Lummus Technology and GTC

FCC Gasoline Desulfurization with CDHDS+®/GT-BTX PluS®
Lummus Technology is a leading licensor of Gasoline Desulfurization Technologies. Our Portfolio Allows Us to Offer a Range of Solutions Tailored to Each Client’s Specific Applications.

**CDHydro®** – Catalytic distillation column simultaneously separating LCN Product and HDS feed while removing mercaptans and dienes from LCN Product.

**CDHDS®** – Catalytic distillation column selectively treating MCN olefins and light sulfur in low-severity zone and heavy sulfur in high-severity zone.

**HDSelect®** – Novel process to maximize octane retention while desulfurizing tight MCN cut and avoiding recombinant mercaptan contamination.

**CDHDS+®** – Fixed bed compliment utilized on a case-by-case basis for varying objectives: Selective Hydrogenation, Heavy Gasoline Desulfurization, or Mercaptan Control.

➤ Over 120,000 KTPA (2.5 MMBPD) total licensed capacity and 83 total licenses.
Innovative Collaboration with GTC

Lummus’ Gasoline Desulfurization Technology Portfolio

+ GTC’s GT-BTX PluS Extractive Distillation Technology

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- Maximum Octane Retention and Gasoline Yield
- Maximum Feed / Product / Operational Flexibility
- Minimum Utility and Hydrogen Consumption
LCN/MCN Olefin Distribution

Comparison of FRCN Olefin Content

- LCN PRODUCT
- MCN to Extraction
- HCN to HDS Reactor

MCN Olefins Avoid Saturation in HDS Reactor
Conventional Fixed Bed Approach

FCC C5-180 Naphtha Feeds → Diene Saturation and Mercaptan Removal → LCN Product

High Octane C6+ Olefins Exposed to Saturation

Dual HDS Reactor System → HCN Product
Conventional Fixed Bed Approach

FCC C5-180 Naphtha Feeds

Diene Saturation and Mercaptan Removal

LCN Product

MCN/HCN Splitter

Low Purity Benzene to ISOM

Low HCN Product Yield

High Octane C6 Olefins Lost to Benzene Purge

Dual HDS Reactor System

HCN Product
CDHDS+®/GT-BTX PluS® Approach

FCC C5-180 Naphtha Feeds

CDHDS+ Selective Hydrogenation Reactor and Divided Wall Splitter

LCN Product

Maximize Octane Retention & Gasoline Yield

Olefin-Rich, Low Sulfur MCN Product

GT-BTX PluS MCN Olefin Extraction

High Purity Benzene Purge

Aromatics and Heavy Sulfur to HDS Section

CDHDS+ Hydrodesulfurization Reactor

Low Olefin Content in CDHDS+ HDS Reactor Feed

HCN Product

Splitter Sidedraw

Splitter Bottoms
CDHDS+®/GT-BTX PluS® Flexibility

FCC C5-180 Naphtha Feeds

- CDHDS+ Selective Hydrogenation Reactor and Divided Wall Splitter
- LCN Product
- Olefin-Rich, Low Sulfur MCN Product
- High Purity Benzene Purge
- Aromatics and Heavy Sulfur to HDS Section
- Optimize Refinery Economics
- Route Back to FCC for Increased Propylene Make

HCN Feed

- Maximum Gasoline Mode
- Opportunistic Feedstocks
- Kerosene Feed

GT-BTX PluS MCN Olefin Extraction

- Splitter Sidedraw
- HCN Product
- Heavy Gasoline To Distillate

CDHDS+ Hydrodesulfurization Reactor

- Splitter Bottoms
<table>
<thead>
<tr>
<th>Advantages</th>
<th>CDHDS+/GT-BTX PluS</th>
<th>Conventional Fixed Bed</th>
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<tbody>
<tr>
<td>Maximize Gasoline Octane Retention</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Maximize Gasoline Yield</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Minimize Hydrogen Consumption</td>
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<td>✓</td>
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<tr>
<td>Operational Flexibility</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduced ISOM capacity</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reduced Hydrogen Inventory</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Feed and Product Flexibility</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Minimal Capital Investment</td>
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<td>✓</td>
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<tr>
<td>Minimal Utility Consumption</td>
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<tr>
<td>Maximum Project Net Present Value</td>
<td>✓</td>
<td>✓</td>
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Questions and Answers

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