FINAL Minutes of December 5, 2019 Ethylene Producers' Environmental Sub-Committee Meeting
(December 5, 2019, Rev. 1)

Following are the minutes of the December 5, 2019 Ethylene Producers' Environmental Sub-Committee Meeting, held face-to-face and via teleconference with Mark Ulrich, Linde Engineering, as host.

Present: David Elam, TRC Solutions [on phone]
Brandon Lithgoe, NOVA Chemicals [in person]
Andrés Muñoz Gandarillas, Neste [on phone]
Walter Postula, Shell Global Solutions (US) Inc. [in person]
Mark Schmidt, Dow [on phone]
Mark Ulrich, Linde Engineering North America [in person]
Gary Wojnowski, BASF [on phone]
Mike Marino, Linde Engineering North America [in person] – Attending at Mark U.'s invitation

Absent: Rick Beleutz, LyondellBasell
Benjamin Burns, SASOL North America
Ahmad Hamad, Siemens
Ted Heron, The Catalyst Group
Jacob Hilbrich, ChevronPhillips
Brad Hopper, BASF
Patti Long, Eastman
Dan Lutz, Ineos
Arijit Pakrasi, Edge Engineering and Science
Jennifer Port, ExxonMobil Chemicals
Gerardo Ruiz-Mercado, US EPA (AIChE Environmental Division)
Jeffrey Seay, University of Kentucky (AIChE Environmental Division)
Debalina Sengupta, Texas A&M (AIChE Environmental Division)
Dick Siegel, R&B Consulting Services (AIChE Environmental Division)
Edward Soliz Jr., SASOL North America
Russell Wozniak, Dow

The meeting began at 9:02am with Walter Postula reading the Ethylene Producers' Committee (EPC) anti-trust statement:

> No activity of the committee shall involve the exchange, collection, or dissemination of information among competitors for the purpose of bringing about or attempting to bring about an understanding or agreement, written or oral, formal or informal, express or implied, among competitors, with regard to costs, prices, 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.

The meeting agenda was published in advance and is included below:

1) Reading of Anti-Trust Statement [9:02 AM]
2) Status of Potential Papers for Environmental Session [9:10 AM]
    . Update to RTR/EMACT – Steve Smith (LyondellBasell) – Double time slot. Abstract uploaded.

a. Electro-oxidation, ZimCad, and/or activated carbon in waste water treatment (topic from Ahmad Hamad, Siemens). Abstract uploaded.
b. Renewable naphtha/diesel as feedstock for producing bio-ethylene/-propylene (topic from Andrés Muñoz, Neste)
c. Zero flaring / Flare Management Plans – Linda Bartlett
d. Update on SCR (NOx removal) operation?
e. CEMS on furnaces – Dave Elam plans to submit abstract on topic of Electronic Reporting
f. CO2 reduction – LyondellBasell presentation on "circular steam" will be pursued if needed.

3) Status of Panel Session – "Ethylene Flare System Challenges and Technical Options relating to recent/on-going EPA Consent Decrees" [9:40 AM]
    . Topic dropped for 2020. Will pursue again in 2021.
4) Decision on Abstracts to Include in Environmental Session [9:45 AM]
5) Review of Action Items [9:55 AM]
6) Important Date Reminders
    - June 21, 2019 – Call for abstracts opens
    - November 22, 2019 – Call for abstracts closes
    - December 13, 2019 – Papers accepted or rejected
    - January 17, 2020 – Program goes live
    - March 6, 2020 – Paper submission closes
    - March 30 – April 2, 2020 – Spring Meeting – Houston, TX
7) Adjourn [10:00 AM]

Status of Potential Papers for Environmental Session: Postponed this discussion until agenda item 4.

Status of Panel Session: Was quickly noted that the Main Committee dropped this topic for 2020 at the Committee meeting on October 10th. Supported revisiting topic again for 2021 when more producers may be willing to participate.

Decision on Abstracts to Include in Environmental Session: Brandon led discussion by presenting his thoughts on relevance/interest of abstracts that were circulated in the PDF file prior to the meeting. The abstract list is attached in the Appendix. The five that Brandon identified (and were agreed to by those present) are given below.

1) Steve Smith – Ethylene Risk and Technology Review: What's the Outlook?
2) Linda Bartlett – Flaring Enforcement into the Next Generation Flare Rule Making: Flare Management Plans and Beyond
3) Andres E. Muñoz G. – Increasing Sustainability of the Steam Cracking Industry through Drop-In Renewable Feedstock
4) David Elam – Electronic Reporting Requirements for the Proposed Ethylene Production Maximum Achievable Control Technology Standard (EMACT)
5) Troy Boley – Down the Road-The Future of Ground Flares and AMELs

Those that were deferred were either multiple submissions from the same company or relevance to ethylene manufacture not clearly established. Brandon will communicate with all authors on status. For those not selected, Brandon will give author choice to be held in Environmental for 2021 or released in the general paper pool (potential to be picked up by another EPC subcommittee or another AIChE session).

