IHS CHEMICAL

Process Economics Program (PEP):
Wide Range Linear Alpha Olefin Processes &
On-Purpose Linear Alpha Olefin Processes

PEP CR001 & CR002 Prospectus
Contents

Contents................................................................................................................................................. 2
Introduction .................................................................................................................................................. 3
Abstract..................................................................................................................................................... 5
Key Questions Addressed in the Reports ................................................................................................. 6
Deliverables ............................................................................................................................................... 6
Process Technologies Reviewed in CR001 & CR002 .......................................................................... 6
Table of Contents................................................................................................................................... 7
CR001 - Wide Range Linear Alpha Olefin Processes .............................................................................. 7
CR002 - On-Purpose Linear Alpha Olefin Processes ............................................................................ 10
Meet the Author...................................................................................................................................... 15
About the IHS Chemical Process Economics Program (PEP) ............................................................ 16
About IHS Chemical................................................................................................................................. 18
About IHS.................................................................................................................................................. 19
Contact Information................................................................................................................................. 19
Introduction

How do the processes, economics, and key process indicators differ for competing LAO processes? How do the economics vary with geographical region?

CR001, Wide Range Linear Alpha Olefin Processes
The report delivers detailed process analyses and presents direct comparisons of key process indicators (KPIs), including production costs and capital investment costs, for seven competing wide range linear alpha olefins (LAO) processes.

CR002, On-Purpose Linear Alpha Olefin Processes
The report focuses on detailed process analyses and KPI comparisons for 11 processes and process variants, including 4 selective ethylene oligomerization processes, 6 processes and process variants for 1-butene from refinery raffinate streams, and 1 process for 1-hexene from refinery raffinate.

LAO capacity is expected to expand rapidly, with several new projects recently announced. Global LAO capacity is estimated to grow from 4,280 thousand metric tons per year (ktpy) in 2012 to 6,200 ktpy in 2018, a 45% increase over the six-year period. Most of the capacity growth will be in North America, accounting for 80% of global growth.

LAO are unsaturated carbon chains having 4 to more than 20 carbon atoms with the double bond at the end of the chain. The short chain linear alpha olefins, C₄–C₈, are used mainly as comonomers for production of polyethylene and polypropylene. Adding short chain linear alpha olefins to ethylene-based polymers such as linear low density polyethylene (LLDPE) increases flexibility and strength in the end product. The total demand for LAO in polyethylenes accounted for approximately 54% of global LAO demand (3.5 million tons) in 2012.

Medium and longer chain length linear alpha olefins are used in the production of detergents (C₁₀–C₁₈), plasticizers, and synthetic lubricants. Long chain linear alpha olefins are used as lubricants or drilling liquids, and in particular LAO itself can be polymerized to provide a base stock for synthetic lubricants. The total demand for LAO of carbon chain length greater than eight accounted for approximately 46% of global LAO demand in 2012.

While LAO plants initially used technologies that were based on the thermal cracking of waxy paraffins from petroleum, as ethylene became abundant and inexpensive, producers turned to ethylene oligomerization. The first commercial production of LAO based on ethylene oligomerization came on stream in 1966. Today LAO are produced mainly by oligomerization of ethylene, and also by separating them from coal to liquids (CTL) product streams or from refinery streams.

LAO processes are grouped into two types: wide range and narrow range. Wide range processes produce C₄ to C₂₀, or C₃₀, LAO. Recent entrants into the wide range market have focused on a narrowed product slate, as shown in the table (inset). On-purpose processes produce predominantly C₄, C₆, or C₈ LAO. Production economics and product yield sets are the most important factors that will determine the competitive landscape and supply of LAO in the coming years.

For example, demands for 1-hexane and 1-octene have risen in recent years, mainly because copolymerization of ethylene with a small percentage of 1-hexene or 1-octene changes the
This prospectus is for the recipient's internal use only. No part can be copied, distributed, or republished. © 2016 IHS

grade of the LLDPE product, from commodity to specialty.

This allows companies that produce specialty grades to increase profitability and compete effectively with commodity grade producers.

Copolymerization of ethylene with 1-butene also improves the properties of the polyolefin product. Traditionally, 1-butene has been recovered from refinery and naphtha steam cracking raffinate streams, but the supply of 1-butene has not kept pace with demand. This supply gap is being filled by 1-butene from LAO processes, particularly ethylene oligomerization and selective ethylene dimerization.

