presents difficulties for liquid-phase reactions due to the poor solubility of hydrogen. Low hydrogen concentration at catalytic sites can result in unwanted side reactions and coking. Hydrogen pressures of tens or even hundreds of atmospheres are used to overcome the solubility limitation. Catalytic membrane reactors (CMRs) have been shown to improve the selectivity of hydrogenation processes by supplying adequate hydrogen directly to catalyst sites avoiding liquid-phase mass transfer limitations and utilizing hydrogen supplied near ambient pressure. Most hydrogenation CMR research focuses on the nature of the membrane material, but it is also important to consider the nature of the catalyst and its interactions with hydrogen. In the past, it has been suggested that hydrogen permeates through the membrane and migrates to catalytic sites, but this has been difficult to prove. Although a range of technology exists to study catalytic surfaces, most of it relies upon high-vacuum conditions that make in-situ research difficult, or impossible in the case of liquid-phase applications. Atomic force microscopy (AFM) is one technology that does allow for the study of solid-liquid interfaces. Tapping-mode AFM allows further expansion of the range of information that can be obtained from a sample using measurement techniques based on the responses of probes to various stimuli. The work presented shows the application of tapping-mode AFM in real-time studies of catalytic surfaces under liquid at ambient conditions. This is hoped to enable an improved understanding of the dynamics of hydrogen coverage and mass transfer on catalytic surfaces at atmospheric pressure and under liquid. Such information on the mechanism and kinetics of liquid-phase hydrogen/catalyst interactions will aid in the optimization of CMRs.

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE- 0903701.

Poster # 15

Fabricating polymer/ceramic composite membranes for the hydrogenation of hydroxymethylfurfural to 2,5-dimethylfuran

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2,5-dimethylfuran (DMF) is a biomass derived biofuel with characteristics more favorable than ethanol and comparable to gasoline, and is a product of the hydrogenation of hydroxymethylfurfural (HMF). This reaction conventionally requires hydrogen pressures in excess of 20 atm. Membrane reactors are capable of delivering hydrogen directly to a catalyst site, allowing for a significant reduction in operating pressure. Polymeric membranes have the potential to be used in this application, but first require stabilization. This study seeks to determine if a composite membrane consisting of a dense, thin polymer film layer supported by a ceramic substructure can be utilized in the hydrogenation membrane reactor system. By using a ceramic support, the substructure will be resistant to the degradation exhibited by polymers at elevated temperatures. Future research will focus on using a homogenous blend of two different polyimides for the polymer film layer, Matrimid®5218 and polybenzimidazole (PBI), each with individually favorable properties. Currently only pure Matrimid®5218 film layers have been tested.

Matrimid®5218 was dissolved in methylene chloride (DCM), and refined using a 0.45um syringe filter. 1mL of filtered solution was deposited onto a 0.02um pore, 47mm diameter Whatman® Anopore ceramic disc, and solvent evaporation was conducted in a DCM enriched enclosure to control the evaporation rate. The resulting composite was dried under vacuum at 60°C for two hours and bubble flux tested to determine permeance for H_2 and N_2, as well as H_2/N_2 selectivity. 2.0wt%, 1.0wt%, and 0.10wt% Matrimid®5218 in DCM compositions have been tested, with lower wt% being more desirable due to thinner films and thus higher H_2 permeance. A H_2/N_2 selectivity of 57.3 was observed for the 0.10wt% Matrimid®5218 composite, with a H_2 permeance of 77.13 GPU. Future work will involve the testing of Matrimid®5218/PBI blended polymer film layers using a common solvent.

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.

Poster # 16

Mia Sole Thin-Film Photovoltaic Array Performance at Variable Temperatures and Substrates.

