

---

# WORLDWIDE REFINERY PROCESSING REVIEW

*Monitoring Technology Development and Competition in One Single Source*

---

## Fourth Quarter 2009

*Light Olefins Production*



**HYDROCARBON PUBLISHING COMPANY**

*Translating Knowledge into Profitability<sup>SM</sup>*

P.O. Box 661 Southeastern, PA 19399 (U.S.A.)

Phone: (610) 408-0117/ Fax: (610) 408-0118

[Review@Hydrocarbonpublishing.com](mailto:Review@Hydrocarbonpublishing.com)

# 4Q 2009 Review

## Light Olefins Production

### Light Olefins Production

- 3.1 MARKET/TECHNOLOGY TRENDS & OPPORTUNITIES
  - 3.1.1 *Introduction*
  - 3.1.2 *Market Conditions and Outlook*
    - 3.1.2.1 Propylene Demand and Growth
    - 3.1.2.2 Product Pricing
    - 3.1.2.3 Propylene Capacity and Source Distribution
    - 3.1.2.4 Expansion
  - 3.1.3 *Technology Competition, Directions, and Future Prospects*
    - 3.1.3.1 FCC Process and Catalyst
      - 3.1.3.1.1 Process Configuration and Operating Conditions
      - 3.1.3.1.2 Catalyst and Additive Systems
      - 3.1.3.1.3 Recovery
    - 3.1.3.2 On-purpose Techniques
      - 3.1.3.2.1 Cracking Heavier Olefins
      - 3.1.3.2.2 Metathesis
      - 3.1.3.2.3 Propane Dehydrogenation
      - 3.1.3.2.4 Methanol-to-Olefins (MTO)
    - 3.1.3.3 Trends in R&D
- 3.2 STATE-OF-THE-ART TECHNOLOGY
  - 3.2.1 *Introduction*
  - 3.2.2 *FCC Technologies*
    - 3.2.2.1 Commercial Processes
      - 3.2.2.1.1 Axens
      - 3.2.2.1.2 KBR
        - 3.2.2.1.2.1 MAXOFIN
        - 3.2.2.1.2.2 Advanced Catalytic Olefins (ACO)
      - 3.2.2.1.3 Lummus Technology
        - 3.2.2.1.3.1 Selective Component Cracking
        - 3.2.2.1.3.2 Indmax FCC (I-FCC)
      - 3.2.2.1.4 Nippon Oil Corp./Saudi Aramco
      - 3.2.2.1.5 Petrobras
        - 3.2.2.1.5.1 Double Riser FCC
        - 3.2.2.1.5.2 Downflow Reactor
      - 3.2.2.1.6 Shell Global Solutions
      - 3.2.2.1.7 Sinopec
        - 3.2.2.1.7.1 Deep Catalytic Cracking
        - 3.2.2.1.7.2 Flexible Dual-riser Fluid Catalytic Cracking
        - 3.2.2.1.7.3 FCC Process for Producing Clean Gasoline and Propylene
        - 3.2.2.1.7.4 MIP-CGP
        - 3.2.2.1.7.5 Maximizing Iso-Olefins
        - 3.2.2.1.7.6 Catalytic Pyrolysis Process
      - 3.2.2.1.8 UOP
    - 3.2.2.2 Commercial Catalysts and Additives
      - 3.2.2.2.1 Albemarle
        - 3.2.2.2.1.1 AFX
        - 3.2.2.2.1.2 Additives
      - 3.2.2.2.2 BASF Catalysts
        - 3.2.2.2.2.1 Maximum Propylene Solution (MPS)

