# CHEMSYSTEMS TRAINING

## THE GLOBAL PETROCHEMICAL INDUSTRY:

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

## DAY 1

**8:30** **Industry Cyclicality – 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

**10:00** **Coffee Break**

**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

**12:00** **Lunch**

**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

**3:00** **Tea Break**

**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

**4:30** **Finish of Day 1**

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# CHEMSYSTEMS TRAINING

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## DAY 2

**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

**10:00** **Coffee Break**

**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, expandable
- 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
- Epoxy resins
- Polycarbonates

**12:00** **Lunch**

**1:00** **The Businesses from the $C_4$'s**

**Separation of the $C_4$ 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
- Thermoplastic elastomers – a neat trick

**Other $C_4$ Derivatives**

- ABS – the Chi Mei story
- MTBE and alternatives
  Maleic Anhydride

**3:00** **Tea Break**

**3:20** **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
- The Isocyanate and Polyurethane business – a versatile and protected business

**4:30** **Finish of Day 2**

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# CHEMSYSTEMS TRAINING

## THE GLOBAL PETROCHEMICAL INDUSTRY:

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*Special Session: Coal Conversion to Chemicals and Fuels*

## DAY 3

**8:30 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
- Phthalic anhydride – a mature product
- Unsaturated Polyester Resin (UPR)
- Alkyd Resins

**10:00 Coffee Break**

**10:20 The Businesses From Methane – A Shift To Low Cost Gas Regions***

- Natural gas sources and terminology
- 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:**

**Coal Conversion to Chemicals and Fuels**

**Overview of Chinese Coal Industry**

- Supply & Demand
- Pricing
- Government Policies & Regulations
- Drivers for Coal Conversion

**Coal to Chemicals (CTC)**

- Chemicals via Coal Gasification Option
  - Gasification Technologies and Coal Properties
  - Ammonia & Derivatives
  - Methanol, DME, Acetic Acid, Formaldehyde & Derivatives
  - Methanol to Olefins (MTO/MTP) & Derivatives
  - Ethanol & Derivatives

**3:00 Tea Break**

**3:20 Coal to Chemicals (CTC) (continued)**

- Chemicals via Coke Production Option Acetylene & Derivatives

**Coal to Synthetic Natural Gas (CTG) via Coal Gasification**

**Coal to Liquids (CTL)**

- Indirect Coal to Liquids (ICTL) via Coal Gasification
- Direct Coal to Liquids (DCTL) via Coal Liquefaction

**Polygeneration from Coal**

**Issues and Challenges of Coal Conversion**

**Review of Key Concepts**

**Awarding of Certificates of Completion**

**4:30 Conclusion of Course**

*Technology, economics, major players, regional end-use patterns, trade flows, key success factors, and current trends for all product areas will be discussed.

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CHEMSYSTEMS TRAINING

# THE GLOBAL PETROCHEMICAL INDUSTRY:

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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.

DR. LARRY SONG

Larry Song is the General Manager and Principal of Nexant Commercial Information Consulting (Shanghai) Limited. Larry has more than 25 years of industrial experience in coal conversion to chemicals, liquid fuels and synthetic natural gas. He has managed numerous coal conversion projects in China, U.S., Australia, Chile and many other countries and regions.

Larry has a doctoral degree in chemical engineering (with his PhD thesis on coal gasification) from Massachusetts Institute of Technology and an MBA in marketing. He holds several U.S. patents and has published many papers and articles worldwide. He has chaired and lectured extensively at worldwide conferences on syngas & coal gasification technology. Prior to joining Nexant, Dr. Song worked for BP and ExxonMobil specializing in clean utilizations of fuels.

MANUEL ASALI

Manuel Asali recently joined Nexant's Bahrain office as Principal, Middle East, where he is undertaking strategy and business development work related to various petrochemical value chains. Manuel has a degree in chemical engineering from the National University of Mexico and an MBA from London Business School in the U.K. He has more than 20 years of experience in the petrochemical industry in the areas of strategic planning, marketing and consulting. Previously he has worked in Mexico and the U.K. and he spent the last 5 years working for SABIC in Saudi Arabia, focusing on Business Strategy. Manuel's experience also includes part-time lecturing, delivering papers at several conferences and more recently teaching ChemSystems Training Courses.