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Ruth D. Miller, mentor

Department of Electrical and Computer Engineering

The purpose of this research is to collect data from copper-indium-gallium-selenide (CIGS) panels to validate current information and compare performance of suspended CIGS panels vs those installed directly on a roof, and vs polycrystalline silicon panels installed at an angle. Mia Solé Flex Series CIGS thin-film solar panels are an emerging series being produced in late 2012. The objective is to test these panels on different substrates and different temperature variations. Thin film solar panels are less efficient than typical monocrystalline/polycrystalline solar panels and more economical to install; however they are more costly up front. They are designed to be adhered directly to a roof, with no racking. Installation of 14 panels suspended on the roof was completed during the 2014 summer; however we were prohibited from mounting them directly to the roof, and they are instead suspended on a platform above the roof. My specific role in the research is to engineer an experiment/apparatus to record data off a single panel resting on various substrates. The suspended panels are connected in series sharing a single Sunny Boy 2000 inverter. The single panel is connected in series with a load (potentiometer to control the resistance), and a microcontroller called an Arduino Uno to collect voltages and current. Using this data we will make IV (current to voltage) curves to find Vmpp, Impp and Pmpp. We will compare their energy production with respect to temperature. This data we help determine the economic payback of CIGS vs the more common silicon.

Poster # 17

A New Mitigation Technique for Torsional Vibration in Grid-Connected DFIG-Based Wind Turbines

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BACKGROUND: With the growing energy demand, one of the most popular renewable energy systems over the past decade has been the wind turbine [1]. However, the growth in grid-connected wind turbines has led to new technical challenges in this industry. One of the technical challenges is to reduce the amount of stress on the wind turbine drivetrain and gearbox that is caused by interactions between electrical and mechanical subsystems. Sudden voltage dip and series capacitor switching are events that can cause torsional vibrations that contribute to fatigue in the drivetrain and gearbox of wind turbines. A new mitigation technique is used in this work to reduce the stress on gearbox components and extend the life of wind turbine.

METHOD: A new nonlinear control scheme is proposed based on the sliding mode control theory to damp the drivetrain torsional vibrations caused by grid disturbances. The validity of the proposed mitigation approach is demonstrated and compared with the conventional virtual damping method using a 750 kW DFIG-based wind turbine modeled by the National Renewable Energy Laboratory software FAST in a case study of torsional vibrations caused by sudden voltage dip.

EXPECTED OUTCOME: A new control law, based on sliding mode theory, has been developed and tested to mitigate torsional vibrations in DFIG-based wind turbines. The control law is implemented through the rotor-side converter [2]. The simulation results have demonstrated that the torsional vibrations in the drivetrain can be mitigated effectively using the proposed technique.

Also, this technique has been compared with the conventional virtual damping compensation method in the presence of a voltage dip event. This comparison has demonstrated that the performance of the proposed technique in damping the torsional vibration is superior to the conventional approach.

ACKNOWLEDGMENT: The authors gratefully acknowledge the support of this work in part by the industry sponsored KSU Electric Power Affiliates Program.

Poster # 18

AN EXAMINATION OF ALTERNATIVE ALGAE FEEDSTOCK ON THE ECONOMIC FEASIBILITY OF BIOFUEL PRODUCTION

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The need for alternative feedstock in biofuel production has been increasing even as public policies supporting the industry undergoes changes around the world. One feedstock receiving increasing attention is algae in biodiesel production. The study assesses the economic feasibility of the alga biodiesel production using algae from two alternative source – an open-raceway pond and naturally-harvested from the ocean using a system dynamic modeling approach. The primary differences in the two sources lie in the former's production capital cost outlay and the quality and availability uncertainty surrounding the latter. The study assumes a mass balance/unit operation system for carbon to ensure the environmental sustainability of the production system. Working on the assumption of producing 50 million gallons of biodiesel per year and using 14% of the diesel plus the by-products from the diesel production (glycerol and ethanol) as the system's fuel, we find that the algal yield was a major bottleneck in the feasibility of the open raceway system. On the other hand, the uncertainty of availability and lipid quality were the major constraints to the feasibility of the open sea algae harvest. We also found that attempts to minimize availability and lipid quality uncertainties reduced the quantity of final production available for sale due to increased consumption of production in operations in order to maintain the closed system's integrity. This study provides the physical conditions under which the two systems it considered can be economically feasible and presents technical challenges for chemical engineers and policymakers to tackle if either or both systems are going to contribute to the liquid biofuel supply and minimize dependence on fossil fuel.

