AIChE

Rocky Mountain AIChE News

May 2022 Volume 31 Number 9

May Section Meeting: Catalytic Conversion of Methane to Partially Oxidized Products over Copper-Exchanged Zeolites

The selective activation and conversion of methane to liquid oxygenated compounds is a grand challenge in catalysis. Although natural gas can be processed industrially in largescale facilities, new catalytic processes are required for the direct, low-temperature conversion of methane to liquid products in small-scale units to exploit highly abundant but difficult-to-access gas reserves in distributed fields or stranded wells. Narsimhan et al. reported the first instance of a continuous, gas phase catalytic process for the direct conversion of methane to methanol using copper-exchanged zeolites by feeding only methane, water, and oxygen at 473 K.1 While this continuous system is an attractive route for the mild conversion of methane to value-added products, fundamental understanding of the reaction pathway and active site is necessary to engineer improved catalysts and an improved process.

Thus, we first demonstrated a reaction pathway where C-H bond scission of methane is rate-limiting and a [Cu-O-Cu]2+ motif as the active site for the selective catalytic conversion of methane to methanol. Water is required for methanol desorption and carbon dioxide is generated from the sequential over oxidation of partially oxidized intermediates and downstream methanol oxidation. Selective partial oxidation was achieved with catalyst samples of high Al content and moderate Cu content (Cu/cage<0.3) with high methane and water partial pressures.2 These learnings were used to design a tandem partial oxidation and alkylation process that effectively scavenges methanol to produce toluene

May Section Meeting

Topic: Catalytic Conversion of Methane to Partially Oxidized Products over Copper-Exchanged Zeolites

Speaker: Dr. Kimberly Dinh
Senior Research Specialist in Dow's Core R&D: Chemical Science group

Date: Tuesday, May 10th

Time: 6:00 – Introduction
6:05 - Career Discussion
6:15 - Technical Presentation
7:15 – Q & A

Cost: Free

REGISTRATION REQUIRED. More information can be found on our website.

Register

After you register, you will receive instructions via email for joining the meeting.

by introducing an H-ZSM-5 catalyst and benzene co-feed. Benzene reacts with methanol over Brønsted acid sites, arresting methanol over oxidation and enabling >70% selectivity for partial oxidation products at 0.6% methane conversion.3 These findings resulted in a process that can circumvent methane's selectivity-conversion limit and provide a new avenue of research in product protection to increase methane conversion while maintaining high product selectivity over heterogeneous catalysts.

Kimberly Dinh (she/her) is a Senior Research Specialist in Dow's Core R&D: Chemical Science group where she works on catalyst discovery for more sustainable processes such as ethane conversion and waste hydrocarbon upgrading. Prior to Dow, Dinh earned a B.S. in Chemical Engineering from the University of Wisconsin-Madison in 2015, a M.S. of Chemical Engineering Practice in 2017 and a Ph.D. in 2020 in Chemical Engineering from the Massachusetts Institute of Technology under the guidance of Professor Yuriy Román-Leshkov. At MIT, she was an NSF Graduate Research Fellow and was awarded a 2019 Kokes Travel Award by the North American Catalysis Society.

Dinh is a passionate advocate for improving diversity, equity and inclusion in STEM and sports. She served on MIT's Chemical Engineering Department's Graduate Student Advisory Board that worked on improving graduate student quality of life and is currently Mid-Michigan AIChE's Equity, Diversity, and Inclusion Committee Chair and a New Hire co-Chair for Dow's Young Researchers Community. Dinh also volunteers her time as an assistant coach with the high school golf teams.

In her free time, Dinh enjoys staying active – playing golf competitively and ultimate frisbee recreationally. She also enjoys cooking, bread baking, watching a good TV show, and listening to podcasts.

AICHE ROCKY MOUNTAIN SECTION ANNOUNCES SCIENCE FAIR WINNERS

The Science Fair activities are now complete. The following served as judges: Michael Mutnan, Rebecca Spearrott, Pete Sharpe, and Doug Brown. The judging consisted of both virtual land live interviews.

Thanks to our membership for providing funds to increase the prizes to $200.00 for 1st Place and $150.00 for 2nd Place in each Division.

Congratulations to our four winners and to all who participated (275+ projects). The WINNERS are:

1st Place Senior Division

Project Title: Reversing Climate Change with Direct Air Capture
Individual/Team Leader's Name: Chinmay Jayanty
School & City: Sargent High School, Monte Vista
Sponsor's Name: Rafe Paulson
Category: Energy
Abstract: Direct Air Capture (CAD) is the capture of CO2 from atmospheric air through technical chemical processes. DAC technologies have been developed to remove past emissions and reduce atmospheric CO2 to an optimal level below 350 ppm. Amino acid sorbents are environmentally friendly and alternative to toxic and corrosive substances like aqueous alkaline sorbents (NaOH, KOH, and Ca(OH)2) and amines. The aim is to improve the surface area relative to the sorbent volume, which limits the overall CO2 uptake. The loading of CO2 with the humidifier filter method and a bubbler method using 1 M and 0.5 M aqueous solutions of glycine and sarcosine has been tested. The CO2 absorption was

monitored by pH measurements and 1H Nuclear Magnetic Resonance chromatography (NMR) to quantify the formation of carbonic acid and carbamate. The CO2 capture experiments were carried out over a 24-hour period. There was a drop in the pH of glycine and sarcosine solutions after 24 hours at both concentrations and methods. The decline in pH is due to increased levels of carbamate and carbonate. In proton NMR analysis, the intensity of the proton at 3.8 decreases, while the intensity at 6.4 increases with time during CO2 absorption on glycine. Similar changes in peak intensity and shift occurred with sarcosine at 24 hours.