Because competitively priced ethane and ethylene are currently available in North America, several new polyethylene plants have been announced that will further drive demand for LAO upward in the next few years.

<table>
<thead>
<tr>
<th>Wide range LAO processes</th>
<th>Feedstock</th>
<th>Company</th>
<th>98% of LAO product</th>
</tr>
</thead>
<tbody>
<tr>
<td>High temperature process</td>
<td>Ethylene</td>
<td>Chevron Phillips</td>
<td>C₄ – C₂₈</td>
</tr>
<tr>
<td>SHOP</td>
<td>Ethylene</td>
<td>Shell</td>
<td>C₄ – C₂₀+</td>
</tr>
<tr>
<td>Linealene</td>
<td>Ethylene</td>
<td>Idemitsu</td>
<td>C₄ – C₂₀+</td>
</tr>
<tr>
<td>Versipol</td>
<td>Ethylene</td>
<td>DuPont</td>
<td>C₄ – C₂₀+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intermediate wide range LAO processes</th>
<th>Feedstock</th>
<th>Company</th>
<th>98% of LAO product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total butene recycle</td>
<td>Ethylene</td>
<td>INEOS</td>
<td>C₆ – C₁₄</td>
</tr>
<tr>
<td>AlphaSelect</td>
<td>Ethylene</td>
<td>IFP</td>
<td>C₄ – C₁₂+</td>
</tr>
<tr>
<td>alpha-SABLIN</td>
<td>Ethylene</td>
<td>SABIC &amp; Linde</td>
<td>C₄ – C₁₂+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intermediate wide range LAO processes</th>
<th>Feedstock</th>
<th>Company</th>
<th>98% of LAO product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetramerization</td>
<td>Ethylene</td>
<td>Sasol</td>
<td>n-C₈ and n-C₆</td>
</tr>
<tr>
<td>Trimerization</td>
<td>Ethylene</td>
<td>Chevron Phillips</td>
<td>n-C₆</td>
</tr>
<tr>
<td>AlphaHexol</td>
<td>Ethylene</td>
<td>IFP and Axens</td>
<td>n-C₆</td>
</tr>
<tr>
<td>CPT Metathesis</td>
<td>Mixed C₄</td>
<td>Lummus &amp; CBI</td>
<td>n-C₆, C₂, C₃</td>
</tr>
<tr>
<td>AlphaButol</td>
<td>Ethylene</td>
<td>IFP</td>
<td>n-C₄</td>
</tr>
<tr>
<td>Raffinate-1 adsorption</td>
<td>Mixed C₄</td>
<td>UOP &amp; UCC</td>
<td>n-C₄</td>
</tr>
<tr>
<td>Raffinate-1 adsorption</td>
<td>Mixed C₄</td>
<td>Open</td>
<td>n-C₄ and iso-C₄</td>
</tr>
<tr>
<td>Raffinate-2 distillation</td>
<td>Mixed C₄</td>
<td>Open</td>
<td>n-C₄</td>
</tr>
<tr>
<td>Partial hydrogenation</td>
<td>Butadiene</td>
<td>Open</td>
<td>n-C₄</td>
</tr>
</tbody>
</table>
Abstract

LAO are used as comonomers in polyethylene production and in the plasticizer, detergent, and lubricant markets. Reports CR001, Wide Range Linear Alpha Olefin Processes, and CR002, On-Purpose Linear Alpha Olefin Processes, consolidate and update IHS PEP’s technical and economic analyses of wide range and on-purpose linear alpha olefin manufacturing technologies, respectively, since PEP first reported on the subject in the 1960s.

The majority of LAO produced worldwide today come from large-scale processes that make a wide range of LAO with carbon numbers in the range of C4–C20+ or C4–C30+. Major producers of wide range LAO include Shell, Chevron Phillips, and INEOS, each of which has been in commercial operation for several decades. Idemitsu Kosan has also commercialized its wide range LAO process on a small scale, and is currently partnering with Mitsui for new production. SABIC has recently commercialized its technology jointly with Linde AG on a moderate scale. Additional wide range technologies are currently ready for commercialization. Among these are processes developed by Institut Français du Pétrole (IFP), DuPont, and UOP. All three processes have been made available for license, although UOP has since withdrawn LAO technology from its licensing list.

