

# Understanding the Global Petrochemical Industry

A 3-day in-depth training course



## Master Petrochemical Industry Fundamentals.... Make Better Business Decisions

This 3-day in-depth course provides basic information and insights into the Petrochemical Industry. The course covers industry fundamentals, changing feedstock slates, process technology, marketing dynamics, and profitability drivers.

In addition to covering the basics, the course will discuss how the volatile oil prices are impacting decisions around the world, from shale gas in North America, to coal in China, to ethane imports in Europe.

It is important to understand the basic industry drivers and how they affect your business, so you can make better, more informed business decisions.

**CPE credits available. For more information, visit: [ihs.com/chem-edu](http://ihs.com/chem-edu)**

### Who should take this course?

The three-day course is designed for both technical and non-technical professionals, those new to the industry, and those who would like a refresher course. Attendees represent a wide range of job functions and types of companies.

### Job function

- Business managers
- Process engineers
- Financial analysts/accountants
- R&D chemists
- Licensing managers
- Strategic planners
- Purchasing agents
- Sales and marketing executives
- HR and legal managers

“Excellent class! Dr. Jeff has a great understanding of the chemical industry and can explain it in an easy-to-understand way. I will recommend this class to my colleagues.” **Rick Evans, National Market Manager- Americas, Kuraray America, Inc.**

### Company types

- Petrochemical companies
- Oil and gas companies
- Plastics Fabricators and Converters
- Compounders and formulators
- Specialty and performance chemical companies
- Biotech start-ups
- Industrial gas companies
- Technology licensing companies
- Commercial and investment banks
- Private equity and venture capital firms
- Law firms

“Course is informative and useful, Jeff is a great speaker and can keep things fluid and interesting.” **Emilio Planas Rego, Marketing Analyst, Braskem**

## 2016 Course Schedule

Houston.....	Feb. 23-25
London .....	April 5-7
New York.....	April 12-14
Jubail.....	May 16-18
Houston.....	June 21-23
Singapore .....	July 12-14
Shanghai .....	Aug. 10-12
New York.....	Sept. 13-15
London .....	Sept. 20-22
Houston.....	Oct. 18-20
Frankfurt.....	Nov. 8-10
Beijing.....	Dec. 6-8

### About the Instructor



Dr. Plotkin has over 30 years experience in the petrochemical industry working for operating companies and consulting firms. Before joining IHS to head up training and education, Dr. Plotkin was Vice President of Nexant/Chem System's training programs.

He is co-author of the textbook, “Industrial Organic Chemicals, third edition” (Wiley Interscience, 2012) and contributing editor of American Chemical Society's “Patent Watch” on [www.chemistry.org](http://www.chemistry.org). Dr. Plotkin holds 30 US patents and is the author of over 25 publications in peer-reviewed journals.

He holds a PhD in organometallic chemistry from University of Pennsylvania, an MBA from PACE University, and was a post-doctoral research fellow at Ohio State University.

# Understanding the Global Petrochemical Industry

## Day 1 Morning Session

### 9:00 am Introduction to Petrochemicals

"This is the most exciting time to be in the industry as there is so much change. And with change comes opportunity - if we have a good understanding of the industry dynamics driving this change" – Dr. Jeff

#### Regional Overview – "A Trip Around the World"

- **North America** – Shale gas reinvigorating the industry, but will low oil prices put the brakes on this?
- **Western Europe** – Good food, good wine, good beer, but no cheap feedstocks!
- **Russia** – lots of oil and gas but lacking infrastructure
- **Middle East** – A region in transition - going downstream to create jobs, but coping with higher feedstock costs
- **Asia** – China the engine of growth, but slowing – Using coal to invent and re-invent the future
- **South America** – Industry is reorganizing – Brazil leading the way in "green" chemicals

#### Understanding Petrochemical Feedstocks

- **Natural gas** – including an extensive discussion of shale gas. Learn about the concept of "stranded" gas and how this has created pockets of regional advantage in the olefins business
- **Natural gas liquids (NGLs)** – ethane, propane, butanes, condensates – each with their own uses and price drivers – learn how all of this impacts the petrochemical industry
- **Oil** – naphtha, middle distillates, heavy oil – extensive discussion about how refining intersects with petrochemicals and the benefits of refinery/petrochemical integration
- **Coal** – learn how China is leveraging cheap coal using old historical processes but also innovating new approaches as well
- **Renewables** – will bio-based routes to "petrochemicals" make an impact? Come find out about the opportunities and challenges

### 10:30 am Coffee Break

### 10:50 am Introduction to the Olefins Business

Introducing ethylene, propylene, and the C<sub>4</sub> olefins (butadiene, n-butenes, isobutylene) – chemical structures, physical form, sources, logistic issues, trade balances, key players, and value chains

