# 2020 AOCS Annual Meeting & Expo Industrial Oil Products Abstracts

June 29 to July 3, 2020

Hosted online by the American Oil Chemists' Society (AOCS)

For more information, please visit https://annualmeeting.aocs.org.

Presentations dated Friday, January 1, 2021, were provided on-demand.

## Industrial Oil Products

Monday, June 29, 2020

Session Time: 8:25 AM - 10:10 AM

Presentation Time: 8:30 AM - 8:30 AM

Track: Industrial Oil Products

**(3492) Plant Oil-Based Poly(Alkyl Methacrylate) as Viscosity Control Additive for Mineral and Vegetable Oils**

Presenting Author: Sylvain Caillol, PhD - ICGM

Vegetable oils and their fatty acids (FAs) derivatives have become the most promising alternative solution to design performant bio-based polymers. The increasing success toward these renewable resources is explained by their wide availability, their low toxicity, as well as their reactive sites opening up various possibilities of functionalization. However, considering the poor reactivity of the internal unsaturation of FAs through radical process, most currently available synthesis of monomers reported in literature are limited to polycondensation. Consequently, there is an important challenge in providing monomers from FAs suitable for radical polymerization to provide bio-based vinyl polymers. For instance, poly(alkyl)methacrylate (PMAs) have known a significant widespread since the beginning of the 20th century in various applications and more especially as viscosity modifier additives for mineral oils. However, except some patents reporting the synthesis of acrylic acid from glycerol, the majority of common PMAs are originated from petroleum resources. Therefore, the objective of our work is to synthesize monomers from fatty acids bearing reactive function through radical process and evaluate their resulting methacrylate polymers as viscosity modifiers in various oils such as mineral or vegetable oils.

Monday, June 29, 2020
Session Time: 10:25 AM - 12:10 PM

Presentation Time: 10:25 AM - 10:30 AM

Track: Industrial Oil Products

**Introduction: Sustainable Methods for Producing Oleochemicals**

Co-Chair: Dharma Kodali, University of Minnesota, USA - University of Minnesota
Co-Chair: Darrell Sparks, Mississippi State University, USA

This session focuses on chemical modifications of fats and oils to create value-added products and applications, including novel chemical/biological synthesis pathways, replacement/reduction of environmentally harsh reagents or wastes, or use of new feedstocks that promote the sustainability of existing technologies.

Tuesday, June 30, 2020
Session Time: 9:45 AM - 10:15 AM

Presentation Time: 9:45 AM - 9:50 AM

Track: Industrial Oil Products

**Introduction: New Uses of Glycerine**

Co-Chair: Franck Y M Dumeignil, PhD - University of Lille / UCCS, UMR CNRS 8181
Co-Chair: Xiaofei P. Ye, PhD - University of Tennessee

This session deals with current progress in the value-added processing and valorization of glycerin. The addressed topics comprise chemical, biochemical, thermochemical, and catalytic upgrading of purified and raw glycerin. Papers dealing with economical, life-cycle analysis and process design dimensions of glycerin upgrading technologies are also welcome.

Tuesday, June 30, 2020
Session Time: 9:45 AM - 10:15 AM

Presentation Time: 9:50 AM - 10:15 AM

Track: Industrial Oil Products

**(4025) Clarification of key factors promoting selective oxidation of glycerol into glyceric acid on Au catalyst**

Presenting Author: Tsutomu Chida - Tohoku University

Glycerol (Gly) can be converted to various useful compounds by liquid phase catalytic oxidation. In particular, the reaction using Au catalyst under alkaline condition produces glyceric acid (GA), which can be used as a pharmaceutical intermediate. However, some side reactions proceed simultaneously, resulting in generation of other oxidation products. To obtain GA with high selectivity, it is necessary to clarify the key factors that promote the reaction pathway of

Gly to GA. In this research, the batch oxidation of Gly using $Au/Al_2O_3$ catalyst was performed in the presence of NaOH to elucidate the role of NaOH and $O_2$ on the target reaction. The catalyst was prepared by deposition-precipitation method. In the oxidation experiments, while maintaining the temperature at 60°C under total pressure of 0.93 MPa, NaOH concentration and $O_2$ partial pressure were varied. The experimental results showed that GA was not produced unless NaOH was present, but NaOH concentration did not affect GA selectivity. This suggested that NaOH is directly involved in the Gly activation step but not in the GA formation step. Increasing the $O_2$ partial pressure to 0.93 MPa increased GA selectivity to 78%. The initial GA production rate was linearly proportional to the $O_2$ partial pressure, showing that $O_2$ is directly related to the GA formation step as a reactive species. Therefore, after Gly was activated by NaOH, it reacted with $O_2$ to form GA. We have discovered new knowledge that NaOH and $O_2$ concertedly work at different steps of the Gly to GA pathway.