Commercial on-purpose LAO technology is also well-established in processes extracting C4 olefins, from refinery streams or, more recently, shorter chain LAO from Fischer-Tropsch synthetic fuel process effluents. With the market for LAO in the C4–C8 range increasing most rapidly, new processes based on selective ethylene oligomerization are coming online or becoming available for first license. The ethylene dimerization technology of Axens/IFP/SABIC is already established, with about 30 operating units. Sasol’s ethylene tetramerization process and Chevron Phillips’s ethylene trimerization have very recently come onstream, and several other on-purpose LAO technologies are ready for commercialization.

Additional processes based on Raffinate 1 and Raffinate 2 are known and can be expected to come in and out of use depending on specific market demands and refinery logistics.

The reports review all past, present, and emerging LAO technologies and provide a bibliography and abstracts for patents since the 1960s. Each report includes updated information on the status of the industry, along with a summary of major commercial or commercial-ready LAO processes in terms of comparative economics and carbon efficiency, energy intensity, carbon intensity, and capital intensity KPIs. The electronic versions of the reports include an interactive module, the iPEP Navigator WRLAO and OPLAO tools for the wide range and on purpose reports, respectively. The iPEP Navigator provides a snapshot of the economics for each process and allows the user to select the process, units, and region of interest.
Key Questions Addressed in the Reports

- How are LAO produced?
- Who are the producers of LAO?
- Where are LAO plants located, and how much is made?
- What LAO technologies are described in each producer’s IP portfolio?
- What are the design features and technical specifics of each LAO process?
- What are the process economics of each commercial or emerging LAO process?
- How do the processes compare in terms of product value, CAPEX, OPEX, energy efficiency, carbon efficiency, and CO2 emissions?
- How do the process economics change with geographical region?

Deliverables

Each narrative report is delivered in PDF format, with the corresponding iPEP LAO interactive module file in Excel.

Process Technologies Reviewed in CR001 & CR002

CR001, Wide Range Linear Alpha Olefin Processes, provides technical descriptions and economic analysis for the following technologies:

- Chevron Phillips (high temperature process)
- INEOS (total butene recycle)
- Shell (Shell Higher Olefins Process, SHOP)
- SABIC and Linde (alpha-SABLIN™)
- UOP and Union Carbide (Linear-1™)
- IFP (AlphaSelect™)
- DuPont (Versipol™)

CR002, On-Purpose Linear Alpha Olefin Processes, provides technical descriptions and economic analysis for the following technologies:

- Sasol ethylene tetramerization to 1-octene and 1-hexene
- Chevron Phillips ethylene trimerization to 1-hexene
- Axens/IPF ethylene trimerization to 1-hexene (AlphaHexol™)
- Lummus butene metathesis to 1-hexene (Comonomer Process Technology)
- Axens/IPF ethylene dimerization to 1-butene (AlphaButo1®)
- Recovery of 1-butene from Raffinate-2
- UOP adsorption recovery of 1-butene from Raffinate-1
- UCC adsorption recovery of 1-butene from Raffinate-1 (two purities)
- Selective hydrogenation of butadiene (two purities)
Table of Contents

CR001 - Wide Range Linear Alpha Olefin Processes

1) Introduction .......................................................................................................................... 1-1

2) Summary ............................................................................................................................ 2-1
   - Commercial status
   - Industrial producers/licensors
   - Linear alpha olefins technologies
     - Chevron Phillips linear alpha olefins process
     - INEOS linear alpha olefins process
     - Shell Higher Olefins Process for linear alpha and internal olefins
     - SABIC/Linde linear alpha olefins process (alpha-SABLIN®)
     - UOP/UCC linear alpha olefins technology (Linear-1)
     - Institut Français du Pétrole (IFP) LAO technology (AlphaSelect)
     - DuPont linear alpha olefins technology (Versipol)

   Process Economics

3) Industry Status ................................................................................................................. 3-1
   - Demand and market drivers
   - Current producers and plant capacity
   - Recent and planned capacity additions
   - Transaction prices

