Honeywell Technology Summit Kuwait

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Oleflex™ "Light Paraffin Dehydrogenation"
Overview of Propane Dehydrogenation Technology – C₃ Oleflex
Overview of Isobutane/ N Butane Dehydrogenation Technology – C₄ Oleflex
C₃ Oleflex Process Configuration
Advantages of the Oleflex Technology
Brief Introduction of ISOALKY™ Technology
Why Produce Olefins from LPG?

**Feedstocks**
- Propane
- Propane + Isobutane
- Isobutane

**Products**
- Propylene
- Propylene + Contained Isobutylene
- Contained Isobutylene

**Uses**
- Fiber
- Packaging
- High performance plastic
- Gasoline Blending Components
- MTBE
- ETBE
- Iso-Octane
- Synthetic Rubbers & Acrylics

**Oleflex is the best technology for Dehydrogenation**

UOP Oleflex Process
A PDH plant converts one feed ($C_3$ LPG) … into one primary product (propylene) … with the option to export by-product hydrogen.

Key Features …

- One feed – one product
- Simple back integration
- Proven Investment

- Low Capital Intensity
- Highest Yield of Propylene
- Attractive Rate of Return
Propylene Demand Worldwide

- "Propylene Gap"
  - Steam Crackers shifting to lighter feedstocks
  - Refiners limited by low gasoline growth in many regions

- "On-Purpose Propylene" filling the gap
  - UOP Oleflex Process
  - UOP Advanced MTO
  - UOP/Total Olefin Cracking
  - UOP RxPro & PetroFCC

Data Source: IHS Chemical

UOP technologies are supplying the needs of the market!
C$_3$ Oleflex Process

- Continuous Operation Design
- >250 CCR’s in Operation Today
Maximize LPG Profitability with Oleflex Dehydrogenation Technology

- **Butamer** technology converts \( nC_4 \) to \( iC_4 \)
- **Oleflex** for dehydrogenation of your light paraffins
  - Can directly process \( iso\)-butane, \( n\)-butane or mixed butane feeds

Choose your product:

- Ethermax™ for MTBE production (or ETBE)
- Alkylate production options
  - IsoAlky™ (NEW ionic liquid alkylation technology)
  - AlkyPlus™ (HF alkylation) or Sulfuric Acid Alkylation
  - InAlk™ (indirect alkylation)
C₄ Oleflex - Way to Minimize Light Naphtha Export

- In order to maintain the octane of the gasoline pool; some refineries might not be able to add all light naphtha (as isomerate) into the gasoline pool and some of the naphtha will be exported.

- Increasing Alkylate and MTBE production using field butanes will allow addition of more light naphtha as isomerate into the gasoline pool. This can eliminate light naphtha export.
High market activity in response to end-product demand and feedstock availability
Since 2013, 13 new units commissioned in China and 1 in USA
3 Mixed $C_3/C_4$, 6 BDH and 5 PDH
C₃ Oleflex Process Configurations

**C₃ Oleflex Complex**

- Net Gas
- Oleflex Unit
- Deethanizer
- SHP
- Propylene
- P-P Splitter
- Propane
- C₄⁺
Key Advantages of the Oleflex Process

• Highest Return on Investment (ROI)
  – Lowest Capital Cost
    ▪ Small and few reactor vessels
    ▪ Small process line diameters and small reactor vessels
    ▪ Small (fewer stages) and simple reactor effluent compressor
    ▪ Small ISBL Plot Area
  – Lowest Operating Cost
    ▪ Low propane consumption throughout catalyst life.
    ▪ Platinum in the catalyst is recoverable and reusable, avoids disposal costs
    ▪ Low energy usage

• Smallest Environmental Footprint
  – Lowest energy usage
  – Lowest CO₂, NOx, SOx, VOC emissions and water usage
  – Fully recyclable Pt based catalyst. Non-toxic catalyst system
Key Advantages of the Oleflex Process

• **High Process Reliability / Ease-of-Operation / Design Flexibility**
  – Continuous independent reactor/regenerator sections for ease-of-operation enabled by CCR technology
  – Ability to change-out catalyst and perform maintenance on CCR section without shutting unit down
  – Easy to load and unload catalyst system
  – Positive Pressure design
  – Flexible utility design (green-field and brown-field sites)

• **World-Class Service Organization (S/U + Post S/U); RS, FOS & TS**

• **Unmatched Commercial Experience**

• **Commitment to Continuous Innovation**
  – Significant investment in R&D year over year
  – Oleflex Users Conferences
ISOALKY™ - Ionic Liquid Alkylation
New Era for an Old Process
Ionic Liquid (IL) Catalysts

- Ionic Liquids are salts that are liquid phase at low temperature
  - Typically the anion and cation are both large and the cation has a low degree of symmetry
  - These factors reduce the lattice energy of the crystalline form of the salt and lead to a low melting point
- Acidic ionic liquids can have acidity that is orders of magnitude higher than HF or $\text{H}_2\text{SO}_4$
- In contrast to typical liquid acids, ionic liquids are safer to handle
  - Vapor pressure near zero
  - Thermally stable
ISOALKY Simplified Flow Diagram

Four Distinct Areas
- Feed Treating
- Alky Reactor & Separation
- Product Distillation and Finishing
- Ionic Liquid Catalyst Regeneration
A Better Way to Alkylate

• How ISOALKY Works
  – Utilizes strong acid function of IL for alkylation reaction
  – Process design similar to existing alkylation technology
  – Small, in-situ catalyst regeneration

• ISOALKY Performance
  – Low catalyst inventory and catalyst consumption 400 times lower than sulfuric acid alkylation
  – Improved feed flexibility and performance in C$_3$-C$_5$ range for maximum upgrade potential
  – No heavy oil byproduct
  – Equivalent or better alkylate yield and octane

• ISOALKY achieves equivalent or better economic performance relative to sulfuric acid alkylation
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