ETHYLENE PRODUCERS' TECHNOLOGY SUBCOMMITTEE (TSC) MEETING

Date: Thursday: February 1, 2024

Time: 4:30 to 5:30 PM CDT

Location: DoubleTree by Hilton at Greenway Plaza, Houston.

Hilton Honors Meeting PW: hougwstandard

ATTENDANCE

Last Name	First Name	2/1/2024
Arora	VK	X
Buehler	Jack	X
Charlton	Bill	X
de Barros	Jose	
Devakottai	Bala	X
Fox	Rob	X
Hamilton	Jason	X
Imran	Muhammad	X
Kapur	Sanjeev	X
Kehrier	Greg	X
Krinock	Robert	X
Krumins	Aivars	X
Kruse	Ryan	X
Le Geyt	Darren	
Polito	Charles	X
Rafique	Humera	X
Rode	Doug	X
Rollins	Kaleb	
Spicer	David	
Tallman	Michael	
Ting	Tiong-Ee	X
Whitney	Mark	X
Yu	Ying	X
Zygula	Timothy	
		75.0%

Tentative AGENDA

1. Reading of the Anti-Trust Statement (Read by Jason Hamilton):

   No activity of the Committee shall involve the exchange, collection or dissemination among competitors of information, or be used for the purpose of bringing about or attempting to bring about any understanding or agreement, written or oral, formal or informal, express or implied, among competitors with regard to costs, prices or pricing methods, terms or conditions of sale, distribution, production quotas or other limitations, on either the timing, or volume of production, or sales, or allocation of

territories or customers.

2. Five Minutes on Safety-

3. TSC Membership.

Welcome Doug Rode (Eastman)

Mark Whiney will be retiring from sub committee after the 2024 EPC session. Linde will nominate another representative. – They have someone in mind, but they have not responded to date.

Bob will send a CV for a potential member, Jeffory Nickels. He is with Soloman. Could be operations or Technology – Good fit for Operations. Ask operations committee if they were contacted.

4. Discuss 2024 Sessions and Tutorial

a. Fundamentals Session Update
   i. Chair: Jack Buehler
   ii. Co-Chair: Bob Krinock
   iii. Shadow: David Spicer

6 papers. Asked for written drafts of papers by Feb 16th. Drafts of the PP presentation by Feb 23rd. JH to ask Scott about SMR disclosure status.