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.

Poster # 19

Incorporation of Sweet Sorghum Juice into Current Dry-Grind Ethanol Process for Improved Ethanol Yields, Energy Saving, and Water Efficiency[1]

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Sweet sorghum is a promising energy crop due to his low fertilizers and water requirements, short grow period, and high biomass yield. However, the challenge for sweet sorghum as a feedstock for ethanol production is its short harvest period and the extreme instability of the juice. One possible way to solve this challenge and to meet the growing demand of bio-renewable ethanol is to incorporate sweet sorghum juice into current dry-grind ethanol process.

In this study, sweet sorghum juice with varying content of grain sorghum flour were liquefied, saccharified, fermented, and distilled to produce ethanol. Ethanol yield from the optimum grain sorghum flour loading with sweet sorghum juice achieved was about 28% higher than that from conventional ethanol process. It was also found that enzymatic hydrolysis with this process could be reduced by 30 minutes. The fermentation performance of sweet sorghum juice with grain flour using raw starch hydrolyzing enzyme was also investigated. The results showed that an ethanol yield was about 21% higher than that from the conventional process. This innovative technology of ethanol production by sweet sorghum juice could improve ethanol yield, save energy, and significantly decrease the use of water in the current dry-grind ethanol process.

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.

Poster # 20

EXTRACTION OF HIGH VALUE CHEMICALS FROM BIOREFINARY RESIDUES

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BACKGROUND: Lignocellulosic biomass is a sustainable feedstock and is available in abundance for the production of biofuels and chemicals. During the biomass processing, large quantities of byproducts are generated. These byproducts are potential sources for producing valuable chemicals such as antioxidants, colorants, preservatives, and biocides. In the present situation, the byproducts are under-utilized and are mostly used for applications such as co-generation of energy. In this research, two types of biomass byproducts were evaluated for the presence of valuable chemicals. The first byproduct was a residual solid obtained after the release of fermentable sugars from the pretreated biomass, and the second byproduct was the commercially available natural lignin (Protobind-1000).

METHODS: The potential chemicals from the byproducts were extracted in various organic solvents and analyzed by GC-MS. Different types of organic solvents, such as ethanol, methanol and dichloromethane, and extraction techniques were tested to optimize the extraction and isolation methods for the target compounds. Research is in progress to investigate the commercially viable isolation methods of these compounds, and to develop a mathematical model for the extraction process.

RESULTS: The results indicated that the selected biomass byproducts contain relatively higher amount of three valuable compounds: vanillin, apocynin, and phytol. It was found that the efficient technique to isolate the target compounds was by probe sonication using a solvent system of Dichloromethane, hexane, ethyl acetate, chloroform in 1:1:1:0.1 v/v ratio.

ACKNOWLEGEMENT: This project is supported by Plants Engineered to Replace Oil (PETRO) Program. Funding agent is USDA, DOE-ARPA.

Poster # 21

D-lactic acid production from corn stover using genetically engineered *Lactobacillus plantarum*

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Background: The thermo-stability of poly-lactic acid (PLA) is maximized when poly-L-lactic acid (PLLA) and poly-D-lactic acid is blended at 1:1 ratio, and as a consequence the demand for optically pure D-lactic acid is increasing. In order to make the biotechnological production of D-lactic acid feasible and effective, low-cost lignocellulosic biomass utilization is essential. However, xylose derived from hemicellulose portion of lignocellulosic biomass is not used by most lactic acid bacteria, which result in inefficient sugar utilization and low lactic acid yield. The objective of this study was to construct a recombinant lactic acid system that can simultaneously use all major sugars derived from corn stover to produce D-lactic acid at high optical purity.