Tuesday, June 30, 2020
Session Time: 9:45 AM - 10:15 AM

Presentation Time: 10:15 AM - 10:15 AM

Track: Industrial Oil Products

**(3481) From Monometallic to Bimetallic Systems: Improving Glycerol Liquid Phase Catalytic Oxidation**

Presenting Author: Franck Y M Dumeignil, PhD - University of Lille / UCCS, UMR CNRS 8181

From over two decades, scientists are striving to improve glycerol liquid phase oxidation process. A lot of valuable articles were published in the field, discussing among others: the influence of the active phase and of its preparation method, the influence of the initial reaction conditions (i.e., pH of the reaction medium, temperature, oxidant partial pressure…), the issue of impurities in raw glycerol. Such efforts have been made to find the most efficient, environment friendly and economical method for valorizing biodiesel industry-derived glycerol into added-value molecules. To this respect, we will highlight how deeply we could improve the liquid phase glycerol oxidation process, from the use of conventional monometallic (Au, Pt, Pd and Ag) catalysts operating at high temperatures under oxygen pressure to our most recent findings on bimetallic systems, which are active at room temperature, atmospheric pressure and using air as an oxidant.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products

**(3811) Compositional and Physicochemical Properties of Deposits Formed from Commercial Biodiesel Fuels**

Presenting Author: Richard W. Heiden, PhD - R W Heiden Associates LLC

FAME fuels frequently contain minor or trace concentrations of saturated monoglycerides(SMGs), glycerol(GLY) and steryl glucosides(SGs), common systemic impurities that become problematic when concentrations exceed ill-defined solubility limits. These impurities originate from feedstocks and reactions, remaining as residues in finished fuel due to incomplete purification processes, and potentially form heterophases(HPs) in-situ. Filtration obstruction incidents observed globally represent the most acute and tangible evidence that thermodynamic variables controlling solubility, such as concentration and temperature, work together to force the formation of HPs. Reported here are results of compositional analyses of accumulations found in actual vehicular filters, and of HPs formed in the laboratory at 5C from commercial fuels containing 8-19% FAME. Drawn from over 30 filter obstruction events, chosen examples include data from fuel liquids collected from storage tanks feeding filters. Analyses of precipitates were carried out using GC-FID, GC-MS and light microscopy. The SMG,SG or GLY HPs are often commingled in microcrystalline or gel-like deposits, a product of interactions or co precipitation processes. A comparison of the compositions of HPs formed in-situ in the lab with those collected by fuel filters suggests that filtration can lead to separations of HPs due to differences in the physicochemical properties of HPs, such as size. The formation of HPs from mixtures of dissolved monopalmitin(MP) and monostearin(MS) in ratios expected from feedstock fatty acids involves interactions which result in deposits with MP/MS ratios that differ appreciably from those set initially. The results reveal insights into HP formation dynamics relevant to filtration efficiency and measured solubilities.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products

**(3772) Thermoplastic Biopolymers from Glycerine Acetal and Ketal Building Blocks**

Presenting Author: Shailja Goyal - Iowa State University

Biodiesel is produced from various vegetable or animal fats and has emerged as a potential substitute for diesel fuel. Life cycle analyses suggest that biodiesel is carbon-neutral, and is compatible with existing diesel engine design. According to the 2018 National Diesel Board Report, biodiesel production goal for the US is about 4 billion gallons by 2022. Each ton of biodiesel production generates about 10 wt % glycerol, or about 4 million gallons of crude

glycerine in the market. While there are many factors that affect the cost of biodiesel (such as feedstock and plant operation), the current lack in the value of glycerol by-product has a major impact. Thus, the glut of glycerine created in the market calls for its alternate use for new applications to make biodiesel production more cost-effective. This work explores the synthesis of glycerine based thermoplastic polymers. We synthesized glycerine acetals and ketals by the reaction of glycerol and various ketones such as acetone, butanone and cyclopentanone. The (meth)acrylate derivatives of these glycerol acetals/ketals were synthesized using enzymatic transesterification to yield strictly monofunctional monomers. Radical Addition Fragmentation Chain Transfer (RAFT) was used to synthesize linear polymers with low dispersity. The molecular weight of the polymers was determined using SEC and thermal properties were studied using Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA). Dynamic shear rheology provided insight into the flow characteristics and entanglement dynamics. In further studies, these polymers will be studied for various applications such adhesives and biomedicine. Also, these polymers will be used to study the effect of different pendant chain groups in polymer solutions and morphology for acrylic diblock polymers.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products