2024 Technology SC Sessions Summ 12/1/2023

Seq.	Plant Area	Theme	AIChE/ EPC Submission	Title	Author	Company Affiliation	Summary of concept	Summary Tally	Ave	Rank
2	Reactions /Chemistry	New Ethylene Reactor/ Process developments	8478412	**Powering the Transition to Net-Zero: Update on Technology Demonstration of Electric Cracking Furnaces and Future Integration Options into Petrochemical Sites**	**Martin Hofstaetter, Email: martin.hofstaetter @linde.com**	**Linde Engineering,**	As of October 2023, demo plant construction of the two electric cracking furnaces at BASF in Ludwigshafen (Germany) is in full swing and the consortium partners BASF, SABIC and	62	3.0	1
8	Utilities	Decarbonization , Nuclear & Alternative Power	8477629	**Nuclear Smrs for Combined Heat and Power in the Process Industries**	Scott Bury: sjbury@dow.com	**Dow Chemical**	Covers the technical aspects of different SMR designs and how it makes them more or less suitable for use in the chemical industry.	76	3.6	2
6	Reactions /Chemistry	New Ethylene Reactor/ Process	8478203	**Renewable Ethylene Production from CO2 Electrolysis**	Abdollah Hajizadeh, abdollah@co2cert.com	**CERT Systems**	The team has created a pilot-scale electrolysis system for converting CO_2 into C_2H_4 as finalists in the NRG	89	4.2	3
1	Decarbonization	New Ethylene Reactor/ Process	8479524	**Lummus Hybrid Cracking Heaters**	**Baozhong Zhao, baozhong.zhao@lummustech.com**	**Lummus Tecl**	This paper will introduce Lummus Hybrid Cracking Heater technology for revamp of existing heaters with minimum modifications as well as the SRT h™	97	4.6	4
5	Reactions /Chemistry	New Ethylene Reactor/ Process	8478404	**Integration of Rotodynamic Reactor (RDR) into Existing Steam Crackers**	Tuomas Ouni, Email: tuomas@coolbrook.com	**Coolbrook Oy/Linde Engineering,**	Update on RDR technology & pilot plant results	101	4.8	5
7	Decarbonization	Decarbonization , Nuclear & Alternative Power	8477914	**Decarbonizing Olefins Production**	Michael Tallman, michael.tallman@kbr.com	**KBR**	Discsses various carbon reduction technologies being pursued in steam crackers as well as many industries and integration of various Hydrogen	120	5.7	6
9	Reactions /Chemistry	Super Dry CO2 Reforming and Chemical Looping	8476849	**Development, Installation, and Operation of a Chemical Looping Pilot Plant for Super-Dry Reforming of Methane**	Lukas Buelens et al: ukas.buelens@ugent.be	**Ghent University**	Discusses integration of chemical looping to provide heat of reaction for super dry reforming of CO2 plus methane to CO. Developing an effective CO2 to CO conversion provides path for	127	6.0	7
3	Separations	Membrane Separations	8478951	**Commercial Demonstration and Operation of Energy Efficient Olefin-Paraffin Separations with Novel Optiperm™ Membrane System**	**Brandon Burghard, Email: bburghardt@compactmembrane.com**	**Compact Membrane Systems**	In continuing the commercialization of Optiperm™ membranes, CMS' has partnered with Braskem to jointly develop and fabricate a multistage pilot unit to test commercial scale spiral wound membranes in in a mixed	136	6.5	8
4	Reactions /Chemistry	New Ethylene Reactor/ Process developments	8478814	**Manufacture of Sustainable Ethylene from Captured CO_2**	James Middleton, Email: jim.middleton@ten.com	**Technip Energies**	LanzaTech and Technip Energies are combining their LanzaFlex™ syngas to ethanol and Hummingbird® ethanol to ethylene technologies for the	137	6.5	9
11			FUNDZ					0	#DIV/0!	

b. Decarbonization/Sustainability Session Update
    i. Chair: Chuck Polito
    ii. Co-Chair: Humera Rafique
    iii. Shadow: Kaleb Rollins

6 papers. Received OK from authors. Program has been finalized. All authors have agreed to write papers and presentations. The Nalco paper was added back in since the catalyst group pulled out. Other papers were released to general pool.

A general topics session has been added on Monday morning by the main committee. A total of 4 papers have been moved to this session. – Rob Fox/Aivars

All sessions are now online @ AIChE.