Results: A xylose assimilation plasmid pLEM415-*xylAB* was constructed by cloning xylose assimilation genes from *L. brevis* and introduced into an L-lactate deficient strain *L. plantarum* NCIMB 8826; the resulting recombinant strain was designated as *L. plantarum* Δ*ldhL1*-pLEM415-*xylAB*. Corn stover and soybean meal extract (SBME) were evaluated as cost-effective raw materials for D-lactic acid production by this recombinant strain. Simultaneous use of synthetic glucose and xylose was achieved and a D-lactic acid yield of 0.84 g g^{-1} was obtained. While, D-lactic acid yield was 0.77 g g^{-1} when corn stover and SBME were used to replace synthetic sugars and expensive yeast extract in a fed-batch fermentation.

Conclusion: *L. plantarum* Δ*ldhL1*-pLEM415-*xylAB* efficiently used all the sugars derived from corn stover and produced D-lactic acid at high optical purity (>99%). This fermentation process has the potential to reduce the production cost of D-lactic acid since the recombinant strain effectively utilized all biomass-derived sugars and SBME as nitrogen source.

Poster # 22

Sustainable Ammonia Production Using a Solar Thermochemical Reaction Cycle

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Ammonia is required as a main constituent of fertilizer and is widely recognized as at least partially responsible for the boom in food production known as the “green revolution” of the early twentieth century. However global food production will need to double due to expected increase in world population to 9 billion by 2050 and rising demand for protein among developing nations. Global ammonia production is greater than 100 million metric tons annually and will need to increase to keep up with the expected increase in fertilizer demand for food production. Per ton of ammonia produced, the conventional Haber-Bosch process for ammonia synthesis uses 0.5 tons of natural gas as both a source of hydrogen and combustion energy and emits almost 1.5 tons of carbon dioxide. The natural gas used in the process represents 2-3% of global annual energy consumption. Here we report successful ammonia synthesis at atmospheric pressure using a two-step solar thermochemical reaction cycle. In step one, a mixture of manganese nitrides ($Mn_6N_{2.58}$, Mn_4N, $Mn_2N_{1.08}$, and $Mn_2N_{0.86}$) produced in-house is reacted with steam at 500°C and atmospheric pressure to produce ammonia and a manganese oxide (MnO). In step two, the MnO is then reacted with a dilute 4% methane in nitrogen stream at 1150°C and atmospheric pressure to reproduce one or more of the manganese nitrides. Ammonia generation was tracked via an ammonia ion-selective electrode (ISE) and all solids were characterized via powder x-ray diffraction (XRD). Step one results show that 43-50% of the lattice nitrogen in the manganese nitride mixture is converted to ammonia (where the balance recombines to form N_2) and all manganese is converted to MnO. Step two results show MnO conversion between 30 and 37 mol% and nitride yields ranging from 20-27 mol%. Employment of a solar thermochemical reaction cycle appears a promising method to produce ammonia from atmospheric nitrogen and steam at ambient pressure while limiting carbon dioxide emissions and natural gas consumption.

ACKNOWLEDGEMENT:
This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.

Poster # 23

Alkaline organic solvent pretreatment to facilitate 2,3-butanediol production from diverse biomass resources

