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UOP Technologies for Distillate Production
Hydrocracking Innovations

2017 Honeywell Oil & Gas Technologies Symposium

May 15, 2017
Cairo, Egypt
May 17, 2017
Alexandria, Egypt
64 Years in Hydroprocessing Innovations

- Unionfining Units
- Unicracking Units

Licensed Capacity, BPSD

- 340+ Unionfining Units & 220+ Unicracking Units Licensed

- 1952: 1st Unionfining™ Unit
- 1960: 1st Unicracking™ Unit
- 1990s: HPNA Management
- 2006: ExxonMobil Lubes & Fuels Alliance
- 2008: E2S Process
- 2011: ExxonMobil Uniflow™ Reactor Internals 4th Generation
- 2012: ExxonMobil

UOP Hydroprocessing Experience

- Unity™ Hydroprocessing Catalysts

ExxonMobil
# Hydrocracking Technology Portfolio

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Unicracking Reactor Section</th>
<th>Unicracking Fractionation Section</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distillate</td>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td>Naphtha</td>
</tr>
<tr>
<td>LCO</td>
<td><img src="image3" alt="Diagram" /></td>
<td><img src="image4" alt="Diagram" /></td>
<td>Kero/Jet Fuel</td>
</tr>
<tr>
<td>VGO</td>
<td><img src="image5" alt="Diagram" /></td>
<td><img src="image6" alt="Diagram" /></td>
<td>Diesel Fuel</td>
</tr>
<tr>
<td>CGO</td>
<td><img src="image7" alt="Diagram" /></td>
<td><img src="image8" alt="Diagram" /></td>
<td>Lubes</td>
</tr>
<tr>
<td>DAO</td>
<td><img src="image9" alt="Diagram" /></td>
<td><img src="image10" alt="Diagram" /></td>
<td>EMCL MSDW™ &amp; MAXSAT™ Technology</td>
</tr>
</tbody>
</table>

**Customized Solutions to Meet Customer Objectives**
Portfolio of Multiple Solutions

Heavy Oil Processing

Hydroprocessing Catalysts

UOP Uniflex Process

ExxonMobil
Distillate Dewaxing and Lube Base Oil Production

Crystaphase CatTrap

Honeywell Process Control Solutions
Operational Needs
- Maintaining Throughput
- End of Run
- Maintaining Yields
- Maintaining Product Qualities

Improved Profitability and Flexibility

Next Cycle
- Reactor Performance
- Opportunity Feedstocks
- Product Slate Flexibility
- Enhanced Product Qualities
- Improved Product Yield

Long Term
- Increased Throughput
- UCO Utilisation
- High Conversion
- Improved Energy Efficiency
- Greater Product Recovery
Next Cycle Opportunities

- **Catalyst Selection**
  - Increased Yields
  - Improved Product Qualities

- **Increased Conversion**
  - HPNA Management

- **Improved Reactor Performance**
  - Reactor Replacements
    - Opportunities for improved operation
  - Uniflow Reactor Internals
    - Reduced quench zone height
    - Shorter installation time
    - Easier maintenance
    - Improved Distribution
Improved Distribution with UOP Uniflow Reactor Internals

- New design offering a step change in performance & speed of installation
- First sale in 2013
- Sold into 20 units (new and revamp) with 10 operating successfully

Example: Installed in 5-bed HC reactor in Nov, 2014. Unit operating at 32% higher feed rate compared to previous cycle.