Seq.	Plant Area	Theme	AIChE/EPC Submission #	Title	Author	Company Affiliation	Summary of concept
4.1			678458	Electric Cracking Towers for Decarbonization and Optimization of Ethylene Production	Edwin Rodriguez	Purdue University	Ethylene is a fundamental building block of the chemical industry1, with over 150 million tons produced globally in 2021 and demand projected to exceed 255 million tons by 2035. Its list applications expand a wide range of fields including food packaging materials, electronics, medical sterilization, and even textiles. Despite its benefits, current ethylene production poses a major emissions challenge. About 1.3 tons of CO2 are released per ton of ethylene1, making it the second-largest CO2-emitting process in the chemical industry. If left unchanged, associated CO2 emissions may exceed 330 Mt by 2035, comparable to the total annual emissions of 72 million cars or a major industrialized nation. This trajectory conflicts directly with global decarbonization efforts like U.S. goals to cut greenhouse gases ~50% below 2005 levels by 2030 and reach net-zero emissions by 20502. The major source of CO2 emission in ethylene production is the prevalent use of Flame-heated Tubular Crackers (FTCs) powered by fossil fuel combustion3. In response to this challenge, this research presents the concept of Electric Cracking Towers (ECT), a system to decarbonize ethylene production while offering additional operational advantages4. ECTs employ internal staged electric heating elements along the length of the reactor. This heating strategy enables precise temperature control and eliminates the need of parallel tubes for scaling. Furthermore, by tailoring the amount of heat at each element, ethylene yield can be maximized, while undesired side reaction and hot spots reduced. Powered by low-carbon electricity, ECTs could reduce the carbon footprint of ethylene production by over 95%. Even using today's U.S. electricity mix, associated CO2 emissions could be reduced by ~8%. By substituting combustion
4.6			678541	Maximizing Olefin Yields for Steam Cracking of Plastic Waste Pyrolysis Oils: An Experimental and Modeling Study	Tamás Buzogány	Ghent University	Chemical recycling of plastic waste is expected to grow exponentially in the coming decades [1]. Global legislation pushes for increasing the circularity of plastics [2], and mechanical recycling is not robust enough to handle highly mixed plastic waste streams. Therefore, chemical recycling is the favored route, in particular, plastic waste pyrolysis. This process produces as the main product an oil that can be used to (partially) substitute fossil-based feedstocks to produce light olefins, with steam cracking being the most important process. The primary concern of utilizing pyrolysis oils in existing steam crackers is the substantial difference between those synthetic oils and fossil-based feedstocks for which steam crackers are originally designed. Specifically, the high concentration of heteroatom-containing contaminants and up to 60% of unsaturated hydrocarbons [3-5] in typical pyrolysis oils will affect the operation and yields of steam crackers. Today, there are strict specifications on the degree of contamination for steam cracker
4.6			678753	Pre-Investment in Ethylene Plant Design for Future Decarbonization	Melanie O'Sullivan	Lummus Technology	Ethylene production generates more than 260 million metric tons of CO2 each year. As global ethylene demand and capacity continues to grow, decarbonization of this process will become critical to achieving emissions goals. While making this change is imperative, it may be a challenge to implement today based on the uncertainty or nonexistence of carbon tax credits. This presentation will review Lummus' Carbon Capture Ready Design, which can be applied to a grassroots cracker today for decarbonization of the future. This concept considers certain pre-investment steps to minimize CO2 generation during current operation by minimizing fuel firing and maximizing electrification by means such as combustion air preheating and Lummus' Hybrid and Electric Heaters (SRT-h/SRT-e). The Carbon Capture Ready Design also considers pre-investment to easily facilitate the implementation of carbon capture in the future. This paper will review the economic and emissions impact of the Carbon Capture Ready Design on current operation without carbon capture and future operation with carbon capture.
4.8			679684	Developing the Circular Economy: Advances in Advanced Recycling	Dave Smith	Nalco Water, An Ecolab Company,	As Advanced Recycling continues to advance, the feedstocks produced from the various chemical recycling processes can provide challenges for recyclers, chemical manufacturers, and refineries to produce and process. The purpose of this paper is as follows: Present the results of extensive laboratory testing of various recycle plastic feedstocks. Detail some of the potential challenges faced in producing and processing feedstocks derived from recycled plastic. Discuss solutions that address these challenges to improve feedstock quality and reliability and reduce the potential negative impacts of producing and processing recycle feedstock.
