Methane to Ethylene: Drivers, History, Challenges, and Current Developments

Bob R. Maughon
Vice President, Performance Plastics and Hydrocarbons R&D
The Dow Chemical Company

March 7, 2016
The Plastics Wave

Growth in Global Plastics Production

Note: Production from virgin petroleum-based feedstock only (does not include bio-based, greenhouse gas-based or recycled feedstock).
Ethylene Cumulative Supply - 2003

Cash Cost for Ethylene ($/metric ton)

Cumulative Capacity, million metric tons/yr

Source: IHS, Morgan Stanley, ICIS
Volatility Begins to Increase and Drive Concern...
Olefin Routes Urgently Explored in this Period

Syngas / MeOH

Avoid syngas

Avoid intermediates
(methane coupling)
The Dow Methane Challenge
Dow Methane Challenge Proposals
Methane Coupling – A Potential Solution?
A mixture containing a valuable chemical is not the same as a valuable mixture of chemicals.
Shale Gas Drives a Disruptive Market Change

Cash Cost for Ethylene ($/metric ton)

Cumulative Capacity, million metric tons/yr

from disadvantaged to advantaged

source: IHS, Morgan Stanley, ICIS
Dow Investments Aligned Advantaged Feeds

USGC Investments
Performance Packaging Markets

Sadara
Performance Packaging and Performance Mat Markets

Creating the Foundation for Global Growth for Years to Come
Falling Oil Prices – How Should We Respond?

Cash Cost for Ethylene ($/metric ton)

Cumulative Capacity, million metric tons/yr

- Middle East
- North America
- Europe
- Asia

Source: IHS, Morgan Stanley, ICIS
Recent News/Current Trends

Siluria Technologies

Newlight Technologies

Calysta

Methane to Ethylene over the Lattice-confined Single Iron Site
Siluria Technologies – Oxidative Coupling

Natural Gas
Air or Oxygen
Ethane (optional)

OCM
oxidative coupling of methane

Purification/Separations

Purity Ethylene
Power (optional)

ETL
ethylene to liquids

Gasoline
Aromatics
Distillates (diesel/jet)
Condensates

15
Improved Siluria’s Cash Cost (based on new ranges from presentation)

- OCM only: $405/MT$_{C2H4}$ ($385-$425/MT$_{C2H4}$)
- OCM + ASU: $340/MT$_{C2H4}$ ($315-370/MT$_{C2H4}$)
Separation Breakthroughs are Essential to a Step Change in Existing and Alternative Options

Cryogenic Separations
*(large capital cost, energy intensive)*

Energy Use
- separation: 31%
- compression: 22%
- cracking: 47%

Alternatives
- Membrane Separations
- Adsorbent Separations

LHC-8 Freeport, TX

Splitter column >200 ft tall

Ethane Cracker Specific Energy Consumption
Future for Methane and Alternative Feedstocks

• The barriers to implementation (capital, CO₂, C-efficiency/selectivity, separations) are significant

• Success will require:
  ➢ Breakthrough in catalysts, processes, and separations
  ➢ Fundamental technology development
  ➢ Industry / Government / Academic partnerships
  ➢ Consistent, sustained focus

• We may not be good at predicting the future, but we need to be prepared for it.
Questions for the Methane to Ethylene Sub-Group

• What are the impedance to commercial viability of methane to ethylene?

• What are the top 2-3 well-established research approaches to making ethylene viable and what are the challenges associated with them?

• What are some promising but higher risk novel approaches being undertaken?

• What are the research opportunities that exist (new tool, scientific advancements, etc.)?

• *If there is time in the discussion
  What should researchers be aware of in terms of industrial requirements and environmental constraints for new approaches to the utilization of natural gas?
Improved Siluria’s Cash Cost (based on new ranges from presentation)

- OCM only: $464/MT_{C_2H_4} ($443-$485/MT_{C_2H_4})
- OCM + ASU: $447/MT_{C_2H_4} ($430-470/MT_{C_2H_4})