**(3810) High Functionality Vegetable Oil Based Polymers for High Performance Thermosets**

Presenting Author: Dean C. Webster - North Dakota State University

High performance thermoset polymers are used in applications such as coatings, composites, and adhesives and are made in-situ from the crosslinking reactions of functional low molecular weight resins or functional oligomers. While vegetable oils are a readily available and amenable to functionalization to be used in thermosets, their long aliphatic hydrocarbon chains tend to result in materials that are soft and flexible. However, we have found that by creating multifunctional resins from vegetable oil fatty acids and a highly functional polyol, thermosets can be formed that have the strength and stiffness for use in high performance coatings and composites. For example, epoxidized sucrose esters of vegetable oil fatty acids, such as epoxidized sucrose soyate, crosslinked with cyclic anhydrides yield thermosets having high modulus, solvent resistance, and hardness. Methacrylated epoxidized sucrose esters can be used to form high performance resins that can be cured with free radicals and used in composites using either glass or natural fibers as well as in 3D printing. It has also been discovered that 100% bio-based thermosets can be made from the water-catalyzed crosslinking of epoxidized sucrose soyate with naturally-occurring acids such as citric or tartaric acids. Conversion of the epoxy groups into cyclic carbonate groups leads to highly functional resins that can be cured using multifunctional amines to yield polyurethanes without using isocyanates. In all of these examples, the thermosets formed have properties far superior to their triglyceride oil counterparts and equivalent or superior to current petrochemical resins.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products

**(3934) Advances in Lipid-Based Epoxy Resins**

Presenting Author: Jonathan M. Curtis - Dept. of Agricultural, Food and Nutritional Science, University of Alberta

Although epoxy resins derived from unsaturated lipids have a long history, they have some disadvantages in comparison to modern synthetic resins, such as the bisphenol or novolak types of epoxy resins. Therefore, in order to gain acceptance as a biobased replacement, lipid based epoxy resins must be developed which achieve similar levels of performance and convenience for use in manufacturing. This talk will describe new aspects of our work that has focussed on the advancement of lipid-based epoxy resins through research in areas that include: 1) lipid transformations away from the basic triacylglyceride structure; 2) optimisation of the reaction conditions leading to epoxide formation, emphasising the use of green chemistry; 3) the development of novel biobased curing agents that are designed for compatibility with lipid epoxides; 4) epoxidation reactions producing terminal glycidyl groups that provide greater reactivity; 5) prepolymerization of epoxy resins.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products

**(4189) Sustainable Production of Oleochemicals from Glycerol: Retrospect and Prospect**

Presenting Author: Xiaofei P. Ye, PhD - University of Tennessee

In the past two decades we saw the surge of research to valorize crude glycerol, driven by the booming biodiesel industry worldwide. Although the major oil plant resource for the production of biodiesel differs from region to region, glut of crude glycerol is a shared problem in all regions. For the sustainability of oilseeds and biodiesel production, value-added chemicals derived from glycerol should open a new vista for the oleochemical industry, significantly enriching its value chain. This presentation examines the impact of the surging glycerol research, focusing on thermochemical catalytic routes that have been put into commercial productions or have great potential for commercial productions. Obstacles in efficient glycerol conversion, techno-economic aspect, influence of the market fluctuation, and the prospect of oleochemicals from glycerol will also be discussed in the context of our experience with glycerol related research and sustainability of new glycerol conversion technologies.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products

**(4205) Effect of Epoxy Content and Ester Headgroup on Plasticizing Properties of Soybean Oil Fatty Acid Esters in poly(vinyl chloride), PVC**

Presenting Author: Lucas J. Stolp - University of Minnesota

A series of biobased plasticizers with glyceryl or pentyl ester headgroups were synthesized from soybean oil by transesterification with appropriate alcohol. The fatty acid ester unsaturation was converted to epoxy groups by reacting with peracetic acid in the presence of a solid acid catalyst. The epoxy content of the fatty acid esters was varied (0, 50 and 100%) by ring opening of the epoxy groups using different stoichiometric amounts of acetic acid and acetic anhydride to form estolides. The synthesis and physical properties of these bioplasticizers were determined. The bioplasticizers were compounded with PVC and their plasticizer properties were evaluated and compared to commercial controls, diisononyl phthalate (DINP) and cyclohexane-1,2-dicarboxylic acid diisononyl ester (Elatur CH). The epoxy rings of the epoxy fatty acid esters were ring opened partially and fully with acetic and acetic anhydride. The series of epoxy fatty acid ester estolides having different epoxy content were compounded with PVC using a plastisol method and compared to commercial plasticizers DINP and Elatur CH. As epoxy content of the bioplasticizers was increased an increase in plasticizer functionality was observed indicating the necessity of the epoxy function for effective plasticization.