5.0			677788	Nuscale Power Corporation Small Modular Reactor (SMR) Technology	Kaleena Fisher	Fluor Corporation	NuScale Power Corporation is a small modular reactor (SMR) technology company established in 2007 of which Fluor Corporation became the lead investor in 2011. They have designed the fully factory fabricated NuScale Power Module (NPM), each with the capacity of generating 77 MWe of electricity (gross). The advantage of SMRs as compared to typical pressurized water reactors is that they can operate more safely and can passively get to a safe cooled down state using natural convection without using pumps, external power or external water. SMRs also provide scalable power production by providing options for 4, 6, or 12 NPMs. The NPMs are capable of black start and load following.
5.7			678822	Reformulated Feeds Cracking to Produce Olefins	Kandasamy Sundaram	Lummus technology	Petrochemical industry is moving to reduce green house gas emissions and sustainability. Instead of fossil feeds, ethylene industry is looking for alternate sources. Biofeeds in general and vegetable oil in particular is an excellent feed to produce olefins. In this paper feed characterization and contaminants removal will be discussed using CLG's ISOTERRA process. Vegetable oil and other bio feeds can be converted to hydrogenated vegetable oil (HVO), a generic term used for bio feeds. Cracking HVO feed and its impact on existing ethylene plant performance will be discussed.
5.8			676835	Unconventional and Sustainable Production Routes to Olefins	Christopher Dziedziak	The Catalyst Group	The focus of recent R&D and commercial developments for novel processes and catalysts for olefins production goes well beyond traditional thermal steam cracking, fluid catalytic cracking (FCC) and propane dehydrogenation (PDH) routes, to include numerous unconventional, green, and circular approaches. These routes include, but are not limited to, utilization of biomass or waste plastic, renewably produced methane and syngas, direct CO2 conversion, and the electrification of reactors. All these approaches must address certain critical factors affecting technology viability, notably the CO2 footprint, lifecycle analysis, and overall sustainability in a move towards NetZero2050, and of course favorable economic conditions. This presentation first establishes the state-of-the-art of the conventional olefins landscape, discussing any notable improvements in steam cracking and the growing utilization of on-purpose propylene technologies. The core of the presentation discusses the improvements and discoveries made to unconventional catalytic olefins production methods including direct methane/C1 conversion, biomass and recycled waste, electrification, and CO2 utilization, as
6.4			678750	Ethylene Production and Decarbonization Strategy Using Oxidative Coupling of Methane	Balaji Krishnakumar	Lummus Technology LLC	Oxidative Coupling of Methane (OCM) upgrades low-value methane-rich feedstock into high value petrochemicals. Latest improvements in Lummus' Gemini® OCM technology bring it closer to commercial deployment on a cost-competitive basis. It also offers an avenue for reduction in CO2 emissions. OCM can be deployed in a stand-alone mode using natural gas and gas liquids as feedstock; integrated with a Gas Plant; integrated with a steam cracker; or utilize CO2 as a feedstock. Different process schemes can be employed for OCM when external H2 source, particularly from a green source such as electrolysis is available, CO2 itself can be used as a feedstock to produce green ethylene using OCM. Some of the salient features of this technology and the different flow schemes will be discussed in this paper.
6.4			678557	Imtex's Permylene Membrane Separation Technology - Transforming Olefin Extraction and Purification for the Petrochemical and Refining Industries	Jamie Hughes	Imtex Membranes	Imtex's Permylene membrane separation technology transforms olefin extraction and purification for the petrochemical and refining industries. Imtex' membrane technology provides a profitable, high-performance, energy efficient alternative to traditional distillation techniques for olefin-paraffin and olefin-nitrogen separations. Permylene seeks to evolve core olefin processes by debottlenecking, decarbonizing and electrifying olefin separation. Permylene focuses on olefin recovery from polyolefin vent/purge processes, olefin recovery from raffinate streams, and novel propylene upgrading for process debottlenecking, energy savings and greenhouse gas reduction. Imtex Permylene is nearing its goal for full commercializing – in late 2022, Imtex sold its first commercial technology license to a Top 15 Global petrochemical industry player.
7.1			678975	Ete Evergreen™, a Proven Route to Low Carbon Intensity Ethylene	Scott Neifert	Lummus Technology	An overview of the Ethanol-to-Ethylene technology licensed by the partnership between Braskem and Lummus. The presentation includes a technology overview, the economics of using ethanol as ethylene feedstock, and strategies for upgrading ethanol to sustainable materials. The ETE technology and the economics of using ethanol as a feed will be presented.