#### Ethylene – The Largest of the Building Blocks

- **Steam Cracking** – a detailed look at the "heart and soul" of the petrochemical industry. Learn how Carbon Petroleum Dubbs put the "steam into steam cracking"
- **Methanol to Olefins (MTO)** – Finally commercial! Is this a game-changer? Will MTO grow outside of China?
- **"Green" Ethylene from Bioethanol** – A great example of Dr. Jeff's theory of "Reverse Process Economics"

### 12:30 pm Lunch

## Day 1 Afternoon Session

### 1:30 pm Propylene – The Second Largest Building Block, but the Fastest Growing Olefin

- Unlike ethylene, three grades: polymer grade, chemical grade, and refinery grade
- Steam cracker co-product – the largest source, but shale gas causing a reduction – learn why
- Propylene from FCC units – refineries coming to the rescue
- On-purpose propylene – Mind the gap! – Propane dehydrogenation (PDH), olefin metathesis, enhanced FCC, olefin cracking, methanol to propylene (MTP), and "green" propylene

#### The C<sub>4</sub> Olefins – Butadiene, Butene-1, Butene-2, and Isobutylene

- C<sub>4</sub> disposition – recycle co-crack or separate for chemical use
- Separating the C<sub>4</sub>'s – not straightforward, must use our "bag of tricks" – learn how and understand what raffinate-1 and raffinate-2 are all about
- **Butadiene** – steam cracker by-product, but once again shale gas is hurting this source. Will on-purpose butadiene technology proliferate?
- **n-Butenes (butene-1/butene-2) and isobutylene** – from both steam crackers and FCC units -competing with gasoline use

### 3:00 pm Coffee Break

### 3:20 pm Olefin Economics

**Cost of production methodology** – learn how costs are built-up in the petrochemical industry

- Capex versus opex
- Raw material costs
- Utility costs
- By-product credits
- Variable or incremental costs
- Fixed costs – labor, maintenance, etc.
- Selling, general & administrative costs
- Cash costs
- Cash margins
- ROI

**Ethylene Economics** – a case study comparing the costs of an ethane cracker versus a naphtha cracker. Regional costs are compared over the 20 years. Understand the huge Saudi advantage stemming from \$0.75/MM Btu gas. The concept of cost curves is introduced and a global cost curve for ethylene production is presented and discussed.

**Propylene and Butadiene Economics** – Both propylene and butadiene are for the most part by-products. This feature complicates the methodologies used to assign costs to these two important olefins. Various approaches will be discussed and illustrated.

**Overview of the Olefin Markets** – To close out Day 1, an overview of the markets and value chains of the ethylene, propylene, and C<sub>4</sub> olefins will be presented. Detailed discussion of the individual olefin derivatives will be presented later in the course.



## Day 2 Morning Session

### 9:00 am **Introducing Benzene, Toluene and the Xylenes – Taking the Complexity out of Aromatics Complexes**

Chemical structures, physical form, logistic issues, trade balances, key players, and value chains. Simplifying aromatics complexes – separations techniques, and rebalancing supply/demand via isomerization and interconversions

#### **Benzene – The Largest of the Aromatics**

- Learn how benzene limits in gasoline around the world are impacting benzene supply
- Understand how cheap shale gas negatively impacts benzene supply
- Coal-based benzene becoming more and more important in China
- Secondary sources – hydrodealkylation (HDA) and toluene disproportionation (TDP) fill in supply gaps

#### **Toluene – Learn about the Magic of Toluene Transformations – Fooling Mother Nature!**

#### **Xylenes – para-Xylene Rules!**

- Highlighting the role of refineries in the aromatics business
- How will huge Chinese investments in aromatics change global trade?
- Understand how the industry rebalances mixed xylenes distribution to match market demand

### 10:30 am **Coffee Break**

### 10:50 am **Petrochemical Value Chains – Understanding How the Industry Adds Value by Satisfying Market Demands**

For the remainder of the course, the derivatives of each of the seven building blocks will be discussed one by one. These discussions will include: historical origins, key players, trade, process technologies, and end-use applications. In many cases, end-use application discussions will be reinforced by many “colorful and interesting” graphics and “show and tell” demonstrations.