Monday, June 29, 2020

Session Time: 10:25 AM - 12:10 PM

Presentation Time: 11:20 AM - 11:45 AM

Track: Industrial Oil Products@@@Biotechnology

**(4127) Innovations and Regulations For Biobased and Sustainable Lubricants**

Presenting Author: Mark Miller, MBA - Biosynthetic Technologies

Green initiatives are everywhere. Bio-fuels, wind energy, renewable fibers are just a few of the environmental initiatives that have recently made headlines. Meanwhile some of the greatest innovations have been in the development and utilization of high performance, environmentally acceptable lubricants (EALs). This paper/presentation focuses on the innovations, features, benefits, strengths and limitation of the different types of EALs. It explores classification of base fluids and additives as well as the requirements of finished lubricants. It compares the performance of conventional petroleum products and biolubricants. The different definitions of environmental acceptability why that is important will be explored. The regulatory driving forces will be identified as well as the requirements for each. The considerations for choosing the type of EAL that is most applicable to specific applications will be studied. Finally, the best maintenance practices to ensure long fluid and equipment life will be discussed.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products@@@Biotechnology

**(3615) Successes and Challenges of Oils-to-Polymers Conversion Technologies**

Presenting Author: Zoran Petrovic - Pittsburg State University

The emphasis on sustainability and ecological requirements has driven the recent explosion of research on utilization of renewable feedstocks for new polymeric materials. This review presents the methods and techniques for conversion of natural oils to polymers developed in our laboratories and the effect of oil structure on properties of materials. Commercial successes and issues with biological oil-based polymers are discussed.

Friday, January 1, 2021

Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products@@@Lipid Oxidation and Quality

**(4118) Vegetable oil refinery by a unique Lipase from Penicillium camembertii**

Presenting Author: Keita Okuda, PhD - Amano Enzyme USA

Objective To increase triglycerides contents in vegetable oil. Methods Applying a unique lipase from Penicillium camembertii to convert diglycerides contained in vegetable oil to triglycerides. Results It was confirmed that diglycerides and fatty acids can readily be converted to triglycerides, and moreover the triglyceride composition of the obtained high triglyceride content oils does not change as compared with the starting oil. Conclusion Lipase from Penicillium camembertii could be a excellent tool for improving the purity of vegetable oil and contributing to reduce triglyceride purification load and purification loss.

Monday, June 29, 2020

Session Time: 8:25 AM - 10:10 AM

Presentation Time: 8:55 AM - 9:20 AM

Track: Industrial Oil Products@@@Processing

**(3935) Synthesis of Biobased Freestanding Nylon Films from Plant Oil**

Presenting Author: Reza Ahmadi - Utilization Of Lipids- Polymers/Materials Chemistry Research Group, Department of Agricultural, Food, and Nutritional Science, University of Alberta, 4-10 Agriculture/Forestry Centre, Edmonton, Alberta, Canada T6G 2P5.

Monday, June 29, 2020
Session Time: 8:25 AM - 10:10 AM

Presentation Time: 9:45 AM - 10:10 AM

Track: Industrial Oil Products@@@Processing

**(3794) Bio-based Polyesters and Polyamides from Glycerin and Fatty Methyl Esters**

Presenting Author: Aman Ullah, PhD - University of Alberta

The use of renewable resources in supplementing and/or replacing traditional petrochemical products, through green chemistry, is becoming the focus of research. The utilization of oils can play a primitive role towards sustainable development due to their large scale availability, built-in-functionality, biodegradability and no net CO2 production. Further, the expansion of crude glycerol applications is the foremost importance for the growing biodiesel industry, where methods with low energy consumption, shorter times and high yield are desired. Here we report the rapid conversion of glycerol and fatty methyl esters to monomers and biopolymers thereoff. The optimal predicted parameters were determined by the higher monomers yield at then polymers were synthesized using solution and bulk polymerizations. The polymers were characterized in details for their structural, thermal, mechanical and viscoelastic properties. The ability for complete conversion under solvent free conditions and synthesis of different biopolymers is undoubtedly an attractive concept from both an academic and an industrial point of view

Monday, June 29, 2020
Session Time: 10:25 AM - 12:10 PM

Presentation Time: 10:55 AM - 10:55 AM

Track: Industrial Oil Products@@@Processing

**(4028) Feasibility of the novel utilization of modified Azadirachta Indica seed oil as transformer oil**

Presenting Author: Chinedu Matthew Agu, PhD - Micheal Okpara University of Agriculture Umudike/Nnamdi Azikiwe University Awka

