Successful Operation of the First AlkyClean®
Solid Acid Alkylation Unit

June 29, 2017
AIChE Lecture Dinner Meeting

A World of Solutions
OVERVIEW

- Leading provider of technology and infrastructure for the energy industry
- 125+ years of experience and expertise in reliable solutions
- $19.3 billion backlog (Mar. 31, 2017)
- More than 40,000 employees worldwide
- Relentless focus on safety: 0.00 LTIR (Mar. 31, 2017)
CORE VALUES

SAFETY + ETHICS + TEAMWORK + INNOVATION
Site of Technology’s birth in 1977:
Larry Smith’s Laundry Room
Pasadena, Texas
From here..... in 1988

South Houston Site –

Commercial Development Unit

(CDU)
State of the Art Research Facilities in Pasadena, Texas
BREADTH OF SERVICES

2017 Q1 Operating Income

Technology
- Licensed technology
- Proprietary catalysts
- Technical services

Fabrication Services
- Fabrication & erection
- Process & modularization
- Pipe fitting and distribution
- Engineered products
- Specialty equipment

Engineering & Construction
- Engineering
- Procurement
- Construction
- Commissioning

Capital Services
- Program management
- Maintenance services
- Remediation and restoration
- Emergency response
- Environmental consulting
Capabilities

- Petrochemical, gas processing and refining technologies
- Proprietary catalysts
- Consulting and technical services

Differentiation

- Most complete portfolio of olefins technologies
- World leader in heavy oil upgrading technologies
- Breadth of technologies provides complete solutions
Commitment to Technology: R&D

Chevron Lummus Global, Chevron, Richmond, CA
Lummus Novolen Technology, BASF Site, Ludwigshafen, Germany
Technology Development & Manufacturing Center, Pasadena, TX

Over 3500 Patents

Core Values: Safety, Ethics, Teamwork and Innovation
2005-2015 Technology Awards

- Asia Pacific: 19%
- China: 15%
- CIS/Easter Europe: 9%
- Middle East/Africa: 13%
- North America: 27%
- South America: 4%
- Western Europe: 6%

Technology Awards:

<table>
<thead>
<tr>
<th>Technology</th>
<th>Awards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene</td>
<td>39</td>
</tr>
<tr>
<td>OCT/CPT</td>
<td>36</td>
</tr>
<tr>
<td>MTO/LPR</td>
<td>18</td>
</tr>
<tr>
<td>Ethylbenzene/Styrene</td>
<td>19</td>
</tr>
<tr>
<td>Butadiene Extraction</td>
<td>24</td>
</tr>
<tr>
<td>CATOFIN® Dehydrogenation</td>
<td>15</td>
</tr>
<tr>
<td>Cumene/Phenol</td>
<td>6</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>19</td>
</tr>
<tr>
<td>Other Petrochemical</td>
<td>11</td>
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<tr>
<td>Ethers</td>
<td>19</td>
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<tr>
<td>Gasoline HDS</td>
<td>28</td>
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<tr>
<td>Delayed Coking</td>
<td>23</td>
</tr>
<tr>
<td>FCC</td>
<td>36</td>
</tr>
<tr>
<td>Alkylation</td>
<td>6</td>
</tr>
<tr>
<td>ISOCRACKING®</td>
<td>39</td>
</tr>
<tr>
<td>ISOTREATING®</td>
<td>27</td>
</tr>
<tr>
<td>Lubes (dewaxing/hydrofinishing)</td>
<td>25</td>
</tr>
<tr>
<td>RDS/VRDS/OCR/UFR</td>
<td>18</td>
</tr>
<tr>
<td>Visbreaking</td>
<td>15</td>
</tr>
<tr>
<td>Other Refining</td>
<td>11</td>
</tr>
<tr>
<td>Sulfur</td>
<td>66</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>63</td>
</tr>
<tr>
<td>Gas Processing</td>
<td>32</td>
</tr>
<tr>
<td>Coal/Petcoke Gasification</td>
<td>6</td>
</tr>
</tbody>
</table>