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Efficient pretreatment method to maximize sugars yield from biomass with minimum undesirable degradation of biopolymers is vital for lignocellulosic-based biorefineries. Organosolv pretreatment is an effective method to improve enzymatic hydrolysis efficiency of pretreated biomass for biofuels and chemicals production. It also produce quality lignin for high value application. Acid catalyst is commonly used in organosolv pretreatment process, but it leads to significant loss of hemicellulose during pretreatment. Alkali catalyst seems to be a promising approach for biomass pretreatment without significant sugar loss. However, vast variation in composition and structure of biopolymers among biomass types deters the optimization of a single pretretreatment method. All bioenergy resources, therefore, must be separately optimized to select the best pretreatment solvent for each type of biomass. In this study, pretreatment of grass (corn stover), hardwood (poplar) and softwood (douglas fir) were evaluated using various alkaline organic solvents, including dimethyl sulfoxide (DMSO), (2,3)-butanediol, glycerol, ethanol, propanol, butanol and acetonitrile. The results were compared with conventional aqueous alkali pretreatment. It was found that 0.4% alkaline (sodium hydroxide) alcohols and glycerol were promising for grass and hardwood respectively. Pretreatment of softwood was not effective with these solvents, including 10% (w/v) aqueous sodium hydroxide. The quality of biomass-derived sugars for 2,3-butanediol production using robust microbial cultures, such as *Bacillus licheniformis*, was statistically equal to that of synthetic sugars. Research is ongoing to develop novel pretreatment approaches for softwood, and characterization of biomass lignin using GC-MS and NMR.

Poster # 24

Assessing the Impact of Oil Price Volatility in the U.S. Ethanol Fuel Market

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The depletion of finite oil resources has induced the world to find alternative renewable energy resources. Ethanol is the most viable and favorite choice as it will not run out and have a lower environmental impact than fossil fuels. The development of ethanol will enhance energy security, decrease the dependence on oil resources, and empower the national economy by creating more jobs. The development of the ethanol industry was empowered by the Energy Information and Security Act of 2007 that requires the production of renewable energy resources for 36 million gallons by 2022. However, the development of the ethanol industry is not without controversy. Ethanol production may raise food insecurity problems by shifting corn away from food to fuel resulting in higher corn and food prices. The ethanol industry is greatly influenced by oil price volatility. The sudden drop of oil price has decreased the ethanol price and may endanger the sustainable supply of ethanol in the energy market. These changes in oil and corn prices may affect the economic feasibility of ethanol production.

This study will use two-stage least square (2SLS) regression to estimate supply and demand curves. Following the approach of Rask (1998), Luchansky and Monks (2009), we use the Newey-West robust variance and covariance standard errors. This statistical method is used to account for autocorrelation and endogeneity between ethanol quantity and price.

Ethanol provides a possible alternative renewable energy to conventional oil, which is more environmentally friendly. This study will give some insight in explaining the trend of oil, ethanol and corn prices. The magnitude effect of oil and corn price to ethanol supply and ethanol price will be examined using 2SLS method. The result will be useful to policymakers and stakeholders in demonstrating the impact of oil and corn prices to ethanol production feasibility.

ACKNOWLEGDEMENT: *This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.*

Poster # 25

Exceeding Equilibrium Conversion of Alkane Dehydrogenation by Using Catalytic Membrane Reactors

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The production of crude oil in US has increased significantly in the past years as a result of shale oil reserve exploitation. The surplus of supply in light fractions calls for rational utilization to increase functionality and economical gains.

One route for light gas upgrade is dehydrogenation. Light alkane dehydrogenation to olefins can add significant value to hydrocarbon where low-value commodity fuels are converted to high-value chemicals (high octane number) and polymer precursors. However, the endothermic dehydrogenation process is thermodynamically restricted. Conventional solution is to increase temperature, or decrease partial pressure by decreasing total pressure or adding diluent such as steam. The harsh conditions always results in low hydrocarbon utilization and coking.

Membranes fabricated with high thermal stability, chemical resistance and excellent transport properties have been adopted in successful dehydrogenation approaches. Preliminary computational study compared the conversion of methyl-cyclohexane dehydrogenation over conventional packed bed reactor with membrane-assisted reactor system, inert membrane system and catalytic membrane reactor. The computational conversion data demonstrates that by the removal of product hydrogen, the equilibrium of alkane dehydrogenation process can be exceeded beyond the thermodynamic limitation by using a membrane reactor.