Three paper from Fundamentals session and four papers from Decarbonization/ Sustainability session are not selected and will be sent to the main committee to see if another session is possible.

Selected papers authors will be contacted for re-confirming their acceptance to present.

Next meeting will be on Feb 1, 2024.

c. Guidelines from Main Committee

Dear Session Chair/Co-Chairs

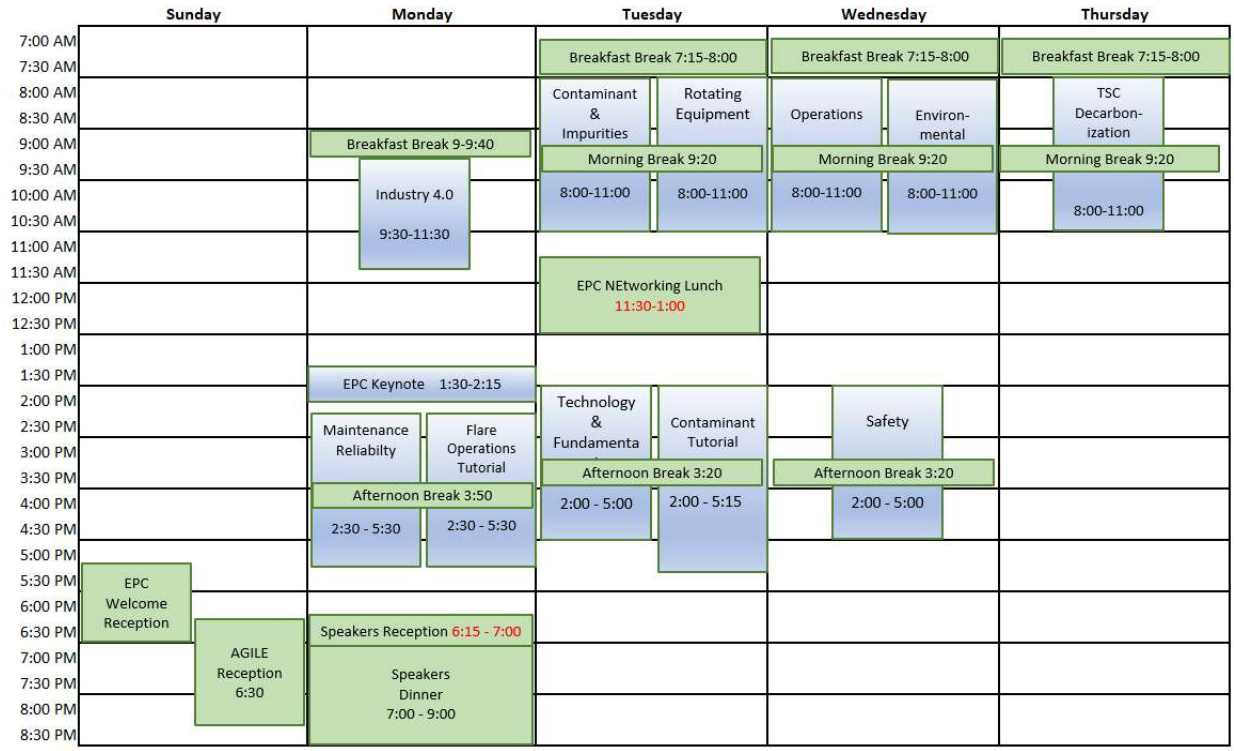
I would like to take this opportunity to thank everyone for their contributions to the upcoming 2024 Ethylene Producers Conference in New Orleans, March 24,28, 2024. As we approach December 11 target date for accepting papers in Confex, this would be a good time to select the order that you want the papers to be presented.

Monday, December 11, 2023	Chairs Accept/Reject Abstracts & Order Sessions
Monday, January 8, 2024	Draft Program Available for Review
Friday, January 12, 2024	Comments from Chairs Due
Friday, January 12, 2024	All info in Confex for Invited Sessions & Keynotes
Wednesday, January 15, 2024	Final Program Posted
Sunday, March 10, 2024	Paper Submission Closes
Sunday, March 24-28, 2024	2024 AIChE Spring Conference

Attached to this email are three documents to share with your authors on formatting the papers and presentations. Some key points to consider for the PowerPoint include,

- Only PowerPoint Presentations may be used,
- Use widescreen (16:9) aspect ratio,
- Avoid font size less than 24,
- Slides should be simple and not busy,
- Try to keep the number of words in a bullet to less than 5, and not more than 7 bullets on a slide,
- Copyright statements or legal disclaimers are fine, but wording indicating “Confidential” , “Proprietary”, “Private”, etc. are not allowed.

The following is the latest draft schedule for the week of the conference.



Feel free to contact me if I can be of any further assistance.

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