2nd Place Senior Division

Project Title: Eco-friendly vs Store-bought Water Repellent
Individual/Team Leader's Name: Elia Lowe
2nd Member's Name: Samantha Abate
School & City: Dolores High School, Dolores
Sponsor's Name: Dave Hopcia
Category: Engineering
Abstract: In this experiment, we attempted to redesign a water-repellent product using all-natural substances to create a more eco-friendly substitute to store-bought water-repellent spray. We researched the water-repellent properties of lotus leaves and based our design on the way the plant is formed and the waxy cuticle substance on its leaves. We attempted to compare the effectiveness of the products based on their chemical makeup to show the benefits of the all-natural substance compared to the store-bought product with respect to environmental concerns. By combining melted beeswax and avocado oil, we created a water-proof substance and spread it thinly over various surfaces. This design provides an alternative to store-bought chemical water repellents. It is important to lessen the environmental impact of water repellents that are currently available. It creates an alternative to chemical based water repellents and is an effective solution that is environmentally friendly. It is a simple and functional product that reduces the harmful effects of store bought chemical water repellents. The results showed that the eco-friendly water repellent substance worked just as well, if not better than the store-bought spray on various surfaces.

1st Place Junior Division

Project Title: Laminar or Turbulent Flow?
Individual/Team Leader's Name: Jacob Kossler
School & City: Turner Middle School, Berthoud
Sponsor's Name: John Kossler
Category: Engineering
Abstract: I am trying to find which shapes have more laminar or turbulent flow. This could be important because it can help us understand the physics of flight. I built a wind tunnel based on a design from the NASA Glenn Research Center. I tested 5 different shapes in the wind tunnel and took pictures of each piece to document which one I thought had the most laminar or turbulent flow based on the patterns in the smoke. I found that a smoother symmetrical design has the most laminar flow, and a more rough, bumpy design is the most turbulent. The symmetrical piece would be a good design for the nose of a plane because it has good laminar flow, but not enough turbulence for a wing, in other words it is aerodynamic. The block is not good for anything on a plane because it has all turbulent but no laminar flow, in other words it would cause only drag. The typical wing is a good design for a wing because it has a balance between laminar on the bottom of the wing, and turbulence on the top of the wing which provides lift for a wing.

2nd Place Junior Division

Project Title: The effects of droplets size from irrigation sprinklers on evaporation rates
Individual/Team Leader's Name: Haydan Drullinger
School & City: Liberty School, Joes
Sponsor's Name: Niccoli Linda
Category: Physics
Abstract: The purpose of this project is to investigate the evaporation rates caused by different types of irrigation sprinkler nozzles. The hypothesis was that a smaller nozzle resulted in smaller droplets which should cause more evaporation. The process of measuring relative humidity was by using a LabQuest. The LabQuest was set to run for 2 minutes when play is pressed. The readings were taken every 30 seconds. Before relative humidity was measured the sprinkler ran for 2 minutes. After the two minutes were up the humidity tester was put in the drum and for the 0 second reading humidity was very low. For every nozzle size (20, 30, 40) five tests were performed. Before moving on to the next trial the depth of the water was measured to see how much water was being used. Nozzle size 20 had the most evaporation measuring around the 62 for the highest reading. For the 30 nozzle the highest the humidity got was 57. Last for nozzle 40 the highest reading was 40. Like the hypothesis stated the results showed that with a smaller nozzle that more evaporation was generated.

VOLUNTEER AS A YOUNG PROFESSIONAL LIAISON (YPL)

We are looking for Young Professional Liaisons for each state – CO, NM, WY, SD & MT. Please send nominations to any section officer listed below.

AIChE Meetings

2022

May 2-5	2022 Synthetic Biology; Evolution, Engineer and Design (SEED) Arlington, VA
June 1-3	Advanced Manufacturing and Processing Conference Bethesda, MD
June 7-9	Process Development Symposium Philadelphia, PA
June 26-28	NDEW-ChE: National Diversity Equity Workshop for Chemical Engineering Academic Leaders Baltimore, MD

National AIChE Contact Info

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The objectives of AIChE are to advance chemical engineering in theory and practice, to maintain a high professional standard among its members, and to serve society, particularly where chemical, engineering can contribute to the public interest.

AIChE Rocky Mountain is a public non-profit 501(c)(3) organizations and thus all donations are tax deductible.

MEETING SCHEDULE

The Rocky Mountain Local Section (RMLS) of AIChE generally meets the second or third Tuesday of every month, September through May.