- 3.2.2.2.2 Additive
    - 3.2.2.2.3 JGC Catalysts & Chemicals
    - 3.2.2.2.4 Grace Davison
      - 3.2.2.2.4.1 ProtAgon
      - 3.2.2.2.4.2 NEXUS
      - 3.2.2.2.4.3 NACER
      - 3.2.2.2.4.4 Additives
    - 3.2.2.2.5 Instituto Mexicano del Petróleo (IMP)
    - 3.2.2.2.6 Indian Oil Corp. (IOC)
    - 3.2.2.2.7 INTERCAT
    - 3.2.2.2.8 Sinopec
      - 3.2.2.2.8.1 Conventional FCC Catalysts
      - 3.2.2.2.8.2 FCC Catalysts for Heavy Feeds
      - 3.2.2.2.8.3 DCC Catalysts
      - 3.2.2.2.8.4 CPP Catalysts
      - 3.2.2.2.8.5 Additives
- 3.2.3 Light Olefin Recovery, Separation, and Purification
  - 3.2.3.1 Propane-Propylene Splitter for FCCU
    - 3.2.3.1.1 Shaw Group
    - 3.2.3.1.2 UOP
  - 3.2.3.2 Propylene Recovery from Refinery Offgas
    - 3.2.3.2.1 Advanced Extraction Technologies
    - 3.2.3.2.2 Air Products and Chemicals
      - 3.2.3.2.2.1 Cryogenic System
      - 3.2.3.2.2.2 Dephlegmator
    - 3.2.3.2.3 Black & Veatch
    - 3.2.3.2.4 Costain Oil, Gas & Process
      - 3.2.3.2.4.1 Light Olefin Recovery
      - 3.2.3.2.4.2 LPG Recovery
    - 3.2.3.2.5 Linde BOC Process Plants
    - 3.2.3.2.6 Shaw
  - 3.2.3.3 Butene Recovery and Separation
    - 3.2.3.3.1 Snamprogetti
    - 3.2.3.3.2 Uhde
- 3.2.4 *Cracking of Heavier Olefins to Propylene*
  - 3.2.4.1 Asahi Kasei Chemicals
  - 3.2.4.2 ExxonMobil
    - 3.2.4.2.1 Mobil Olefins Interconversion (MOI)
    - 3.2.4.2.2 Propylene Catalytic Cracking (PCC)
  - 3.2.4.3 KBR
  - 3.2.4.4 Linde/Lurgi Öl Gas Chemie
  - 3.2.4.5 Sinopec
  - 3.2.4.6 UOP/Total Petrochemicals
- 3.2.5 *Metathesis*
  - 3.2.5.1 Axens
  - 3.2.5.2 Lummus Technology
- 3.2.6 *Propane Dehydrogenation*
  - 3.2.6.1 Linde/BASF
  - 3.2.6.2 Lummus Technology
  - 3.2.6.3 Snamprogetti/Yarsintez
  - 3.2.6.4 Uhde
  - 3.2.6.5 UOP
- 3.2.7 *Methanol-to-Olefins*
  - 3.2.7.1 ExxonMobil
  - 3.2.7.2 JGC Corp./Mitsubishi Chemicals