(as of 12/2015)
Refining Technologies

- **Conversion Processes**: Hydrocracking, Fluid Catalytic Cracking (FCC), Alkylation, Dewaxing, Reforming
- **Residue Upgrading Processes**: LC-FINING, Residue Desulfurization, Delayed Coking, Visbreaking
- **Treatment Processes**: Hydrotreating, Hydrodesulfurization (HDS)
CB&I’s Innovative Technology Bundling

Maximize flexibility to address market changes

ARDs/ VRDS, Virgin Gas Oils / Residues, HT VGO

Indmax (R)FCC

Dry gas → LPR Ethylene Recovery → Ethylene → Dimers

C₃s → PRU → C₃ LPG

C₄s → CDIsom → Propylene

C₅s → OCT → Alkylate

Ether/Dimer Technologies → MTBE/ETBE/TAME/Dimers

Gasoline HDS CDHydro/CDHDS → Ultra Low Sulfur Gasoline

Naphtha HDS+ BTX Extraction → Benzene, Toluene, Mixed Xylenes

Slurry Oil → LCO product

Coal → Delayed Coking

PetCoke → Gasification E-Gas → Anode/Needle coke

H₂, Steam, Power, SynGas & Chemicals

Higher Octane Gasoline
What is Driving the Demand for Octane?

- Global Fuel Demand Increasing, Including Gasoline
- High Octane Components Being Removed from Gasoline Pool
- Tighter Government Mandates
- Higher Performance Engines Requirements
- Overall Octane Deficit

<table>
<thead>
<tr>
<th></th>
<th>China V</th>
<th>US Tier 3</th>
<th>California CaRFG3</th>
<th>Euro 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur, ppm</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Olefins, %</td>
<td>24</td>
<td>10</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>Aromatics, %</td>
<td>40</td>
<td>25</td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td>Benzene, %</td>
<td>1</td>
<td>0.62</td>
<td>0.7</td>
<td>1</td>
</tr>
<tr>
<td>RVP, kPa Winter/Summer</td>
<td>85/65</td>
<td>7.0 psi ~48 kPa</td>
<td>7.0 psi ~48 kPa</td>
<td>60</td>
</tr>
</tbody>
</table>
How Do We Address the Octane Balance Competitively?

• Blend options for meeting the octane demand
  ▪ Reformate
    ▪ High aromatics content
    ▪ Associated yield loss at high severity operation
  ▪ Ethers (except US)
    ▪ Acceptable, up to the oxygen content limit
  ▪ Bio-ethanol
  ▪ Iso-octane/ Iso-octene
    ▪ No volume gain on olefin
  ▪ Alkylate
    ▪ The ‘Preferred’ blend component
    ▪ No olefins or aromatics, low Sulfur, low RVP
Octane Balance in a Refinery

- Octane Loss must be compensated by using higher value octane boosters – reformate, alkylate, MTBE.
- Typical value of octane: ~US$ 1 / bbl / octane point.
- Example:
  - 75,000 BPSD FCC gasoline, 1 RON point octane loss.

Cost of 1 RON Point = US$ 23 million, every year.
Blending Properties of Some Gasoline Blending Stocks

![Graph showing blending properties of gasoline blending stocks](image)

- **Pentenes**
- **LCN**
- **Alkylate**
- **MTBE**

**Axes:**
- **CLEAR RESEARCH OCTANE NUMBER (RON)**
- **REID VAPOR PRESSURE, RVP (psig)**

**Legend:**
- Pentenes
- LCN
- Alkylate
- MTBE
Main Reaction

\[
\text{Iso-butylene} + \text{Methanol} \rightarrow \text{MTBE}
\]

\[\text{CH}_3\text{-C} = \text{CH}_2\text{CH}_3\]

\[\text{CH}_3\text{OH}\]

\[\text{CH}_3\text{-C-O-CH}_3\text{CH}_3\]
### Primary Alkylation Reaction

**C3 Olefin Alkylation:**
- \(iC_4 + C_3 = \rightarrow C_7 \text{ Alkylate}\)
- \(2iC_4 + C_3 = \rightarrow C_3 + C_8 \text{ Alkylate}\)