The papers were ordered for the session as follows.

1) Steve Smith – Ethylene Risk and Technology Review: What's the Outlook? [50 min]

2) Linda Bartlett – Flaring Enforcement into the Next Generation Flare Rule Making: Flare Management Plans and Beyond [25 min]

BREAK [20 min]

3) David Elam – Electronic Reporting Requirements for the Proposed Ethylene Production Maximum Achievable Control Technology Standard (EMACT) [25 min]
4) Troy Boley – Down the Road-The Future of Ground Flares and AMELs [25 min]
5) Andres E. Munoz G. – Increasing Sustainability of the Steam Cracking Industry through Drop-In Renewable Feedstock [25 min]

Mark Schmidt reminded the subcommittee that the Environmental session is scheduled for Wednesday (April 1, 2020) morning.

Review of Action Items: **Brandon Lithgoe** will communicate with all authors on status. For those not selected, Brandon will give author choice to be held in Environmental for 2021 or released in the general paper pool (potential to be picked up by another EPC subcommittee or another AIChE session). **Brandon** will accept/reject abstracts and order in Confex.

Important Date Reminders: The dates provided in the agenda were reviewed.

Adjourn: The meeting/teleconference was closed at 9:46 am.

APPENDIX

Down the Road: The Future of Ground Flares and AMELs

Troy Boley – Vice-President, Spectrum Environmental Solutions LLC

Facilities using pressure-assisted multi-point ground flares have requested Alternative Means of Emissions Limitations (AMELs) from the U.S. EPA to operate above the limits on exit velocity found in the General Provisions and Refinery Sector Rule. On October 9, 2019, the U.S. EPA proposed amendments to the Ethylene Maximum Achievable Control Technology (MACT) standards. These proposed changes include a new set of compliance requirements for ground flares without the need to request an AMEL. This presentation will review the new requirements for ground flares found in the Ethylene MACT draft rule. The presentation will also discuss how these proposed changes could affect ground flares in other sectors and the future of the AMEL process.

Proposed Ethylene MACT Flare Requirements

Herman Holm – Director, Spectrum Environmental Solutions LLC

New regulations requiring improved monitoring and control of flares at petroleum refineries are starting to be passed along to other manufacturing sectors. In October 2019, the U.S. EPA proposed amendments to the Generic Maximum Achievable Control Technology Standards for Ethylene Production (EMACT). Among those amendments are new monitoring and operational requirements related to flares at ethylene production facilities. This presentation will summarize the new flare requirements and will draw heavily on the lessons learned from implementing the similar flare requirements in the refining sector.

Flare Instrumentation – Minimum Expectations

Derek Stuck – Project Manager, Spectrum Environmental Solutions LLC

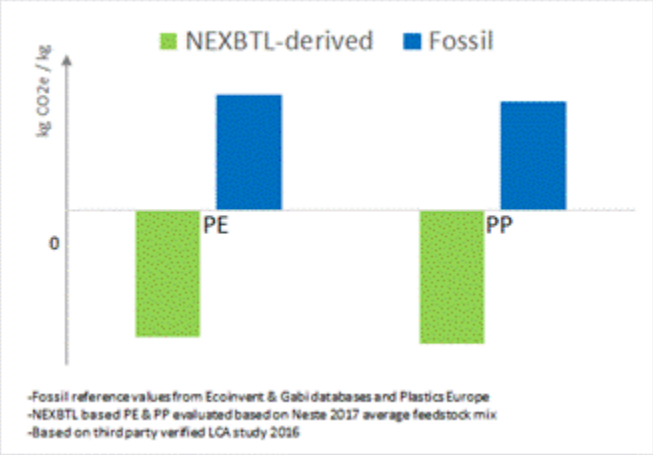
As the U.S. EPA begins expanding the flare requirements first found in the Refinery Sector Rule to other industries, newly affected facilities need to begin planning the installation of new monitoring on covered flares. This potentially includes pilot monitoring, visible emissions monitoring, vent gas flow monitoring, assist gas flow monitoring, and net heating value and/or composition monitoring; all of which will be required to meet the new requirements. This presentation will summarize the monitoring required by the new flare requirements and describe some of the technologies which may be used to comply with the regulations' requirements.