4) Technology review ........................................................................................................... 4-1
   - INEOS linear alpha olefins process
   - INEOS research on oligomerization catalysts and process
   - Chevron Phillips linear alpha olefins process
   - Chevron Phillips research on oligomerization catalysts and process
   - Shell Higher Olefins Process for linear alpha and internal olefins
   - Shell research on oligomerization catalysts and process
   - Shell research on isomerization/disproportionation catalysts and process
   - Institut Français du Pétrole (IFP) LAO technology
   - IFP research on oligomerization catalysts and process
   - UOP/UCC linear alpha olefins technology
   - UOP/UCC research on oligomerization catalysts and process
   - SABIC/Linde linear alpha olefins technology
   - SABIC/Linde current research on oligomerization catalysts and process
   - DuPont linear alpha olefins technology
   - Exxon linear alpha olefins technology
   - Idemitsu linear alpha olefins technology
   - Other Ziegler catalysis type processes: Conoco and Dow linear alpha olefins technologies
   - Other titanium- and zirconium-based catalysts
   - Other nickel-based catalysts
   - Zeolite and Lewis acid catalyzed syntheses
   - Syngas-based synthesis
   - Wax cracking linear alpha olefins technology
     - Feedstocks
       - Thermal cracking conditions
       - Variants of wax cracking

5) **Chevron Phillips linear alpha olefins process** ................................................................. 5-1

   - **Process review**
     - Chemistry and reaction conditions
     - Reactor
     - Catalyst and product distribution
     - Product separation
   - **Process description**
     - Section 100—Ethylene oligomerization
     - Section 200—Alpha olefins separation
   - **Process discussion**
     - Materials of construction
     - Process waste effluents
   - **Cost estimates**
     - Fixed capital costs
     - Production costs

6) **INEOS linear alpha olefins process** .................................................................................. 6-1

   - **Process review**
     - Chemistry and reaction conditions
     - Reactors
     - Catalyst and product distribution
     - Product separation
   - **Process description**
     - Section 100—Ethylene growth
     - Section 200—Displacement from alkylaluminum compounds
     - Section 300—Alpha olefins separation
   - **Process discussion**
     - Materials of construction
     - Process waste effluents
   - **Cost estimates**
     - Fixed capital costs
     - Production costs

7) **Shell Higher Olefins Process for linear alpha and internal olefins** ..................................... 7-1

   - **Process review**
     - Chemistry and reaction conditions
     - Catalyst system and product distribution
     - Reactors
     - Product separation
     - Product purity
   - **Process description**
     - Section 100—Ethylene oligomerization
     - Section 200—Alpha olefins separation
     - Section 300—Isomerization and disproportionation
   - **Process discussion**
     - Materials of construction
     - Process waste effluents
   - **Cost estimates**
     - Fixed capital costs
     - Production costs
8) **SABIC-Linde linear alpha olefins process** .................................................................................. 8-1

- Process review
  - Chemistry and reaction conditions
  - Reactors
  - Catalyst system and product distribution
  - Product separation

- Process description
  - Section 100—Ethylene oligomerization
  - Section 200—Alpha olefins separation

- Process discussion
  - Materials of construction
  - Process waste effluents

- Cost estimates
  - Fixed capital costs
  - Production costs

9) **UOP linear alpha olefins process** .................................................................................. 9-1

- Process review
  - Chemistry and reaction conditions
  - Reactors
  - Catalyst system and product distribution
  - Product separation

- Process description
  - Section 100—Ethylene oligomerization
  - Section 200—Alpha olefins separation

- Process discussion
  - Materials of construction
  - Process waste effluents

- Cost estimates
  - Fixed capital costs
  - Production costs

10) **DuPont linear alpha olefins process** .................................................................................. 10-1

- Process review
  - Chemistry and reaction conditions
  - Reactors
  - Catalyst system and product distribution
  - Product separation

- Process description
  - Section 100—Ethylene oligomerization
  - Section 200—Alpha olefins separation

- Process discussion
  - Materials of construction
11) Appendix A – Design and cost bases ................................................................. A-1
12) Appendix B – Effect of operating level on production costs ............................... B-1
13) Appendix C – References by document number .................................................. C-1
14) Appendix D – Selected patent summaries by assignee ....................................... D-1
15) Appendix E – Process flow diagrams ................................................................. E-1
16) Appendix F – iPEP Navigator for wide range LAO ........................................... F-1

CR002 - On-Purpose Linear Alpha Olefin Processes

1) Introduction ........................................................................................................ 1-1

2) Summary ........................................................................................................... 2-1