**C4 Olefin Alkylation:**
- \(iC_4 + C_4 = \rightarrow C_8 \text{ Alkylate}\)
  - 2,2,4-trimethylpentane (TMP) \(\text{RON: 100}\)
  - 2,3,3 TMP \(\text{RON: 106}\)
  - 2,3,4 TMP \(\text{RON: 109}\)

**C5 Olefin Alkylation:**
- \(iC_4 + C_5 = \rightarrow C_9 \text{ Alkylate}\)
- \(2iC_4 + C_5 = \rightarrow iC_5 + C_8 \text{ Alkylate}\)
Undesirable Side Reactions

- **Polymerization**  \[ xC_4H_8 \rightarrow C_4xH_{8x+2} \]
- **Hydrogen Transfer**  \[ 2 \text{iC}_4H_{10} + C_5H_{10} \rightarrow C_8H_{18} + C_5H_{12} \]
- **Disproportionation**  \[ 2 C_8H_{18} \rightarrow C_7H_{16} + C_9H_{20} \]
- **Cracking**  \[ C_xH_{2x+2} \rightarrow C_yH_{2y} + C_{x-y}H_{2(x-y)+2} \]
- **Contaminants, i.e., Oxygenates, Butadiene, Mercaptans, Aromatics**

By-Products

- **Acid Soluble Oil (ASO)**
  - **Esterification**  \[ C_4H_8 + H_2SO_4 \rightarrow \text{MBS mono-butyl sulfate} \]
  - **Polymerization**  \[ xC_4H_8 \rightarrow C_4xH_{8x+2} \]
  - **SO2**  \[ H_2SO_4 + C_xH_y (ASO) \rightarrow 2H_2O + SO_2 + C_xH_{y-2} \]

Strategy: Minimize undesirable side reactions with Colder Reaction Temperatures

For C4= & C5= operating at LOW TEMPERATURE is even more CRITICAL!
• **HF Alkylation**
  – High quality alkylate, low acid consumption, good feedstock flexibility
  – Extremely hazardous; not preferred anymore
  – Some refiners are considering shutting down existing units due to risk profile
  – Public pressure is growing due to safety and environmental risks

• **Sulfuric Acid (SA) Alkylation**
  – The alkylation technology of choice for refiners at this time
  – Currently the best choice in balancing the safety/operability issues with benefits of high quality alkylate (particularly at low temperatures)
  – **CDAAlky** has become the technology of choice for sulfuric acid alkylation
CDAAlky® Has Become the Alkylation Technology of Choice:
- ~120 kBPD Alkylate Capacity by 2020

<table>
<thead>
<tr>
<th>Licensee</th>
<th>Capacity</th>
<th>Start-up</th>
<th>Awarded</th>
<th>Feedstock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sincier, PRC (1)</td>
<td>5,000</td>
<td>200</td>
<td>2013</td>
<td>2012 C4 Raffinate</td>
</tr>
<tr>
<td>Haiyue, PRC (1)</td>
<td>15,000</td>
<td>600</td>
<td>2014</td>
<td>2011 C4 Raffinate</td>
</tr>
<tr>
<td>Tianheng, PRC (1)</td>
<td>5,000</td>
<td>200</td>
<td>2014</td>
<td>2012 C4 Raffinate</td>
</tr>
<tr>
<td>YuTianHua, PRC</td>
<td>6,800</td>
<td>265</td>
<td>2017</td>
<td>2014 C4 Raffinate</td>
</tr>
<tr>
<td>S-Oil, Korea (2)</td>
<td>16,000</td>
<td>624</td>
<td>2018</td>
<td>2014 C4s</td>
</tr>
<tr>
<td>Pertamina, Indonesia (2)</td>
<td>7,400</td>
<td>290</td>
<td>2019</td>
<td>2016 FCC C4s</td>
</tr>
<tr>
<td>Undisclosed, USA (2)</td>
<td>23,000</td>
<td>900</td>
<td>2020</td>
<td>2016 FCC C5s</td>
</tr>
<tr>
<td>Zhejiang Pet. Co. (ZPC), PRC</td>
<td>14,000</td>
<td>555</td>
<td>2018</td>
<td>2016 C4 Raffinate</td>
</tr>
<tr>
<td>Yanchang, PRC</td>
<td>5,000</td>
<td>200</td>
<td>2019</td>
<td>2016 C4 Raffinate</td>
</tr>
<tr>
<td>PetroChina Location 1, PRC</td>
<td>12,000</td>
<td>420</td>
<td>2018</td>
<td>2017 C4 Raffinate</td>
</tr>
<tr>
<td>PetroChina Location 2, PRC</td>
<td>5,000</td>
<td>200</td>
<td>2018</td>
<td>2017 C4 Raffinate</td>
</tr>
<tr>
<td>PetroChina Location 3, PRC</td>
<td>6,500</td>
<td>250</td>
<td>2018</td>
<td>2017 C4 Raffinate</td>
</tr>
</tbody>
</table>