Increasing Sustainability of the Steam Cracking Industry through Drop-in Renewable Feedstock

Andres E. Muñoz G. – Manager-Production Partnership Management, Neste

It is a known fact that the demand for polymers and chemicals is increasing at a high pace, with studies predicting that demand for polymers will roughly double within the coming 15 years. In order to meet this demand, several investments in new capacity for the production of olefins and subsequent products are

being made at a global scale. Consequently, ever-increasing amounts of fossil resources are being utilized, which puts additional strain on the environment.
Steam cracking is already a mature process, and revolutionary technologies are rather scarce in the field. In this context, with the aim of improving the environmental footprint of the process and its products, sustainable feedstock usage is one of the most straightforward, beneficial and scalable solutions readily available for cracker operators.
In this paper, technical aspects of Neste's renewable hydrocarbons are discussed, focused on their suitability as a drop-in steam cracker feedstock, as well as their sustainability record and environmental impact, which is typically evaluated by means of a life-cycle assessment (LCA). It has been determined that the environmental benefit offered by bio-based Polypropylene (PP), produced using steam-cracker-based propylene is substantial [1]. Calculations indicate up to 80% lower CO_2 eq. compared to conventional fossil PP [2].



Flaring Enforcement into Next Generation Flare Rule Making: Flare Management Plans and Beyond

Linda Bartlett – Principal Consultant, Environmental Resources Management
Brian Woodbury – Senior Consultant, Environmental Resources Management

Flaring has been a focus for EPA enforcement for several years. Regulations are now catching up with the Consent Decrees and the National Enforcement Initiative to cut Hazardous Air Pollutants (HAPs). Clean Air Act 114 information requests are now extending into other industries beyond refining including chemicals operations. These non-refinery operations can learn from the refinery journey and potentially stay a step ahead of coming regulations.
An early step in this next generation of flaring regulation is focused on refineries under Title 40 Code of Federal Regulations Part 60, New Source Performance Standards Subpart Ja (NSPS Ja) and Part 63, National Emission Standards for Hazardous Air Pollutants Subpart CC (NESHAP CC). Refineries are required to prepare and submit a lengthy, in-depth flare management plan (FMP) which prescribes how the facility will minimize flaring. ERM has been working with multiple refiners and chemical manufacturers on their flare management plans. In this process, ERM has identified key lessons which will be summarized in this presentation. ERM's experience will provide historical context and "lessons learned" to the ethylene industry as they prepare for adapting to new proposed standards similar to refinery NSPS Ja and NESHAP CC. Examples of the lessons learned include:

- how to actively engage facility stakeholders to ensure understanding, particularly for developing minimization procedures;

- implications with multiple process units on a single flare header for minimization and alternate baseline flow rates,
- why and how summarized startup and shutdown procedures can be used; and
- important options to consider for monitoring such as sample conditions (wet or dry analysis).

Furthermore, with continued EPA and state enforcement pressure around flaring, ERM will present the following ideas on how to maintain compliance after the flare management plans have been submitted:

- programs and procedures needed to maintain an evergreen plan in a continuously changing facility environment,
- potential cost savings around plan structure and management,
- incorporation of minimization procedures into current operating procedures, and
- potential "red flags" associated with the content submitted in the FMP such as baseline flow compared against the production capacity.

Chemical manufacturers may want to consider a proactive review of flaring operations with respect to the journey that refineries have traversed. Actions taken now can position manufacturers not yet subject to such rigorous flaring regulations for coming capital and operating needs, and potentially reduce operating costs by enacting good flaring practices.

Electronic Reporting Requirements for the Proposed Ethylene Production Maximum Achievable Control Technology Standard (EMACT)

David Elam – VP-Project Director, TRC

On October 9, 2019, EPA proposed Maximum Achievable Control Technology (MACT) Standards for Ethylene Production (National Emission Standards for Hazardous Air Pollutants: Generic Maximum Achievable Control Technology Standards Residual Risk and Technology Review for Ethylene Production). An important requirement of the proposed rule is electronic reporting using EPA's Compliance and Emissions Data Reporting Interface (CEDRI). Specifically, the proposed rule requires that Notices of Compliance Status (NOCS), Flare Management Plans (FMPs), and any emission tests performed using test methods that are supported by EPA's Electronic Reporting Tool (ERT) be submitted through CEDRI. CEDRI is accessible from EPA's Central Data Exchange (CDX).
CDX supports the requirements of EPA's Cross-Media Electronic Reporting Rule (CROMERR). The CROMERR program is intended to ensure the enforceability of regulatory information collected electronically by EPA and EPA's state, tribal and local government partners. Accordingly, understanding CEDRI reporting requirements is fundamental to compliance should electronic reporting remain in the final rule.
This presentation will provide an overview of CROMMER and CDX, review the specific CEDRI reporting requirements of the proposed rule, and outline the registration and reporting process for CEDRI.