   Commercial status
   Industrial producers/licensors
   Linear alpha olefins technologies
     1-Octene and 1-hexene by the Sasol ethylene tetramerization process
     1-Hexene by the Chevron Phillips ethylene trimerization process
     1-Hexene by the Axens ethylene trimerization process
     1-Hexene by the Lummus C4 metathesis process
     1-Butene by the Axens-IFP-SABIC ethylene dimerization process
     1-Butene by distillation of raffinate-2 from MTBE production
     1-Butene from raffinate-1 by the UOP adsorption process
     1-Butene and isobutylene from raffinate-1 by the UCC adsorption process
     1-Butene-enriched C4 by selective hydrogenation of butadiene

   Process Economics

3) Industry status ..................................................................................................... 3-1

   Demand and market drivers
   Current producers and plant capacity
   Recent and planned capacity additions
   Transaction prices

4) Technology review .............................................................................................. 4-1

   Historical process development
Ethylene oligomerization to produce C4, C6, and C8 LAO
I. Ethylene tetramerization: 1-octene
II. Ethylene trimerization: 1-hexene
III. Ethylene dimerization: 1-butene

Production of LAO from raffinate streams
I. Isolation of 1-butene from raffinate streams
II. Partial hydrogenation of butadiene to produce 1-butene from raffinate-1
III. Telomerization of butadiene to produce 1-octene
IV. Dimerization of 1-butene to produce 1-octene
V. Butene metathesis to produce 1-hexene from raffinate-1

Production of LAO from Fischer-Tropsch synthesis via hydroformylation
Hydroformylation
Hydrogenation
Dehydration

5) Octene and 1-hexene by the Sasol ethylene tetramerization process ........................................ 5-1

Process review
Chemistry and reaction conditions
Reactor
Catalyst and product distribution
Product separation

Process description
Section 100—Ethylene tetramerization
Section 200—Product recovery
Materials of construction
Process waste effluents

Cost estimates
Fixed capital costs
Production costs

6) 1-Hexene by the Chevron Phillips ethylene trimerization process ........................................ 6-1

Process review
Chemistry and reaction conditions
Reactor
Catalyst and product distribution
Product separation

Process description
Section 100—Ethylene tetramerization
Section 200—Product separation

Process discussion
Materials of construction
Process waste effluents

Cost estimates
Fixed capital costs
Production costs

7) 1-Hexene by the Axens ethylene trimerization process ......................................................... 7-1
   Process review
   Chemistry and reaction conditions
   Reactor
   Catalyst and product distribution
   Product separation
   Process description
   Section 100—Ethylene tetramerization
   Section 200—Product separation
   Process discussion
   Materials of construction
   Process waste effluents
   Cost estimates
   Fixed capital costs
   Production costs

8) 1-Hexene by the Lummus C4 metathesis process ................................................................. 8-1
   Process review
   Chemistry and reaction conditions
   Reactors
   Catalyst and product distribution
   Product separation
   Process description
   Section 100—Butene hydroisomerization
   Section 200—Butene distillation
   Section 300—Autometathesis and purification
   Section 400—Hexene isomerization and product recovery
   Process discussion
   Materials of construction
   Process waste effluents
   Cost estimates
   Fixed capital costs
   Production costs

9) 1-Butene by the Axens-IFP-Sabic ethylene dimerization process ........................................ 9-1
   Process review
   Chemistry and reaction conditions
   Reactor
   Catalyst and product distribution
   Product separation
   Process description
   Section 100—Ethylene dimerization
   Section 200—Product recovery
10) 1-Butene by distillation of raffinate-2 from MTBE production .................................................. 10-1

Process review
  Chemistry and reaction conditions
  Reactors
  Catalyst
  Product separation

Process description
  Section 100—MTBE preparation
  Section 200—Raffinate partial hydrogenation
  Section 300—Distillation

Process discussion
  Materials of construction
  Process waste effluents

Cost estimates
  Fixed capital costs
  Production costs

11) 1-Butene from raffinate-1 by the UOP adsorption process .................................................. 11-1

Process review
  Adsorbent and adsorption conditions
  Adsorber

Process description
  Section 100—Feed preparation
  Section 200—Adsorption

Process discussion
  Materials of construction
  Process waste effluents

Cost estimates
  Fixed capital costs
  Production costs

12) 1-Butene and isobutylene from raffinate-1 by the UCC adsorption process .......................... 12-1

Process review
  Adsorbent and adsorption conditions
  Adsorber

Process description
  Section 100—Feed preparation
  Section 200—Adsorption
Section 300—Post fractionation