Footnotes:
(1) Exceeded all performance guarantees
(2) Operate conventional sulfuric acid alkylation unit
Development Timeline – Looking ahead 5-7 years
Emerging Commercialized Alkylation Options

- **Ionic Liquid (IL) Alkylation**
  - Ionic Liquid alkylation was commercialized in a 100 KTA unit in China (2013)
  - Potentially removes some of the safety and hazard issues:
    - This needs to be confirmed particularly in co-catalyst preparation
  - Capital intensive: $130 MMUSD for 100 KTA (complex IL/HC separation)
  - High utility consumption: 50% more than sulfuric acid alkylation
  - Chlorides in the alkylate product: Post-treatment unavoidable
  - Reported alkylate quality value falls short of a technology breakthrough

- **Solid Acid Catalyst Alkylation**
  - Inherently safer than liquid acid technologies, particularly HF
  - Optimized for low to average alkylate capacities
  - CB&I and Albemarle successfully commercialized the first solid acid alkylation technology in China in 2015 using AlkyClean® technology (capacity 2,700 BPD)
  - AlkyClean technology is the first and only commercialized solid acid alkylation technology in the world
• Challenges with HF Alkylation Units:
  – Safety issues
  – Environmental issues
  – Operational issues

• Revamps & Grassroots Solution offered by CB&I and Albemarle:
  An environmentally friendly and competitive Solid Acid Catalyst technology to replace HF alkylation technology: AlkyClean
HF Alkylation

- Olefins
- Pretreatment
  - i-butane
- Reaction
  - HF
  - Main Fractionator
  - HF Polymer
  - HF Stripper
  - KOH Treater
- Propane
- n-butane
- Debutanizer
- Alkylate

- Acid/HC contacting done with eductor or recirculation
- Reaction temperatures near ambient (38°C)
- HF regeneration by fractionation
- Numerous fractionation product schemes
- Product and by-product clean-up required
HF Alkylation: Safety Issues

Incident at Gumi, S-Korea
• September 27, 2012
• Unloading of HF to Storage Tank
• 5 people died
• 18 people injured
• > 3000 people evacuated
• Difficult to approach
• Difficult to decontaminate
• Agricultural damage
• Vehicle damage
• Livestock affected
HF Alkylation: Environmental Issues

- Avoiding HF Release
- Minimizing HF Handling:
  - Transportation
  - Storage/Inventory
  - Regeneration
- Minimizing Waste Disposal
- Minimizing Impact of Other Refinery Units Incidents:
  - Potential major impact
  - Torrance refinery

➢ Costly & Continuous Mitigation Required
Inherent Drawbacks of HF Alkylation:
- Expensive materials used to avoid/minimize corrosion
- Corrosion, Plugging likely in isoStripper due to HF breakthrough
- Breakthrough of HF with products/by-products
- Post-treatment of products required

Maintenance & Turnaround:
- Frequent turn-around needed
- Time on stream reduced significantly
- Safety Risks

Production:
- Yield Loss due to the production of Acid Soluble Oil (ASO)

Operability:
- Operation more difficult compared to other refining units
Client Value Proposition – AlkyClean