<table>
<thead>
<tr>
<th>Hydrocracking Bed</th>
<th>Radial Spread (°F) New Cycle</th>
<th>Radial Spread (°F) Previous Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed 1</td>
<td>Top: 1 Bottom: 1</td>
<td>Top: 3 Bottom: 18</td>
</tr>
<tr>
<td>Bed 2</td>
<td>Top: 4 Bottom: 3</td>
<td>Top: 2 Bottom: 6</td>
</tr>
<tr>
<td>Bed 3</td>
<td>Top: 4 Bottom: 2</td>
<td>Top: 5 Bottom: 6</td>
</tr>
<tr>
<td>Bed 4</td>
<td>Top: 4 Bottom: 3</td>
<td>Top: 12 Bottom: 36</td>
</tr>
<tr>
<td>Bed 5</td>
<td>Top: 4 Bottom: 4</td>
<td>Top: 11 Bottom: 45</td>
</tr>
</tbody>
</table>

Customer Feedback:

“We would never have been able to operate this unit where it is today without these new internals. This is a step change for UOP”
UOP Uniflow™ Reactor Internals

Chimney technology

New UOP Uniflow technology
MIDOR Refinery Expansion Project
Boosting Refinery Capacity – 100,000 to 160,000 BPSD

Project Objectives
• Refinery throughput increased 60%
• Maximising middle distillate yield
• Meet future legislation of high quality EuroV specifications
• Zero fuel oil production

Additional Requirements
• Maximum utilisation of existing refinery units
• Minimise refinery downtime
• Limited plot space
MIDOR Refinery Expansion Project
Boosting Refinery Capacity – 100,000 to 160,000 BPSD
MIDOR Refinery Expansion Project
Current Kerosene and Diesel Processing Configuration

Current Configuration
• Targets local diesel production
• Kerosene to Jet A1 pool only
• No ability to achieve EuroV diesel specifications
Unicracking Unit
Existing Configuration

Separation
Fractionation

Make-up Gas

33,000 BPSD VGO+HCGO

17,000 BPSD

Naphtha
Kerosene
Diesel
UCO

Unicracking Unit
Existing Configuration

Separation
Fractionation

Make-up Gas

33,000 BPSD
VGO+HCGO

17,000 BPSD

Naphtha
Kerosene
Diesel
UCO

Unicracking Unit
Existing Configuration

Separation
Fractionation

Make-up Gas

33,000 BPSD
VGO+HCGO

17,000 BPSD

Naphtha
Kerosene
Diesel
UCO
**Unicracking Unit**

**New Configuration**

- **50,000 BPSD**
  - VGO+HCGO+DAO

- **Uniflow Reactor Internals**

- **Make-up Gas**

- **New RG Scrubber**

- **Separation**
  - 35,000 BPSD
  - UCO

- **Fractionation**

- **Common H₂ Recovery**

- **Naphtha**
- **Kerosene**
- **Diesel**

- **MUG**
  - UCO

- **Separation**

- **Fractionation**
  - **HPNA Management**

- **50,000 BPSD**
  - VGO+HCGO+DAO
MIDOR Refinery Expansion Project
Boosting Refinery Capacity – 100,000 to 160,000 BPSD

- Investment cost of $1.8 billion
- EPC Phase expected to commence 4th quarter 2017
- Internal rate of return 30% confirming the economic importance of the expansion.

<table>
<thead>
<tr>
<th>Product</th>
<th>% Increase</th>
</tr>
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<tbody>
<tr>
<td>LPG</td>
<td>84%</td>
</tr>
<tr>
<td>High Octane Gasoline</td>
<td>52%</td>
</tr>
<tr>
<td>Jet Fuel</td>
<td>180%</td>
</tr>
<tr>
<td>Diesel</td>
<td>33%</td>
</tr>
<tr>
<td>Total Distillate</td>
<td>75%</td>
</tr>
</tbody>
</table>
Solutions for Improved Hydrocracking Performance

Improved Profitability and Flexibility

• Industry-leading hydrocracking technology for optimizing the production of high quality fuels
• Multiple solutions for next cycle and long term opportunities strategies:
  - Hydrocracking innovations
  - Bottom of the barrel upgrading
  - Alliances
  - Honeywell process solutions
• Flexible offerings to meet refiners’ processing and financial objectives
• Focus on innovation to improve hydroprocessing performance and reduce capital and operating costs
• UOP can evaluate the product slate, capital expense and operating expense of the overall complex to provide the highest value solution to the customer