This work focuses on the solvent extraction and chemical modification of Azadirachta Indica seed oil (AISO) into a novel bio-based transformer insulating fluid. The effects of temperature, time and particle size on the AISO yield were studied. Extraction kinetics and thermodynamics were also investigated. The AISO batch was sequentially subjected to transesterification and epoxidation-esterification treatments to evaluate product quality after each stage. The vital operational characteristics of the modified Azadirachta Indica seed oil (MAISO) were determined. The AISO yield of 54.14 % was obtained at 55 °C, 150 min and 0.5 mm particle size. For the solvent extraction, pseudo second order, hyperbolic, Elovich's and parabolic diffusion models all described the process kinetics, while Gibbs free energy, entropy and enthalpy values evaluated at 0.5 mm particle size were – 168.63 kJ/mol, 1.82 kJ/mol, and 428.11 kJ/mol, respectively. MAISO characteristics obtained for epoxidation-esterification were better

than that of transesterification. The final MAISO characteristics after epoxidation-esterification are: -9 °C, 179 °C, 818 Kg/dm3, 1.66 mm2/s, 0.25 mgKOH/g, 0.11 mg/Kg and 52.86 KV for pour point, flash point, density, viscosity, acid value, moisture content and dielectric strength, respectively. The dissolved gas analysis result (in ppm) of the key gases for MAISO obtained after epoxidation-esterification are : <5, 67, 1624, 4, 7, 21, 4, <0.5 for H2, H2O, CO2, CO, C2H4, C2H6, CH4, C2H2, respectively. The characteristics met acceptable standard limits. MAISO properties (from transesterification and epoxidation-esterification) indicated its potential as substitute for mineral transformer fluid.

Monday, June 29, 2020
Session Time: 10:25 AM - 12:10 PM

Presentation Time: 11:45 AM - 11:45 AM

Track: Industrial Oil Products@@@Processing

**(4006) Effects of conifer essential oils on protection of wood from termites and decay fungi.**

Presenting Author: Fred J. Eller, III, PhD - USDA ARS NCAUR

The objective of this study was to determine the effects of extracts from both Eastern Red Cedar (ERC) and Loblolly Pine (LP) on subterranean termites and four species of wood decay fungi (two brown-rot and two white-rot). In addition, amylose inclusion complexes (AIC) with two different ammonium chlorides (a primary and a quaternary amine) were compared for their bioactivity. The results will be used to design treatments to convert/upgrade non-durable wood into more valuable durable wood. Wood blocks were treated by vacuum/pressure impregnation and subsequently exposed to termites and wood decay fungi Treatment effectiveness was evaluated by measuring percentage wood mass loss and termite mortality. Both the ERC and LP extracts had inhibitory effects on wood mass loss by termites and increased termite mortality compared to controls. Both ammonium chloride AICs had inhibitory effects on wood mass loss by termites and increased termite mortality and were comparable to one another. The extract from ERC inhibited all four species of decay fungi, however, the LP extract only had an inhibitory effect on one species of white-rot fungi. Both ammonium chloride AICs had inhibitory effects on wood mass loss by all four species decay fungi and were comparable to one another. The treatment combination containing both the ERC and LP extracts and either AIC gave the best overall wood protection for termites. However, the inclusion of the LP extract only improved protection for one species of decay fungi. Projected use and production costs will determine the cost effectiveness of a given treatment.

Tuesday, June 30, 2020
Session Time: 8:25 AM - 9:45 AM

Presentation Time: 8:55 AM - 9:20 AM

Track: Industrial Oil Products@@@Processing

**(3833) Formulation and Evaluation of a Moisturizing Cream Containing Neem Oil**

Presenting Author: Ukachi E. Igbo - Federal Institute of Industrial Research Oshodi

Neem (Azadirachta indica) is a fast growing tree in the mahogany family Maliaceae. The various bioactive compounds (azadirachtin, meliantriol, nimbin, nimbidin etc.) in different parts of neem exert antimicrobial and other medicinal properties and this explain its various uses. Objective/hypothesis: Neem based creams are good against skin cancers, hence this study is aimed to formulate and evaluate a moisturizing cream using neem oil. Methods: Neem oil obtained by cold maceration was characterized according to standard methods. The fatty acid methyl esters (FAME) of neem oil were prepared by a base catalyzed esterification process and analyzed by GC-MS. Neem cream was formulated by combining water phase and oil phase using the hydrophilic-lipophilic balance system to determine the percentage of emulsifiers. Homogeneity, spreadability, pH, total fatty matter, non-volatile matter, water content, oil content and microbial load and physical stability were evaluated. Results: Neem oil showed predominantly oleic acid (36.45%) and contains alpha amyrin (21.89 %) a triterpene, an antioxidant that may help preserve cutaneous barrier function and cellular immunity. The pH of formulated cream was found to be 6.5 with a garlic odour. The physicochemical parameters were found to be within standard limits. Conclusion: The formulated cream showed good stability with total viable count <100 and no separation observed within 12 months of study. Presence of α amyrin will help ameliorate the effect of skin aging. This suggests that neem oil has potential as an alternative oil in cream production. Keywords: Neem oil, Fatty acid, alpha amyrin.