- 3.2.7.3 Lurgi Öl Gas Chemie
- 3.2.7.4 Lummus Technology/SYN Energy Technology
- 3.2.7.5 Sinopec
- 3.2.7.6 UOP/HYDRO
- 3.2.8 *Technology Summary*
  - 3.2.8.1 Summary of Commercially Available Processes
  - 3.2.8.2 Summary of Commercially Available Catalyst and Additives
- 3.3 PLANT OPERATIONS AND PRACTICES
  - 3.3.1 *Production of Light Olefins in the FCCU*
    - 3.3.1.1 Increasing Propylene Production
    - 3.3.1.2 Balancing Propylene Production with FCC Fuel Products
    - 3.3.1.3 Increasing Isobutane and Isobutylene Production
    - 3.3.1.4 Factors Influencing the Propylene-to-butylene Production Ratio
  - 3.3.2 *Managing Revamp Costs for Producing and Recovering Higher Yields of FCC Propylene*
  - 3.3.3 *Holistic Approach to FCC Gas Plant Optimization for Improved Propylene Recovery*
  - 3.3.4 *Control Issues for Propylene-Propane Separators*
  - 3.3.5 *Polymer-Grade Propylene Compositions*
  - 3.3.6 *Processes Used to Purify FCC Propylene*
  - 3.3.7 *Integrated Refinery/Olefins Plant*
  - 3.3.8 *Energy and GHG Emissions Considerations for Light Olefins Production Alternatives*
- 3.4 REFINING R&D ALERT!
  - 3.4.1 *Introduction*
  - 3.4.2 *FCC Technologies*
    - 3.4.2.1 Process
      - 3.4.2.1.1 Multiple Reaction Zones
        - 3.4.2.1.1.1 Patents
      - 3.4.2.1.2 Dual Risers
        - 3.4.2.1.2.1 Patents
        - 3.4.2.1.2.2 Research
      - 3.4.2.1.3 Downflow Reactor
        - 3.4.2.1.3.1 Patents
      - 3.4.2.1.4 Process Configuration (Recycle), Integration, and Control
        - 3.4.2.1.4.1 Patents
      - 3.4.2.1.5 Cracking Naphtha to Enhance Propylene
        - 3.4.2.1.5.1 Patents
      - 3.4.2.1.6 Biofeeds
        - 3.4.2.1.6.1 Patents
      - 3.4.2.1.7 Miscellaneous
        - 3.4.2.1.7.1 Patents
        - 3.4.2.1.7.2 Research
    - 3.4.2.2 Catalyst
      - 3.4.2.2.1 Pore Structure
        - 3.4.2.2.1.1 Patents
      - 3.4.2.2.2 ZSM-5
        - 3.4.2.2.2.1 Patents
        - 3.4.2.2.2.2 Research
      - 3.4.2.2.3 Zeolite
        - 3.4.2.2.3.1 Patents
        - 3.4.2.2.3.2 Research
      - 3.4.2.2.4 Phosphorous-modified ZSM-5
        - 3.4.2.2.4.1 Patents
        - 3.4.2.2.4.2 Research
      - 3.4.2.2.5 Metal Phosphate
        - 3.4.2.2.5.1 Patents

- 3.4.2.2.6 Metal Oxide
  - 3.4.2.2.6.1 Patents
- 3.4.2.2.7 Oxygen Lattice
  - 3.4.2.2.7.1 Patents
- 3.4.2.2.8 Cracking Naphtha to Enhance Propylene
  - 3.4.2.2.8.1 Patents
- 3.4.2.2.9 Direct Conversion of Butane to Propylene
  - 3.4.2.2.9.1 Patents
  - 3.4.2.2.9.2 Research
- 3.4.3 *Light Olefin Recovery, Separation, and Purification*
  - 3.4.3.1 Propane-Propylene Splitter
    - 3.4.3.1.1 Distillation/fractionation
      - 3.4.3.1.1.1 Patents
      - 3.4.3.1.1.2 Research
    - 3.4.3.1.2 Absorption
      - 3.4.3.1.2.1 Patents
      - 3.4.3.1.2.2 Research
    - 3.4.3.1.3 Membrane
      - 3.4.3.1.3.1 Patents
      - 3.4.3.1.3.2 Research
  - 3.4.3.2 Propylene Recovery from Offgas
    - 3.4.3.2.1 Patents
    - 3.4.3.2.2 Research
- 3.4.4 *Cracking of Heavier Olefins to Propylene*
  - 3.4.4.1 Patents
  - 3.4.4.2 Research
- 3.4.5 *Metathesis*
  - 3.4.5.1 Process
    - 3.4.5.1.1 Patents
  - 3.4.5.2 Catalyst
    - 3.4.5.2.1 Patents
    - 3.4.5.2.2 Research
- 3.4.6 *Propane and Butane Dehydrogenation*
  - 3.4.6.1 Process
    - 3.4.6.1.1 Patents
  - 3.4.6.2 Catalyst
    - 3.4.6.2.1 Patents
    - 3.4.6.2.2 Research
- 3.4.7 *Methanol-to-Olefins*
  - 3.4.7.1 Process
    - 3.4.7.1.1 Patents
  - 3.4.7.2 Catalysts
    - 3.4.7.2.1 Patents
    - 3.4.7.2.2 Research

### 3.5 REFERENCES