The Global Petrochemical Industry: Understanding the Complex Interactions between Technology, Economics, and Markets

# 莱晟特(化学系统) 培训课程

## 第一日

**8:40** **行业的周期性– 是一成不变的吗?**

- 固有（以及现有）模式
- 行业结构的调整
- 私募股权的影响
- 对于利润的看法

**化工行业**

- 规模
- 商品 Vs. 特殊品
- 发展历史
- 真正的全球化产业的涌现
- 成功的关键因素
- 中东地区和中国的重要性
- 主要企业

**10:00** **茶歇**

**10:20** **化工行业的组织结构 –7 个基本组成元素**

- 乙烯(Ethylene)
- 丙烯(Propylene)
- 丁二烯/丁烯(Butadiene/Butylenes)
- 苯(Benzene)
- 甲苯(Toluene)
- 二甲苯(Xylenes)
- 甲烷(Methane)

**石油精炼与化工产品生产的衔接**

- 催化裂化
- 催化重整
- 蒸汽裂化

**经济性**

- 生产成本的计算
- 资本支出的分类
- 规模经济
- 结转价格问题– 利润来源于哪里?
- 成本曲线–是什么以及如何预测
- “关停”经济的概念

**12:00** **午餐**

**1:00** **乙烯行业***

**聚乙烯 – 化工行业内最大的产业**

- LDPE – 戏剧性的发现
- HDPE – 齐格勒的发明带来了产业革命
- LLDPE – 集中了两者的优点

**线性 α –烯烃（LAO） – 多样化而又富有挑战性的行业**

- 全程加工工艺 – 一体化生产
- 沙索公司（Sasol） – 煤炭转化成共聚单体
- 新型的有针对性的技术 – 改变了 LAO 的产业前景
- 洗涤剂用醇类 – 天然与合成
- 生物柴油及甘油– 二合一过程的负面影响

**3:00** **茶歇**

**3:20** **VCM 和 PVC 行业**

- 价值链以及整合程度
- 技术成就未来
- 中国 – 电石法的未来
- 乙烯基产品 – 面临环境，健康和安全问题

**环氧乙烷/乙二醇行业**

- 中东地区能够主导生产的原因
- 亚洲地区需求量最大的原因
- 技术由谁在掌握

**乙醇**

- 合成方法 Vs. 自然途径
- 燃料乙醇 Vs. 工业乙醇
- 乙醇汽油的利与弊

**5:00** **第一日结束**

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# 莱晟特(化学系统) 培训课程

The Global Petrochemical Industry: Understanding the Complex Interactions between Technology, Economics, and Markets

## 第二日

**8:30** **丙烯行业***

**各地区丙烯的供应/需求动态–重要性日益提高**

- 丙烯的价值链简洁
- 各地区的需求状况–历史数据分析，当前形势说明级未来发展预测
- 供应来源和局限性 – 丙烯从何而来?
- 新型的及专门研发的丙烯生产技术

**聚丙烯 – 用途广泛的塑料产品推动了丙烯需求量的增长**

- Natta 和 Phillips 同时发现了聚丙烯催化剂，引发了一场专利争夺战
- 为保障利润，聚丙烯的产业结构经历了大规模的调整
- 全球主要生产企业
- 贸易流向– 谁在生产/谁在使用
- 终端应用及原料间竞争

**10:00** **茶歇**

**10:20** **丙烯腈行业 – 技术障碍依旧存在**

- 氨氧化技术的发明引发了另一项专利之争 – 以非常规的方式得到了解决
- 氰化氢副产品– 设置了市场进入障碍
- 全球业内主要企业中鲜有亚洲生产厂家
- 贸易 – 美国所占比重仍然很大
- 终端应用 – 人造毛, ABS, 及己二胺（HMDA）

**丙烯酸行业 – 有利可图**

- 业内主要企业– 少数几家企业形成了市场垄断
- 聚丙烯酸– 高吸水性聚合物(SAPs)
- 丙烯酸盐 – 水基涂料和 UV 硬化

**12:00** **午餐**

**1:00** **特别专题 ：**

**煤化工与煤制油技术**

**中国煤炭行业综述**

- 供应及需求
- 价格
- 政府相关政策及制度
- 煤炭转化技术发展的推动力

**煤化工技术(CTC)**

- 经气化过程生成的化工学品
  - 气化工艺及煤炭的性质
  - 氨水及其衍生产品
  - 甲醇, DME, 醋酸, 甲醛及其衍生产品
  - 甲醇制烯烃及其衍生物(MTO/MTP)
  - 乙醇及其衍生产品

**3:00** **茶歇**

**3:20** **煤化工技术(CTC) (续)**

- 经焦化过程生成的化工产品
  - 乙炔及其衍生产品

**采用煤气化工艺的煤制合成天然气技术(CTG)**

**煤制油技术(CTL)**

- 采用煤气化工艺的间接煤制油技术(ICTL)
- 采用煤液化工艺的直接煤制油技术（DCTL）

**煤炭多联产技术**

**煤炭转化工艺面临的问题和挑战**

**5:00** **第二日结束**

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The Global Petrochemical Industry: Understanding the Complex Interactions between Technology, Economics, and Markets