- Commercially proven with over 1 year of successful operation
- Inherently Safer and Environmentally Friendly
  - No liquid acid used in the process
  - No corrosion
  - No safety risks through exposure
- Significant Operational Risks Reduction
  - Eliminate HF safety risks
- Very Easy to Maintain and Operate
  - Simple & robust operation: Fixed beds
  - No corrosion
- High Product Quality
  - Higher octane alkylate
  - No Acid Soluble Oil
• **Only** Solid Acid Alkylation Process **Commercially Proven**

• Catalyst Supplier Albemarle:
  – Leader in catalyst manufacturing
  – Leader in catalyst development

• Optimized Catalyst Regeneration System:
  – Longer catalyst cycle/life

• Tolerant to Feed Contaminants by Design
  – Process design
  – Catalyst
• Reactor Type: Fixed Bed Reactor …
  – Well Know & Easy to Operate
• Catalyst Type: AlkyStar™
  – Zeolite Based Catalyst
  – Noble Metal Function
• Catalyst Regeneration Scheme: Maintain Catalyst Activity…
  – Regular & Cyclical at the Alkylation Conditions
  – Occasional Regeneration at Higher Temperature
AlkyClean Development – A Brief History

• **CB&I and Albemarle Catalysts:**
  - Cooperation since 1996
  - Bench scale pilot unit in Amsterdam

• **First Licensee: Shandong Wonfull, Zibo, China**
  - 100 KTA alkylate capacity
  - CB&I executed process design package in 2013
  - Start-up: August 2015

• **AlkyClean Awards**
  - 2016 Presidential Green Chemistry Award from the U.S. EPA
AlkyClean References: Shandong Wonfull, Zibo, China

- Alkylate Production: 100 KTA – 2,700 BPD
- Started up 2015
Oxygenates, sulfur, nitriles and basic nitrogen components are removed to reach the AlkyStar catalyst impurities specification.

A Selective Hydrogenation Unit is included to reduce the concentration of Butadiene in the feedstock.

Hydrogen Rich Fuel Gas

Hydrogen

Make-up i-Butane

Olefin Feed

Imported MTBE Raffinate

Feed Pretreatment

Reaction Section (3 Parallel Reactors)

Product Fractionation Section

Catalyst Regeneration

i-Butane

n-Butane Product

Alkylate Product

100 kTa alkylate

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Reactor Regeneration Optimization

**i-C₄ feed**  →  **Olefin feed**

**Alkylation**

**Mild Regeneration**

**H₂**

**Continuous Operation at 50 to 90°C**

**Occasionally H₂ Regeneration at 250-275°C**

**Alkylate**
Shandong Wonfull: AlkyClean Product Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>RON</td>
<td>95-97</td>
</tr>
<tr>
<td>Sulfur</td>
<td>&lt; 1 ppm</td>
</tr>
<tr>
<td>RVP</td>
<td>&lt; 50 kPa</td>
</tr>
<tr>
<td>ASTM D-86 FBP</td>
<td>&lt; 208°C</td>
</tr>
</tbody>
</table>

The chart below shows the RON values over time from 08/15 to 02/16.
# Feedstock / Operating Conditions Comparison

## Operating Conditions Comparison

<table>
<thead>
<tr>
<th></th>
<th>AlkyClean</th>
<th>HF Acid</th>
<th>Sulfuric Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature, °C</td>
<td>50-90 °C</td>
<td>32-38 °C</td>
<td>-3 - 10 °C</td>
</tr>
<tr>
<td>Feed I/O (External)</td>
<td>15 - 20 / 1</td>
<td>12 - 15 / 1</td>
<td>8 - 10 / 1</td>
</tr>
</tbody>
</table>

## Feedstock olefin variation sensitivity

<table>
<thead>
<tr>
<th></th>
<th>AlkyClean</th>
<th>HF Acid</th>
<th>Sulfuric Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butene-2</td>
<td>Base</td>
<td>Base</td>
<td>Base</td>
</tr>
<tr>
<td>Butene-1</td>
<td>Base</td>
<td>Base - 4.0 RON</td>
<td>Base</td>
</tr>
<tr>
<td>Iso-Butene (25 vol%)</td>
<td>Base - 0.5 RON</td>
<td>Base - 0.5 RON</td>
<td>Base - 1.0 RON</td>
</tr>
<tr>
<td>Propylene (30 vol%)</td>
<td>Base - 1.0 RON</td>
<td>Base - 1.0 RON</td>
<td>Base - 1.5 RON</td>
</tr>
</tbody>
</table>
HF Alkylation Unit Revamps