Process discussion
Materials of construction
Process waste effluents

Cost estimates
Fixed capital costs—Case A
Fixed capital costs—Case B
Production costs

13) 1-Butadiene—enriched C4 by selective hydrogenation of butadiene ........................................ 13-1

Process review
Chemistry and reaction conditions
Reactor
Catalyst and product distribution

Process description
Section 100A—Single-reactor hydrogenation
Section 100—hydrogenation, case B

Process discussion
Reactor system
Temperature control
Butene isomerization
Materials of construction
Process waste effluents

Cost estimates
Fixed capital costs
Production costs

14) Appendix A—Design and cost bases .................................................................................................. A-1
15) Appendix B—Patent list by assignee .................................................................................................. B-1
16) Appendix C—References by document number ................................................................................. C-1
17) Appendix D—Selected patent summaries by assignee ..................................................................... D-1
18) Appendix E—Process flow diagrams ............................................................................................... E-1
19) Appendix F—iPEP Navigator for wide range LAO ....................................................................... F-1
Meet the Author

Marianne Asaro – Sr. Principal Analyst

Marianne Asaro is a senior principal analyst with the Process Economics Program group at IHS Chemical. Dr. Asaro has over 25 years’ experience in RD&D for the chemical and energy industries. Her 30+ publications include six US patents in the areas of gas separations, propylene epoxidation, and catalyst discovery. She holds a BSc degree in Chemistry from UC Berkeley, where she performed research in organic chemistry, and a PhD in Inorganic Chemistry from Harvard University with specialization in the organometallic chemistry of catalysis. She performed postdoctoral work in organometallic chemistry at Princeton University prior to joining the contract R&D firm SRI International. At SRI International, she performed over 75 research projects in catalysis and separations, commodity oxygenates, monomers, and energy. The focus of her work has been the industrial chemistry and development of processes for commodity chemicals and fuels. At IHS since 2013, Dr. Asaro is participating in the launch of the Consolidated Report series beginning with wide range LAO, on-purpose LAO, and propylene oxide.
About the IHS Chemical Process Economics Program (PEP)

PEP provides in-depth, independent technical and economic evaluations of both commercial and emerging technologies for the chemical, biochemical, and refining industries.

PEP analyzes the impact of changes in processes, feedstocks, energy prices, and government regulations on chemical and fuel production economics for our clients. And with the celebration of the 50th anniversary of PEP, we enter a new era, offering new functionality and key report contents through interactive Excel data files that allow our clients to generate process economics tailored to their specific project needs.

Benefits

New technologies can either offer an opportunity or pose a threat. Prompt and thorough analyses of new developments are crucial to making the proper decision—whether you are exploiting a proprietary technology or responding rapidly to a competitor’s move. PEP reduces the time and costs associated with collecting and interpreting the voluminous information needed to assess new technologies. Clients make use of PEP’s independent analyses—which draw on our experts’ industry experience in process design, cost estimation, and R&D planning—to make informed decisions. Complementing that expertise are the program’s extensive databases and ongoing contacts with chemical companies worldwide.

PEP is a partnership

PEP is designed to be a problem-solving partnership, combining independent analysis with client needs. PEP experts stay up-to-date on issues affecting clients through on-going contacts with industry representatives, conference participation, and site visits. The insights gained from these activities are reflected each year in the topics suggested for research. Clients then vote on PEP’s suggestions to ensure the selected topics reflect their areas of interest.

Inquiry privileges

PEP customers receive access to IHS Chemical experts to discuss information in the studies.
PEP Reports and Reviews

Our subscription-based service delivers PEP Reports and PEP Reviews to our clients each year. Each Report covers three or more processes, while each Review covers one process or a specific topic. Available in print and online, PEP Reports and PEP Reviews are universally acknowledged as the industry standard for techno-economic evaluations of chemical process technologies.

PEP Reports emphasize commercially significant products and processes for which technology is rapidly changing. PEP experts develop and evaluate process designs using patent literature and licensor information, and they estimate capital and operating costs of world-scale production plants. Every PEP process economics evaluation is based on an in-depth process analysis and starts with a clear design basis and a PFD (process flow diagram).

PEP Reviews provide timely analysis of “hot issues” affecting the industry—from process technology to industry restructuring. Included with the 2014 Reports and Reviews is an iPEP Navigator Excel-based interactive data module, which allows a user to quickly select a process and a region, and convert process economics between English and metric units.