The Proposed Ethylene Production NESHAP and Potential Complications with Reclaimed Water Use

William Celenza – Senior Technical Advisor-Environmental, KBR Inc.
Sarah Shank – Engineer, SES Inc.

Volatile Organic Compound (VOC) emissions from industrial cooling tower systems can occur due to corrosion or cracking of a heat exchanger's internal tubing material, allowing some process fluids to mix with or become entrained in the circulating cooling water. VOCs in the process fluids may subsequently be released from the cooling water into the atmosphere when the water is exposed to air. The Ethylene

Production National Emission Standard for Hazardous Air Pollutants (NESHAP) includes heat exchange or cooling tower systems as emission sources at ethylene production facilities. Under this standard, an Ethylene Production Maximum Achievable Control Technology (EMACT) identifies work practices that specify monitoring and Leak, Detection and Repair (LDAR) to control potential heat exchange system VOC air emissions. In September 2019, the EPA proposed EMACT amendments for heat exchange systems that would further reduce potential air emissions. A leak action level is to be defined using the Modified El Paso Method for Determination of VOC Emissions from Water Sources. The resultant action level is equivalent to less than 1 ppmw of strippable VOC in the return cooling water. Since the monitoring point for this proposed EMACT is only after the heat exchanger(s) in the system, organics in makeup water, such as from a reclaimed/recycled water source, are not factored in as a background concentration and would be counted toward compliance. This paper presents an analysis of the impact this proposed EMACT may have on options to use reclaimed water sources for cooling water makeup at ethylene production facilities subject to this standard.

Ethylene Risk and Technology Review: What's the Outlook?

Steve Smith – LyondellBasell

Per the court-mandated timeline, the EPA is currently working through the statutorily-required risk and technology review (RTR) for the ethylene NESHAP (40 CFR, Part 63, Subpart XX and Subpart YY) process. The proposed rule was published in the Federal Register October 9, 2019, and will impact current ethylene operations. The proposed rule mirrors certain aspects of the refinery rule, such as the flare, heat exchange systems and PRD refinery language, decoke emissions (both decoke to the fire box and decoke to an atmospheric pot) and waste water emissions.
This paper will discuss the proposed rule and the potential impact on the ethylene facilities.

A Novel Approach of Converting Industrial Wastewater into Energy

Chad Felch – Technology & Innovation Manager, Siemens Energy Inc. Water Solutions
Bryan Kumfer – Lead Research Engineer, Siemens Energy Inc. Water Solutions

Many industries use complex production processes that result in high-strength, hard-to-treat wastewaters. Examples include oil and gas refining, petrochemicals, and pharmaceuticals. Their wastewaters may vary in composition, but they typically have at least one of these problematic characteristics: high levels of biorefractory compounds; toxic compounds; halogenated organics; and aromatic or aliphatic hydrocarbons.
In addition, their chemical oxygen demand (COD) levels can range widely, up to 300,000 mg/l. On top of that, some process waters/wastewaters have high salt levels, especially chlorides, requiring expensive materials of construction, making cost-effective treatment especially challenging.
Existing treatment solutions for these high-salt wastewater streams are typically incineration or gasification. The former combusts the wastewater completely in the presence of excess oxygen at 1,100°C (2,012°F), producing carbon dioxide, water, and salts. The latter burns the wastewater using stoichiometric oxygen to produce carbon monoxide and lesser amounts of hydrogen. In turn, these gases can be processed into more useful fuel gases. Unfortunately, both processes are expensive, especially their energy costs. Also, high-temperature processes can be expensive to maintain, requiring backup units that consume capital, operating expenses, labor, and space.
Given these challenges, this presentation will focus on hydrothermal gasification to handle wastewaters that cannot be economically treated with other oxidation technologies. It uses a heterogeneous catalyst to spur reactions similar to those that typically occur in steam reforming and gasification. These

reactions occur in an aqueous phase, so temperatures are much lower than what gas-phase gasification processes require. This paper will provide data on treatment for organics and chlorides; propylene oxide/styrene monomer (PO/SM) wastewaters; produced waters containing kinetic hydrate inhibitors (KHI); and propylene glycol wastewaters.

The benefits of catalytic gasification will be explained. They include fuel-gas production, providing data of gas composition for different types of compounds treated; high COD destruction rates, helping reduce downstream treatment costs; capital and energy savings, due to a lower-temperature process; and saving space, relative to other oxidation treatment approaches.