

# CHEMSYSTEMS TRAINING

## THE GLOBAL PETROCHEMICAL INDUSTRY:

*Understanding the Complex Interactions between Technology, Economics, and Markets*

### DAY 1

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#### 8:30 Industry Cyclicity – Are We Doomed to Ride this Cycle Forever?

- The “Old (and current?) Paradigm”
- Industry restructuring
- The impact of private equity
- Some thoughts on profitability

#### The Chemical Industry

- Size
- Commodity versus specialty
- Historical beginnings of the industry
- Emergence of a true global business
- Key success factors
- The importance of the Middle East and China
- Major players

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#### 10:00 Coffee Break

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#### 10:20 How to Organize the Industry – The 7 Basic Building Blocks

- Ethylene
- Propylene
- Butadiene/Butylenes
- Benzene
- Toluene
- Xylenes
- Methane

#### The Petroleum Refinery/Petrochemical Interface

- Catalytic Cracking
- Catalytic Reforming
- Steam Cracking

#### Economics

- Cost of production calculations
- Economy of scale – why size matters
- Cost curves – what are they and what they can predict
- The concept of “shut-down” economics

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#### 12:00 Lunch

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#### 1:00 The Businesses from Ethylene

#### Polyethylenes – The Single Largest Segment in the Industry

- LDPE – the accidental discovery
- HDPE – Ziegler's invention revolutionizes the business
- LLDPE – the best of both worlds!

#### Linear Alpha Olefins – A Diverse and Challenging Segment

- Full range processes – make one, make them all
- Sasol – coal to comonomers
- New On-purpose technologies – changing the LAO landscape

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#### 3:00 Tea Break

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#### 3:20 VCM and PVC Business

- Value chains and integration
- How technology saved the day
- China – going back to the future with acetylene
- Vinyls – fraught with environmental, health and safety issues

#### Ethylene Oxide/Ethylene Glycol Business

- Why the Middle East dominates production
- Why Asia dominates demand
- Who controls the technology

#### Ethanol

- Synthetic versus natural
- Fuel use versus industrial use
- “Green” Ethylene and Polyethylene

#### The Businesses from Propylene

#### Propylene- No Longer Ethylene's Step-Child

- Introduction to the propylene value chain
- Historical, current, and forecast demand by region
- Supply sources and limitations – where will all the propylene come from?
- On-purpose propylene technologies

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#### 4:30 Finish of Day 1

# CHEMSYSTEMS TRAINING

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### DAY 2

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- 8:30 Polypropylene – The Versatile Plastic Driving Propylene Growth**
- Natta and Phillips discover polypropylene catalysts at the same time and a patent fight ensues
  - Evolution and massive restructuring in the polypropylene business in an effort to maintain profitability
  - End-uses and intermaterial competition
- The Acrylic Acid Business**
- Key players – a few players dominate the market
  - Polyacrylic acid – superabsorbent polymers (SAPs)
  - Acrylates – water based paints and UV curing
- The Acrylonitrile Business – Technology Still a Barrier!**
- HCN by-product – provides a barrier to entry
  - End-uses – synthetic wool, ABS, and HMDA

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**10:00 Coffee Break**

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- 10:20 The Propylene Oxide Business**
- Technology evolution – from chlorohydrin to PO/SM
  - New co-product free routes driving change
- The Styrene/Polystyrene Business – Will New PO-Only Routes Help?**
- PO/SM versus conventional EB dehydro
  - General purpose, HIPS, EPS
  - How a Donald Duck cartoon became prior art
- The Phenol Value Chain – The Other 2 for 1 Process**
- Phenol and acetone – the magic of chemistry
  - Bisphenol A – toxicity concerns

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**12:00 Lunch**

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- 1:00 The Phenol Value Chain (continued)**
- Epoxy resins
  - Polycarbonate
  - Acetone/Methyl Methacrylate (MMA)
- The Oxo Alcohols Business – Regulation and Biofuels Affecting this Segment**
- Technology – the power of homogeneous catalysis
  - *n*-Butanol – Is biobutanol a threat?
  - 2-Ethylhexanol and the plasticizers business- health and safety concerns
  - Other oxo-alcohols
- Epichlorohydrin**
- Doing the right thing for the wrong reason
  - Route to synthetic glycerin
  - Now a route from glycerin

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**3:00 Tea Break**

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- 3:20 The Businesses from the C<sub>4</sub>'s**
- Separation of the C<sub>4</sub> Olefins**
- Natural and Synthetic Elastomers**
- Historical development of the rubber industry
  - Charles Goodyear finds the key to curing rubber but dies penniless
  - Why rubbers are elastomeric
  - WW II spurs development of synthetic rubbers
  - Polybutadiene rubber (BR)
  - Styrene butadiene rubber (SBR)
  - Butyl rubber, EP, EPDM
- Other C<sub>4</sub> Derivatives**
- ABS – the Chi Mei story
  - MTBE and alternatives
  - Maleic Anhydride