PEP Consolidated Reports

Each PEP Consolidated Report provides a single and comprehensive report on a specific chemical that includes all competing processes, with the same detailed process design and economics as PEP Reports. Consolidated Reports also contain an iPEP Navigator module that allows a user to quickly select a process and a region, and convert process economics between English and metric units. To ensure the information in the Consolidated Reports remains relevant, we will update the process economics and industry review section of each report once a year. PEP Consolidated Reports serve technical managers and process engineers who are interested in understanding all competing processes in detail and keeping track of market conditions and production economics annually.

PEP Process Summaries

PEP Process Summaries offer a concise comparison of competing processes by capturing key differences in design features and process parameters. Process Summaries include an iPEP Spectra interactive data module prepared in an Excel pivot table where quarterly production economics of competing processes are easily compared over a period of 10 or more years. The iPEP Spectra data module will enable our customers to compare production economics of competing processes in various plant locations using a wide selection of economics metrics. The process summaries are meant to serve business and project managers who are interested in understanding competing processes’ key differences at a high level but still need to closely track profitability.

PEP Yearbook

The PEP Yearbook is the world’s largest online process economics database. Updated quarterly starting in 2014, it provides current production economic data for more than 1,400 processes used to manufacture over 600 chemical, polymer, refining, and biotech products. The database estimates raw material and utility requirements and demonstrates capital and production costs for three plant capacity levels, while an online application tool enables users to customize plant capacity for quick scaling analysis.
About IHS Chemical

**Best-in-class brands**

IHS Chemical now combines the former CMAI and SRI Consulting groups together with Chemical Week Magazine, Harriman Chemsult, IntelliChem and PCI Acrylonitrile into one integrated business unit comprising its multiclient and single client services. IHS Chemical’s experts, analysts and researchers who are well respected throughout the industry for their deep-rooted analysis and forecasts, extends the value that IHS can now offer by connecting clients with the vast resource of insight and expertise that exists across IHS including energy, supply chain and economics.

**Comprehensive coverage**

IHS Chemical provides the most comprehensive chemical market content and industry expertise in the world. The company has more than 200 dedicated chemical experts working together to create a consistent and integrated view across more than 300 industrial chemical markets and 2,000 chemical processes for 95 industries. Ensure that your decisions are based on broad, comprehensive information, forecasts, intelligence, and analysis.

IHS has assembled a team of chemical experts that offers an unprecedented coverage level for core chemical markets and technologies. Backing them is a larger IHS community of experts covering related markets, from energy and the macro economy to the world’s largest chemical-using industries, such as automotive, construction and others. IHS Chemical’s intellectual capital is built on an operating model that utilizes over 1,800 consultants, researchers and economists to advance cross-disciplinary collaboration and analysis.
About IHS

IHS is the leading source of information, insight and analytics in critical areas that shape today’s business landscape. Businesses and governments in more than 165 countries around the globe rely on the comprehensive content, expert independent analysis and flexible delivery methods of IHS to make high-impact decisions and develop strategies with speed and confidence.

IHS has been in business since 1959 and became a publicly traded company on the New York Stock Exchange in 2005. Headquartered in Englewood, Colorado, USA, IHS is committed to sustainable, profitable growth and employs more than 8,000 people in 31 countries speaking 50 languages around the world.

IHS serves businesses and all levels of governments worldwide ranging from 85% of Global Fortune 500 to small businesses. IHS provides comprehensive content, software and expert analysis and forecasts to more customers in more than 180 countries worldwide.

Information, analytics, and expertise

IHS offers must-have business information, advanced research and analytics, and deep expertise in core industry sectors, such as energy and natural resources, chemicals, electronics, and transportation. We focus on business-critical workflows that support our customers’ needs, including:

- Energy Technical: Exploration-Production, Geoscience, Engineering, Commercial Development
- Product Design: Engineering Design, Research and Development
- Supply Chain: Procurement, Logistics, Operations, Manufacturing

This interconnected information, expertise, and analytics across industries and workflows allows IHS to provide best-in-class solutions that power growth and value for our customers.

Contact Information

To make an inquiry about this report, please reach out to the IHS Chemical team at:

Americas  ChemicalSalesAmericas@ihs.com  APAC  ChemicalSalesAPAC@ihs.com  EMEA  ChemicalSalesEMEA@ihs.com