#### **Exploring the Ethylene Value Chain – Dominated by Four Very Commoditized Businesses**

- **Polyethylene – LDPE, LLDPE, HDPE** – Learn what polymers are and what the difference is between the three types of polyethylene. Tupperware and Hula Hoops start a new industry! “Green” polyethylene – what is it? What does “green” mean? Is it here to stay?
- **PVC and the Vinyls Chain** – Chlor/Alkali, EDC, VCM, PVC. Environmental, health & safety issues are always a consideration in this value chain. How can PVC be both rigid and flexible?
- **Ethylene Oxide (EO) and Monoethylene Glycol (MEG)** – Key to the polyester business, anti-freeze and a range of specialty uses. Learn why the Middle East players dominate trade in MEG?
- **Styrene** – Key monomer for polystyrene, ABS, SBR and UPR – this discussion will be held off until the discussion of the benzene value chain on Day 3.

### 12:30 pm **Lunch**

## Day 2 Afternoon Session

### 1:30 pm **Exploring the Propylene Value Chain – Bringing Good Things to Life**

- **Polypropylene** – The most versatile and fastest growing of the polyolefins. Who invented PP? The most disputed story of invention in the entire industry!
- **Cumene/Phenol/Acetone** – “Tyranny of the Two for One Process”
- **Bisphenol A (BPA)** – Toxicity issues weighing on this industry segment.
- **Polycarbonate** – Strong, tough, glass-like clear – a wonderful plastic
- **Epoxy resins** – Super-tough thermoset

### 3:00 pm **Coffee Break**

- **Phenol Formaldehyde (PF Resins)** - The original thermoset molding resin
- **Methyl Methacrylate (MMA)/PMMA** – The other glass-like plastic, competing with polycarbonate
- **Propylene Oxide (PO)** – Understanding the alphabet soup of process routes to PO: CHPO, PO/MTBE, PO/SM and more recently HPPO. Impacts the polyurethane business.
- **Oxo- Alcohols** – n-Butanol and 2-Ethylhexanol. Biotech and regulatory issues impacting business
- **Acrylic Acid** – Key monomer for Super Adsorbent Polymers (SAPs). Diaper demo not to be missed! Also impacts the coatings business – water based paint and UV-cured coatings
- **Acrylonitrile** - By-product hydrogen cyanide a barrier to entry. Acrylic fiber – synthetic wool and world’s second synthetic fiber. Also polyacrylonitrile is precursor to carbon fibers

## Day 3 Morning Session

### 9:00 am Exploring the C<sub>4</sub> Olefins Value Chains – Key to the Synthetic Rubber Industry

- **Natural Rubber** - Fascinating tale of discovery, but importantly led to the development of the synthetic rubber industry
- **Polybutadiene Rubber (PBR) / Styrene Butadiene Rubber (SBR)** – Key to the development of synthetic tires. WW II spurs innovation.
- **Butyl Rubber (IIR)** – How we keep the air in tires
- **EPDM** - automotive hoses, gaskets, sealants, roofing, membranes
- **Butene -1** - Comonomer for LLDPE and HDPE
- **Butene-2** – Monomer for making methyl ether ketone (MEK)
- **Isobutene** – Butyl rubber, MMA, and MTBE production
- **MTBE** – The sad story of the demise of MTBE in the US
- **Maleic Anhydride (MAN)** – Exception to the rule. No need for a double bond, made direct from n-butane

### 10:30 am Coffe Break

### 10:50 am Exploring the Aromatics Value Chain

- **Styrene** – An interconnected story – conventional technology versus POSM technology
- **Polystyrene** – GPPS/HIPS/EPS – What are they and their different end-use applications
- **ABS** – High impact plastic. Key to Lego products
- **Nylon 6,6 and Nylon 6** - First well understood polymers and led to the development of the synthetic fiber industry
- **Cyclohexane/Adipic Acid** – Nylon 6,6 precursors
- **Caprolactam** – Nylon 6 precursor

### 12:30 pm Lunch

## Day 3 Afternoon Session

### 1:30 pm Exploring the Aromatics Value Chain (continued)

- **Polyurethanes** – Very high value business
- **MDI/TDI** – The two large volume isocyanates for polyurethane production. Phosgene provides a barrier to entry
- **PTA/DMT** – Key monomers for polyester
- **Polyester (PET)** – The fastest growing polymer in the world. Fiber, film and bottle end-uses

### 3:00 pm Coffee Break

### 3:20 pm Exploring the C1 Value Chain – Cheap Shale Gas and Coal is Stimulating Interest

- **Synthesis gas (Syngas)** – what is it, how we make it and what we do with it
- **Ammonia** – The world's largest volume chemical
- **Methanol** – Who says you can't teach an old dog new tricks! - Increasing fuel uses and MTO
- **Acetic Acid/Acetic Anhydride** – Totally built up from C1 chemistry
- **VAM/PVAc/PVOH/PVB** – An extensive value chain into very specialized end-use applications

### Wrap-up and Conclusion of Course