Varied application of membranes in the reactor system can achieve higher conversion than PBR at mild temperature and pressure. The future work will focus on the experimental part of alkane dehydrogenation beginning with reactor design and membrane fabrication, following with the optimization of the membrane and the process.

This material is based upon work supported by USDA National Institute of Food and Agriculture as Award Number 2011-67009-20055.

Poster # 26

Membrane Reactors for Multiphase Hydrotreating of Biomass: Overcoming Gas-Liquid Mass Transfer Limitations

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2. *Department of Chemical Engineering, Kansas State University, Manhattan, Kansas*

An important step in the realization of large scale biorefineries is the efficient conversion of a diverse range of biomass feedstock into not only biofuels, but also an array of chemical products. However, due to the physical properties of the substrate, hydrotreating biomass with conventional methods is not easily achieved. Biomass intermediates are not easily vaporized and must be processed in the liquid phase, requiring extreme hydrogen pressures to ensure sufficient hydrogen coverage at the catalyst. In this work membrane contactors have been evaluated for the selective hydrotreating of model compounds with hydrogen pressure two orders of magnitude lower than conventional reactors.

The membrane contactors considered are hollow fiber pervaporation membranes, in bench-scale modules and coated *in-situ* with various noble catalysts. Hydrogen was supplied from the shell side of the membrane fiber and permeated from the shell side to the bore side, where it adsorbed directly onto the metal surface. Liquid reactant is circulated through the bore side, allowing the liquid to come into direct contact with the metal coated surface of the membrane where the hydrotreatment occurred. Our membrane contact reactor approach replaces the traditional three phase batch slurry reactor. These traditional reactors possess inherent mass transfer limitations due to low hydrogen solubility in liquid and slow diffusion to the catalyst surface. This causes hydrogen starvation at the catalyst surface, resulting in undesirable side reactions.

Here we report on the potential to produce propylene glycol (PG) from lactic acid (LA). LA already has a strong market presence, with current production at over 400,000 tonnes per year. LA is currently used in the food and beverage, pharmaceutical, personal care products, and many other industries. With the addition of LA in the US Department of Energy's top 30 chemical building block candidates from sugar, there is additional growth potential for LA in the commodity chemical sector (such as producing PG from LA).

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.

Poster # 27

Efficient detoxification of pretreatment-induced inhibitors using activated charcoal and resins

Jungeun Lee, Yadhu N. Guragain, Krishna P. Bastola, Praveen V. Vadlani

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Lignocellulosic biomass is a sustainable feedstock for the fermentable sugars in the production of biofuels and chemicals. Fermentable sugars are derived from biomass via hydrolysis of carbohydrate polymers. However, recalcitrant of biomass for enzymatic hydrolysis due to strong outer lignin layer requires energy-intensive pretreatment process prior to hydrolysis. Biomass pretreatment process produces many undesirable compounds and inhibits the activity of the microorganism in the fermentation of sugars to produce fuels and valuable chemicals. The major toxic compounds are hydroxymethylfurfural (HMF), furfural, formic acid, acetic acid and phenolics, and they are formed due to the degradation of lignin and sugars during the pretreatment process. In our study, activated charcoal and two types of resins: cationic (DOWEX 50WX-200) and anionic (IRA 743), were evaluated to remove these inhibitors from the biomass hydrolyzates. The results showed that charcoal detoxification effectively removes HMF and furfural, but not formic and acetic acid. Also in this process, 3% sugar loss was observed. The cationic and anionic resin when used separately did not significantly remove the inhibitors. However the resin mixtures of cationic and anionic in 7:3 (w/w) ratio removed all types of inhibitors without any sugar loss.

The results indicated that the detoxification process with resin mixture is an efficient method to remove the inhibitors from the biomass hydrolysates. Research is ongoing to evaluate the activity of the oleaginous yeast cultures in the production of lipids using detoxified hydrolyzates.

