Maximize Conversion and Flexibility With the UOP Uniflex Process

- Market Factors
- Technology Summary
- Capital Savings Through Integration
Product Demand, Specifications, and Prices are Changing

Incremental Fuel Demand 2010-2020

Bunker Fuel Oil Sulfur Specifications

NW European Product Differentials to Brent, Forecast in Constant 2010 $/Bbl

Diesel Price Premium over Coke

Common goal: Maximize residue conversion to distillates
UOP’s Heavy Oil Upgrading Processes

Distillation

Crude Oil

Vacuum Residue

Residue Conversion

Vacuum Gas Oil

Distillates

Gasoline, Jet Fuel, Diesel

Transportation Fuels:

Fuels:

Naphtha

Naphtha

Hydrotreating & Reforming

Distillate Hydrotreating

FCC or Hydrocracking

Heavy Fuel Oil, Pitch, Coke

UOP Solutions for Residue Conversion

UOP RCD Unionfining™ Process

UOP/FWUSA Solvent Deasphalting

FWUSA SYDEC™ Delayed Coking Process

UOP/FWUSA Visbreaking

UOP UNIFLEX Process
UOP Uniflex Process

- Slurry hydrocracking technology
- High conversion to desired products
- Contains elements of proven processes
  - CANMET Hydrocracking Process
  - UOP Unionfining™ and UOP Unicracking™ Processes

- **Uniflex Process has >25% yield advantage over Delayed Coking**

Typical Yields
Uniflex Process
*Extensive Commercial Experience*

- 25 years R&D
- 15 years commercial operation
- Variety of feedstocks
- High conversion
- 97%+ availability

**Petro-Canada Montreal Unit**

### Commercial Performance

<table>
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<th>Conversion</th>
<th>85%</th>
<th>90%</th>
<th>94%</th>
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<td>Naphtha</td>
<td>80</td>
<td></td>
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<td>Distillate</td>
<td>40</td>
<td>60</td>
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<tr>
<td>VGO</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Pitch</td>
<td>20</td>
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Many UOP improvements in the last 5 years
Uniflex Process
Proven Flowscheme with Improvements

- **Large Unit Capacities**
- **Capital Cost Savings Through Process Integration**
Uniflex Process
HVGO Recycle Improves Yields and Quality

- Maximum naphtha and diesel yield from vacuum residue
- VGO conversion without a separate Mild Hydrocracking Unit
Uniflex Process Benefits:
- High liquid yields on vacuum residue feed, especially distillates
- Minimum residue by-products
- Significantly increases margins

Base Case:
Uniflex Process Compared to Other VR Conversion Processes

![Graph showing residue conversion yields and distillate yield comparisons between SDA, Delayed Coking, EBED HC, and Uniflex Process.](image)

![Graph showing upgrading margins with hydrocracking comparisons between SDA, Delayed Coking, EBED HC, and Uniflex Process.](image)
Uniflex Process Integrated with
UOP/FW Solvent Deasphalting & Unicracking Process

Vacuum Gas Oil

Vacuum Residue

UOP/FWUSA Solvent Deasphalting Process

SDA Pitch

DAO

Uniflex VGO

UOP Unicracking Process

Unicracking Naphtha and Distillate

Unicracking UCO (to FCC)

Uniflex Naphtha and Distillate
To New or Existing HDT

Uniflex Pitch

• Maximum Distillate Production
  - 95% Vacuum Residue Conversion with Uniflex and SDA
  - 99+% VGO conversion with Unicracking Process

• Low Capital Cost Upgrading Complex
  - Low capital cost SDA
  - Small, moderate reactor pressure Uniflex Process Unit
Integrated Case:
Solvent Deasphalting/Uniflex/Unicracking Processes

SDA/Uniflex/Unicracking Benefits:
- Very high vacuum residue conversion
- Maximum distillate yields on vacuum residue feed
- Highest margins
- Capital cost reduced
- Increased operating flexibility

SDA + Uniflex + Unicracking Benefits:
- Very high vacuum residue conversion
- Maximum distillate yields on vacuum residue feed
- Highest margins
- Capital cost reduced
- Increased operating flexibility

Upgrading Margins With Hydrocracking

Distillate Yield (After Hydrocracking)
UOP/FWUSA SDA Process
Commercial Experience

• UOP/FWUSA Combined Experience
  – Over 70 units licensed (500 to 50000 BPD)
  – Proven scale-up between pilot plant and commercial operations

• Recent Selection in 6 Projects
  – All units won in competitive bidding
  – Utilizing features from both UOP and FW technologies
UOP Unicracking Process
Commercial Experience

• Proven Experience
  – >60% of the World’s Licensed Hydrocracking Units
  – 195 Licensed Units in 40 Countries
  – >100 Operating Units
  – 54 Licenses Since 2000
  – Experience with all flow scheme options and DAO processing

*Experience IS the difference*
Uniflex Process Integrated with *Existing Delayed Coking Unit*

- **Increased Naphtha and Distillate yield**
- **Heavy Coker Gas Oil converted in Uniflex**
- **Uniflex Pitch converted in Coker**
- **Debottleneck Coker and Coker Heavy Gas Oil Hydrotreater**
Integration of Hydroprocessing Units

- Distillation
- Vacuum Residue
- UOP Uniflex Process
- Hydrocracking
- Naphtha Hydrotreating
- Distillates
- Crude Oil
- Transportation Fuels: Gasoline, Jet Fuel, Diesel
- Residues: Heavy Fuel Oil, Pitch, Coke

Integration Drivers - Capital Cost Reduction and Energy Efficiency
Issues that impact optimal degree of integration

- Economics
  - Capital cost savings
  - Utilities savings

- Design and operating flexibility
  - Operating pressures and relative flowrates of units
  - Future changes in crudes and product slate
  - Catalyst performance in HC and HDT
  - Timing of catalyst and inspection turn-arounds
  - Start-up, shut-down, emergency procedures
Full Process Integration Challenges

Features
- Combines slurry hydrocracking and Hydroprocessing in one hydrogen gas loop
- Requires both sour and sweet fractionation systems – products fractionated twice
- Slurry HC and Hydroprocessing sections require same high reactor pressure

Challenges
- Moderate effect on overall capital and operating costs
- \( \text{H}_2\text{S} \) and \( \text{NH}_3 \) depress catalytic activity and selectivity
- Diesel yield loss via cracking
Selective Integration Benefits

- UOP offers many integration options to meet refiners varied requirements

- Examples
  - Common H₂ recovery and compression systems for make-up gas and off-gas
  - Parallel recycle gas systems
  - Uniflex products integrated directly to UOP Unicracking and UOP Distillate Unionfining

- Benefits
  - >10% capital savings for Uniflex, Unicracking, Distillate Unionfining Heavy Oils Complex
  - Performance optimized of each unit
    - Reduced contamination in catalytic process units
    - Unicracking: >99% VGO conversion
    - Distillate Unionfining - Maximum diesel yield, quality and cycle length at minimum reactor pressure
UOP Uniflex Process Will Meet Your Future Transportation Fuel Requirements

- Ideal Process for Maximizing Transportation Fuels from Vacuum Residue
- Unique Solutions for Maximizing Distillate
- Extensive Commercial Operations Background
- UOP Development Program Assures Future Units Success
- Optimization and Integration Solutions will Maximize Benefits for your Refinery
Q&A