Tuesday, June 30, 2020
Session Time: 8:25 AM - 9:45 AM

Presentation Time: 9:20 AM - 9:45 AM

Track: Industrial Oil Products@@@Processing

**(4024) Design of selective ester synthesis process by controlling reaction field in porous resin catalyst**

Presenting Author: Kousuke Hiromori - Tohoku University

Propylene glycol fatty acid esters consist of fatty acid and propylene glycol. Monoester and diester have different functions depending on number of fatty acids bonded. These are industrially produced by esterification with homogeneous acid catalyst under severe conditions (170–210°C, vacuum). Because the esterification proceeds sequentially, the product becomes a mixture of mono- and di-esters. Additionally, more severe conditions are required to improve the diester selectivity. Thus, it is necessary to separate not only the catalyst but also each ester, so the complicated process with large environmental impact is necessary. As an alternative, we propose

a simple process for selectively producing each ester by controlling reaction field in heterogeneous porous resin catalyst. It is expected that monoester is produced preferentially by using resin catalyst swollen by propylene glycol, while diester is also produced by the resin swollen by fatty acid. The batch esterification using the resin swollen by each reactant was performed under mild condition (80°C, atmospheric pressure). Using the resin swollen by propylene glycol, the monoester selectivity was obtained at about 98%, whereas the diester selectivity was about 78%. These were significantly improved compared with those in conventional process (30-50%). Based on the results, a continuous production process with two columns packed with the resin swollen by each reactant connected in series was designed. Monoester-rich product was obtained from the first column and diester-rich product was obtained from the second column. Thus, the process enables to produce desired esters selectively by controlling the resin swelling condition.

Tuesday, June 30, 2020
Session Time: 9:45 AM - 10:15 AM

Presentation Time: 10:15 AM - 10:15 AM

Track: Industrial Oil Products@@@Processing

**(3610) Glycerol Valorization Under Continuous Flow Conditions–Recent Advances**

Presenting Author: Christophe Len - Chimie Paristech

The design of environmentally friendly methodologies has been the driving force of scientists in recent years. In particular, the use of biomass-derived materials, green solvents and continuous flow as an alternative technique has been investigated. In this regards, glycerol has the potential to be both an excellent renewable solvent in modern chemical processes and a versatile building block in biorefineries. Indeed, various glycerol transformations such as oxidation, hydrogenolysis, etherification, esterification, dehydration and oligomerization can be executed to create a large number of value-added chemicals with specific industrial applications [1]. In parallel, continuous flow synthesis has got many advantages: thermal management, mixing control, scalability, energy efficiency, waste reduction, safety among others. Recent advances in glycerol valorization to valuable products (acrolein, lactic acid, glyceric acid, propanol, propanediols, glycerol carbonate, solketal, acetin, and oligomers ) under liquid phase continuous flow systems using different types of catalysts and processes will be highlighted [2]. [1] C. Len and coll., J. Agric. Food Chem. 1996, 44, 2856; 1997, 45, 3; Green Chem. 2011, 13, 1129; Eur. J. Org. Chem. 2013, 2583; Catal. Commun. 2014, 44, 15; RSC Adv. 2014, 4, 21456; Catalysis Today 2015, 255, 66; J. Chem. Technol. Biotechnol. 2017, 92, 14; ACS Sustainable Chem. Eng. 2016, 4, 6996; Catalysts 2017, 7, 123; Molecules 2019, 24, 1030; Front. Chem. 2019, 7, 357. [2] C. Len and coll., J. Ind. Eng. Chem. 2017, 51, 312; Synthesis, 2018, 50, 723; Curr. Opin. Green Sustain. Chem. 2019, 15, 83.

Wednesday, July 1, 2020
Session Time: 8:25 AM - 11:45 AM

Presentation Time: 8:25 AM - 8:30 AM

Track: Industrial Oil Products@@@Processing

**Introduction: Biofuels**

Co-Chair: Robert O. Dunn, Jr., PhD - USDA ARS NCAUR
Co-Chair: Bruce Patsey, Oil-Dri, Corp., USA

This session investigates recent advances in biofuels production. Biofuels produced from oils, fats or by-products of the oil plants value chain can offer sustainable alternatives to fossil fuels. Potential topics include, but are not limited to, biomass pre-treatment, enzymatic and catalytic processing, thermochemistry, carbon footprint analysis, optimization of biofuels, new feedstocks, chemical structure-property relationships, and fuel properties.