# 莱晟特(化学系统) 培训课程

## 第三日

**8:30 混合碳 4 行业**

**碳 4 烯烃的分离**

**天然与合成橡胶**

- 橡胶工业的历史发展
- Charles Goodyear 发明了橡胶硫化法，但死后身无分文
- 橡胶为什么具有弹性
- 第二次世界大战促进了合成橡胶的发展
- 聚丁二烯橡胶（BR）
- 丁苯橡胶（SBR）
- 丁基橡胶，乙丙橡胶（EP），三元乙丙橡胶（EPDM）
- 热塑弹性体 – 独特的性质

**其它碳 4 衍生产品**

- ABS – 奇美公司的故事
- MTBE 及其替代产品
- 马来酸酐

**10:00 茶歇**

**10:20 芳烃产品的来源 – 平衡问题**

- 主要来源 – 裂解汽油，重整生成油，炼焦油
- 次要来源 – 加氢脱烷基化反应，甲苯歧化反应，烷基转移反应
- 地区间差异

**纯苯行业***

- 苯乙烯 (already covered)
- 异丙苯/苯酚 (already covered)
- 尼龙产业– 杜邦公司（DuPont）是如何发明的，巴斯夫公司（BASF）又是怎样取得专利的
- 异氰酸盐和聚氨酯行业 – 一个用途广泛但同时受到保护的产业

**12:00 午餐**

**1:00 甲苯行业 – TDI***

**二甲苯行业***

- 分离二甲苯异构体
- PTA/聚酯行业 – 化工行业中发展最快的产业
- 聚酯薄膜，纤维，包装瓶
- 1,3-PDO 和 PTT – 新型的单体和聚合物
- 邻苯二酸酐– 一种成熟的产品
- 不饱和聚酯树脂(UPR)
- 醇酸树脂

**2:30 茶歇**

**2:50 甲烷行业 – 向低成本燃气领域发展***

- 天然气的来源及专业术语
- 合成气的制备途径
- 燃气液化（GTL）
- 氨水
- 甲醇
- 甲醛
- 醋酸/乙酸酐
- 1,4-丁二烯/四氢呋喃（THF）(由于企业不熟悉“关停”经济概念而发生的真实故事)

**重点概念回顾**

**4:30 课程总结**

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# 莱晟特(化学系统) 培训课程

The Global Petrochemical Industry: Understanding the Complex Interactions between Technology, Economics, and Markets

## 主讲人简介：

DR. JEFFREY S. PLOTKIN

Jeffrey Plotkin 先生是莱晟特有限公司的副总裁,负责化学系统培训课程及工艺评价和研究报告（PERP）项目。在从事上述工作的过程中，Plotkin 先生经常同包括生产企业和工程承包企业在内的技术研发商密切合作。Plotkin 先生的研究方向涉及生产工艺研发的各个环节，在天然气化工，选择氧化工艺，烷烃活化技术以及化工产品的生物催化反应制取等领域有着很深的造诣。

同时，Plotkin 先生还是美国化学学会（ACS）专利监控网站（Chemistry.org）的副总编辑，并与他人合著了《工业有机化学》（第二版），该书已由 Wiley Interscience 出版社出版。 此外，他撰写的技术性文章经常被收录于 ICIS 的相关专栏中。Plotkin 先生拥有 30 余项美国专利，并有 25 项著作发表在经同行评审的专业期刊中。 .

宋益宏博士 （DR. LARRY SONG）

宋先生是莱晟特有限公司中国分公司的总经理。宋先生在煤化工的相关行业中有着超过 25 年的从业经验，其中为莱晟特及其前身化学系统工作的时间长达十年。在麻省理工（MIT）就读期间，宋先生就对煤炭气化及燃烧的化学反应进行了深入的研究。他的煤化工及相关技术的研究贯穿了他的整个职业生涯。2008 年 9 月来到中国以后，宋先生参与了众多煤化工项目，亲自走访了内蒙古，新疆，宁夏，陕西，陕西及其它产煤大省，并考察了众多煤化工企业。宋先生拥有多项美国专利，发表的论文数量众多，在世界各地作过大量的演讲报告。在加入莱晟特之前，宋先生曾在英国石油公司（BP）和埃克森美孚公司（ExxonMobil）担任过技术职位和管理职位。

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