Poster # 28

Renewable Energy and Community Capital in Kansas

Patrick Rissler IGERT Trainee in Biorefining, Department of Sociology
Kansas State University

Background: During challenging economic periods an increasing number of rural communities are looking toward attracting new businesses around renewable energy. Specific businesses may include geothermal plants, wind farms, ethanol refineries, and bio-diesel plants. In the state of Kansas there are 25 operational wind farms, 12 ethanol refineries, and three bio-diesel plants. These entrepreneurial and sustainable enterprises both depend on and benefit from arrangements and aggregations of what sociologists refer to as human and social capital.

Methods: The Community Capitals Framework (Flora & Flora; 2008) identifies seven types of capital on three different levels that play a role in the economic development of rural communities. My research looks at how these forms of capital play a role in the interaction between rural communities and these new renewable industries locating in Kansas communities. Using interviews of residents living in these communities, I will look at the interplay of Community Capitals and economic development as it is currently unfolding to better understand keys to success and failure.

We will collect data and interviews from 30 communities and counties that have invested in their future with the introduction of renewable energy as an economic, revitalization source for their community. These communities are as follows:
Ethanol Plants: Atchison, Garnett, Scandia, Colwich, Lyons, Russell, Oakley, Leoti, Hugoton, Liberal, Garden City, & Pratt.
Bio-Diesel Plants: Minneola, Sedgwick, & Cottonwood Falls
Wind Farms: Gray, Butler, Ford, Lincoln, Ellsworth, Cloud, Berber, Wichita, Ford, Kiowa, Sumner, Harper, Grant, Finney, Ellis, Coffey, & Rush.

Results: This project is still in the design phase, there is no results yet.

ACKNOWLEGDEMENT: This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.

Poster # 29

Incorporation of Sweet Sorghum Juice into Current Dry-Grind Ethanol Process for Improved Ethanol Yields, Energy Saving, and Water Efficiency[1]

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Sweet sorghum is a promising energy crop due to his low fertilizers and water requirements, short grow period, and high biomass yield. However, the challenge for sweet sorghum as a feedstock for ethanol production is its short harvest period and the extreme instability of the juice. One possible way to solve this challenge and to meet the growing demand of bio-renewable ethanol is to incorporate sweet sorghum juice into current dry-grind ethanol process.

In this study, sweet sorghum juice with varying content of grain sorghum flour were liquefied, saccharified, fermented, and distilled to produce ethanol. Ethanol yield from the optimum grain sorghum flour loading with sweet sorghum juice achieved was about 28% higher than that from conventional ethanol process. It was also found that enzymatic hydrolysis with this process could be reduced by 30 minutes. The fermentation performance of sweet sorghum juice with grain flour using raw starch hydrolyzing enzyme was also investigated. The results showed that an ethanol yield was about 21% higher than that from the conventional process. This innovative technology of ethanol production by sweet sorghum juice could improve ethanol yield, save energy, and significantly decrease the use of water in the current dry-grind ethanol process.

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Poster # 30

Effect of grassland grazing systems on microbial communities

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Climate change, as a result of anthropogenic gases, is expected to significantly alter precipitation patterns. Changes in precipitation patterns will affect the balance of carbon within soils. Geographic trends indicate that precipitation in the northern hemisphere will likely increase. Greater amounts of precipitation is expected to fall within shorter periods of time. This can lead to intense thunderstorms and rapid runoff. Intense storms and rapid runoff may lead to less available water in soils for organisms and drought conditions. Native grasslands store significant quantities of carbon in the soil and help mitigate CO2 in the atmosphere. Grazing can alter C flow from aboveground to belowground. Drought can also impact C and N cycling by affect C assimilation and transfer to the soil microbial community. The interaction between grazing and drought on the soil microbial community and thus C and N cycling is not known. The goal of this study is to better understand the relationship between grassland grazing systems, drought conditions and microbial communities.

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.