Wednesday, July 1, 2020
Session Time: 8:25 AM - 11:45 AM

Presentation Time: 8:30 AM - 8:55 AM

Track: Industrial Oil Products@@@Processing

**(3554) Adsorptive Removal of Contaminants from Fats and Oils for Production of BioFuels**

Presenting Author: Brian S. Cooke - Clariant

Both Biodiesel and Renewable Diesel are derived from fats and oils. These fats and oils can often present challenges in the process due to contaminants that interfere with the efficiency of the reaction often resulting in a decrease of catalyst activity. This study looks at the removal of these contaminants to help with the biodiesel reaction efficiencies as well as helping to protect the catalyst used during the hydrotreating process for renewable diesel. The use of activated clay has been shown to remove these contaminants through the process of adsorption. The life of the catalyst for renewable diesel can be significantly improved by removing contaminants such as metals and phosphorus. This can result in significant cost savings during the production of renewable diesel. The activated clay can also be used to remove contaminants from the crude biodiesel, such as glycerol, soap and metals. It is imperative that these contaminants are removed to ensure that the biodiesel will meet the desired specifications.

Wednesday, July 1, 2020
Session Time: 8:25 AM - 11:45 AM

Presentation Time: 9:20 AM - 9:45 AM

Track: Industrial Oil Products@@@Processing

**(3756) The Use of Controlled Flow Cavitation (CFC™) to Enhance Biofuel Processing**

Presenting Author: Darren J. Litle, MBA - Arisdyne Systems Inc

The power of controlled flow cavitation to reduce catalyst consumption, increase throughput, and reduce monoglyceride content in finished biodiesel is described and industrial examples given. The use of cavitation technology in the pretreatment of renewable diesel feed stocks is also discussed.

Wednesday, July 1, 2020
Session Time: 8:25 AM - 11:45 AM

Presentation Time: 9:45 AM - 10:10 AM

Track: Industrial Oil Products@@@Processing

**(4178) Displacing Petroleum Heating Oil with Biodiesel**

Presenting Author: Ryan Kerr - National Oilheat Research Alliance

Biodiesel fuel is produced from new and used vegetable oil and animal fats, typically through a base-catalyzed esterification process. Much of the attention has been focused on use in engines and the transportation sector. Another end use with strong potential for biodiesel is the stationary heating market. Relative to transportation, this market has the advantages of simpler equipment and a controlled end-use temperature environment. Recently, the heating oil industry has decided to transform this market sector, replacing all petroleum-based heating oil with biofuels by 2050. The technical questions which will need to be addressed and potential solutions are presented. With petroleum heating fuel, current practice is to manage cold flow properties through fuel selection to match the application requirements. While a similar approach will be taken, the cold flow parameters are more challenging with biodiesel. Options include moving tanks, tank enclosures, tank and line heaters, additives, and adjustment of blend levels to specific customers. The air/fuel ratio requirements of biodiesel are different than those of petroleum heating fuel. There is a concern that rapid shifts in the delivered blend biodiesel content could lead to combustion performance issues. The cleaner flame of biodiesel has less light emission and this is important relative to flame sensing for safety control. Results of considerable testing on these questions are presented. Concerns have been raised about the interaction between “yellow metals” and biodiesel. These can potentially attack the fuel and accelerate the oxidative degradation of these fuels. Results of studies on these questions are presented.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products@@@Processing

**(4017) Correlation of Biodiesel Cold Flow Properties Using the Long-chain Saturation Factor**

Presenting Author: Robert O. Dunn, Jr., PhD - USDA ARS NCAUR

The cold flow properties of biodiesel are an ongoing concern for industry and consumers. Development of new feedstocks often yields lipids with high concentrations of long-chain (C12+) saturated fatty acids. Conversion to biodiesel (fatty acid methyl esters) can result in fuels that have moderate to high cloud point (CP) and cold filter plugging point (CFPP). Direct measurement of these properties takes time and requires expensive instruments. This work examines the long-chain saturation factor (LCSF) as a parameter for quickly predicting the CP and CFPP of biodiesel made from different feedstocks as a more cost-effective alternative to direct measurement of these properties.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products@@@Processing

**(4129) Downstream corn oil from bioethanol industry: A versatile green feedstock for advanced material application**

Presenting Author: Manusri Misra, MSc, MPhil, PhD - University of Guelph

Vegetable oil (VO) is an abundant sustainable resource which is non-toxic and low in cost. In recent years, their applications have been expanded tremendously in the polymer industry. The unsaturated chains in VO structure allow for many possible chemical modifications and functionalizations such as epoxidization, hydroxylization, esterification, etc. With proper modification, the modified VO can be used as a lubricant, plasticizer, toughening agent, biobased resin or hydrophobic coating. In this work, we presented a few approaches to modify VO obtained from downstream corn oil (a co-product from the bioethanol industry). Multifunctional corn oil was successfully synthesized through a ring opening process with formic acid and hydrogen peroxide. Plastic products are usually flammable due to their carbon-based rich backbone structure. Hence, flame resistant plastic products are commonly desirable for engineering applications. Halogen-free biobased flame retardant (FR) from downstream corn oil was successfully synthesized through phosphorylation process with phosphorus acid. Nuclear Magnetic Resonance (NMR) spectroscopy was used to confirm the synthesized phosphorylated corn oil structures. It was found that the flame retardancy of engineering plastics was improved after incorporation of our biobased FR. In another approach, we modified the downstream corn oil with itaconic acid and a crosslinking agent to obtain an effective toughening agent for