Olefins → Pretreatment → Main Fractionator → Reaction → HF Stripper → KOH Treater → Debutanizer → HF/Water → HF Polymer → Polymer Column

i-butane → Reaction → HF → HF Polymer

Propane → n-butane → Alkylate
• Feed Pretreatment requirements similar

<table>
<thead>
<tr>
<th>Feed Pretreatment Requirements</th>
<th>HF Alkylation</th>
<th>AlkyClean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercaptan Removal</td>
<td>Recommended</td>
<td>Recommended</td>
</tr>
<tr>
<td>Water Removal</td>
<td>Recommended</td>
<td>Recommended</td>
</tr>
<tr>
<td>Selective Hydrogenation</td>
<td>Recommended</td>
<td>Recommended</td>
</tr>
<tr>
<td>Hydro-Isomerization</td>
<td>Recommended</td>
<td>Not Needed</td>
</tr>
</tbody>
</table>

➢ Feed Pretreatment section can be reused
➢ If Hydro-Isomerization function exists, catalyst cost is reduced
Differences between HF Alkylation and AlkyClean

<table>
<thead>
<tr>
<th>Reaction Condition Comparison</th>
<th>HF Alkylation</th>
<th>AlkyClean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reaction Temp</td>
<td>Ambient</td>
<td>50 - 90 °C</td>
</tr>
<tr>
<td>Heat Removal</td>
<td>Cooling Water</td>
<td>Cooling Water</td>
</tr>
<tr>
<td>Acid/Hydrocarbon contacting/separation</td>
<td>Required</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Acid volume</td>
<td>Required</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

- Reaction Section replaced by AlkyClean reactors and associated equipment
• HF IsoStripper:
  – Slightly Lower I/O ratio: 12-15 vs. 15-20
  – IsoStripper Trays may be replaced—High Capacity Trays

• HF Product Treaters:
  – HF Stripper is not required
  – KOH Treater is not required

• HF Regeneration:
  – HF polymer (rerun) column is not required
HF Alkylation

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## HF Alkylation Revamp to AlkyClean

<table>
<thead>
<tr>
<th>Section</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Pretreatment Section</td>
<td><strong>Reuse</strong></td>
</tr>
<tr>
<td>HF Regeneration Section</td>
<td><strong>Decommission</strong> HF polymer (rerun) column</td>
</tr>
<tr>
<td>HF Reactors Section</td>
<td><strong>Decommission</strong> Reactor Section to AlkyClean Reactors</td>
</tr>
<tr>
<td>HF Product treaters</td>
<td><strong>Decommission</strong> HF Strippers &amp; KOH Treaters</td>
</tr>
<tr>
<td>HF Alkylate Fractionation</td>
<td><strong>Reuse and/or Revamp</strong></td>
</tr>
</tbody>
</table>
HF Alkylation Revamp to AlkyClean: Incentives

- Safety: Peace of Mind
- Product quality: Higher
  - No ASO = Higher Yield
  - Higher RON, due to insensitivity for Butene-1
  - Impact of products on downstream units None
- Continuous cost of HF mitigation: Eliminated
- Maintenance Cost: Eliminated
  - No replacement of expensive materials
  - No corrosion issues
  - Less frequent shutdowns & turn around
- Operating costs: Similar
  - Catalyst instead of HF acid processing
Conclusions

• CB&I and Albemarle Successfully Developed & Commercialized The World’s First Solid Catalyst Alkylation Process: AlkyClean

• AlkyClean Technology is Proven & Demonstrated:
  – High Alkylate Product Quality
  – Economically Viable

• Can easily Revamp HF Alkylation Units to AlkyClean

• AlkyClean Process Utilizes a Commercialized Solid Acid Catalyst, and therefore:
  – Is an Inherently Safer Alkylation Technology
  – Releases Refiners of HF Safety, Environmental and Operational issues
  – Provides Refiners with Peace of Mind