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**4:30 Finish of Day 2**

# CHEMSYSTEMS TRAINING

## THE GLOBAL PETROCHEMICAL INDUSTRY:

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*Special Session: Bio-Renewable Chemicals and Fuels*

### DAY 3

- 8:30 Sources of Aromatics – A Question of Balance**
- Primary sources – pyrolysis gasoline, reformate, coke oven oil
  - Secondary sources – hydrodealkylation, toluene disproportionation, transalkylation
  - Regional differences
- Businesses from Benzene**
- Styrene (already covered)
  - Cumene/Phenol (already covered)
  - The Nylon business – how DuPont invented it and how BASF got around their patents
  - Isocyanates and polyurethanes
- The Businesses From Toluene – TDI**
- The Business from Xylenes**
- Separating the xylenes
  - PTA/Polyester business – the fastest growing segment in the industry
  - Polyester film, fiber, bottles
  - 1,3-PDO and PTT – A new monomer and polymer – biotech has an impact

**10:00 Coffee Break**

- 10:20 The Businesses From Synthesis Gas**
- Routes to synthesis gas
  - Gas to liquids (GTL)
  - Ammonia
  - Methanol
  - Formaldehyde
  - Acetic acid/Acetic Anhydride
  - 1,4-Butanediol/THF (A sad, but true story of how one company did not understand “shut-down” economics)

**12:00 Lunch**

**1:00 SPECIAL SESSION: RENEWABLES**

#### **Sugar, Oils, and Cellulosic Biomass Utilization for Chemicals and Fuels**

##### **Overview of Bio-resources**

- Sugar and Starch Crops
- Oilseeds and Animal Fats
- Cellulosic Biomass
- Algae

##### **Initial Conversion Platforms**

- Fermentation
- Pyrolysis
- Gasification
- Catalytic
  - Transesterification
  - Hydrocracking
  - APR
- Hybrid Routes
- Other

**3:00 Tea Break**

**3:20 Renewables (continued)**

##### **Secondary Conversions**

- Alcohols to olefins
- Bio-glycerine routes
- Other

##### **Fungible vs. Unique New Products**

- Olefins
- Aromatics
- Nitriles
- Acids
- Oils
- Isoprenoids
- Other
- PHAs

##### **Issues & Challenges of Renewables Substitutions**

- Is there a “Green Premium”?
- Product Qualification
- Who needs biodegradability?

**Review of Key Concepts  
Awarding of Certificates of Completion**

**4:30 Conclusion of Course**

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## ABOUT THE PRESENTERS

### DR. JEFFREY S. PLOTKIN

Jeffrey Plotkin is Vice President of Nexant ChemSystems Training Programs and the Process Evaluation/Research Planning (PERP) program. Managing these activities often involves working closely with technology developers, including operating companies and engineering contractors. Jeff's interests are in all phases of process research and development with special emphasis on gas to chemicals, selective oxidations, alkane activation and biocatalyzed routes to chemicals.

Jeff is co-editor of the American Chemical Society's Patent Watch website at Chemistry.org, co-author of "Industrial Organic Chemistry, 2nd Edition" (Wiley Interscience), and is a frequent contributor of technology-oriented articles to ICIS Chemical News. Jeff holds more than thirty U.S. patents and is author of 25 publications in peer reviewed academic journals.

### RONALD F. CASCONI

Ron Cascone is a Principal and a leader of Nexant's broad and growing involvement in bio-renewables. He is a chemical engineer with over 40 years of industrial experience, and has led many technical, economic and business feasibility analyses and finance due diligence assignments across a wide range of industries and technologies. Ron has a broad knowledge of the global chemical and energy industries, biofuels and other bio-based materials, bio-based processing, and agriculturally-related sustainable development strategies.

Ron has authored Nexant multiclient reports on conventional and advanced liquid biofuels, bio-gasification, biobutanol, algae, bio-based feedstocks, "Plants as Plants" (PHA developments), "Refinery of the Future as Shaped by Environmental Regulations", "Biodiesel", and "Biogasoline". He has studied biofuels production related to chemicals derivatives and uses of similar technologies to produce chemicals ("biorefineries"), chemicals that can be made by hybrid processes and by PHA depolymerization, and other related subjects. He is currently spearheading a major multiclient study, "Biobased Chemicals: Going Commercial", which is having a strong market response. The study catalogues and analyzes the commercial development status of first step processes from Biobased feeds to fungible green versions of conventional chemicals such as polymer intermediates, solvents, and specialties, as well as unique new Biobased replacement molecules.