polylactic acid (PLA) modification. It was found that the elongation of PLA enhanced remarkably (18 times) with addition of small amounts of our modified oil. Finally, a novel approach to develop a sustainable super hydrophobic coating from downstream corn oil was also discussed.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products@@@Processing

**(4083) Design of Sustainable Chemistry to Produce Functional Bioactive Fatty Acid Products**

Presenting Author: Helen Ngo, PhD - USDA ARS ERRC

Petroleum-based materials, while generally cheaper to produce than biobased products, tend to resist the typical degradation processes found in nature, resulting in global problems with waste management. Biobased products, on the other hand, have an established track record as reliable and low-carbon footprint replacements for many petroleum-based products. This presentation will focus on the design of sustainable chemistry to create a family of unique biobased fatty acid products exhibiting effective functional (phenolic) groups against bacteria. The enhanced bioactive properties come from the hydroxyl functional group on the aromatic ring as it improves the hydrophilicity of the fatty acid. The paper will also discuss the hurdles encountered in the process design of these products including production, process cost and product performance. Our recent work will also demonstrate that the phenolic fatty acid-based epoxy curing agent could construct antimicrobial epoxy polymers. This development will result in a renewable family of products replacing petroleum-based materials in the lubricant, corrosion protection, antimicrobial, and polymer areas.

Tuesday, June 30, 2020

Session Time: 9:45 AM - 10:15 AM

Presentation Time: 9:50 AM - 10:15 AM

Track: Industrial Oil Products@@@Surfactants and Detergents

**(3579) Oligomerization of Glycerol in the Presence of Homogeneous or Heterogeneous-acid Catalysts**

Presenting Author: Karine De Oliveira Vigier - Cnrs-Universite De Poitiers- IC2MP

In recent years, use of glycerol as a renewable raw material for the chemical industry has received considerable attention. One interesting reaction is the catalytic oligomerization of glycerol yielding highly hydrophilic molecules. The resulting oligo-glycerols are an interesting class of chemicals that exhibit a broadrange of applications in various industrial sectors such as

cosmetic, food and pharmaceutic industries It is a difficult reaction mainly because of the difficulty to closely control the reaction selectivity. Oligomerization of glycerol can be heterogeneously or homogeneously-catalyzed either by bases or acids. Under basic conditions, high temperature are generally required (T > 220°C) leading to the competitive dehydration or dehydrogenation of (oligo)glycerol. On the other hand, under acid conditions, side dehydration of (oligo)glycerol to readily polymerizable substrates occurs which represent an important limitation of this route. In this study we screen various homogeneous acid catalysts and Aquivion®PFSA PW98 a solid superacid catalyst. Under optimized conditions, a mixture of oligoglycerol with an average degree of oligomerization of 3.4 was obtained at a glycerol conversion of 80% in the presence of metal triflates catalyst. At such conversion, the selectivity to oligoglycerols was higher than 90%. In the presence of Aquivion®PFSA PW98 wasnearly fully selective to oligoglycerols up to 80% conversion of glycerol was selectively converted to and Aquivion®PFSA PW98 was found highly robust and was sucessfully recycled at least 10 times.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Industrial Oil Products@@@Surfactants and Detergents

**(4116) Evaluation of Oil Soluble Polyalkylene Glycols (PAGs) as Synthetic Lubricants**

Presenting Author: Thu Nguyen, BE - University of Manitoba

Polyalkylene Glycols (PAGs) have been identified as synthetic lubricants that provide many benefits superseding conventional base oils. PAGs can range from water-soluble to water-insoluble characteristics depending on their molecular structures. This study focused on the development and evaluation of oil-soluble PAGs with various viscosity grades, which were shown to be dependent on the alkoxylation degree. The physical properties such as appearance, viscosity index, and pour points were evaluated. These PAGs were found to have excellent compatibility with different types of seals, including EPDM, FPM and PTFE up to 100 oC as well as with different types of base oils over a 4 – 40 oC temperature range. The results also showed that the studied oil soluble PAGs have many advantages in performance when compared to mineral oils. Those advantages include enhanced anti-wear properties, increased water separability, corrosion inhibition, and sludge control. In addition, the effect of the alcohol structure (carbon chain length and branching) on the properties of the oil-soluble PAGs as synthetic lubricants was also investigated.