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FCC naphtha post-treatment

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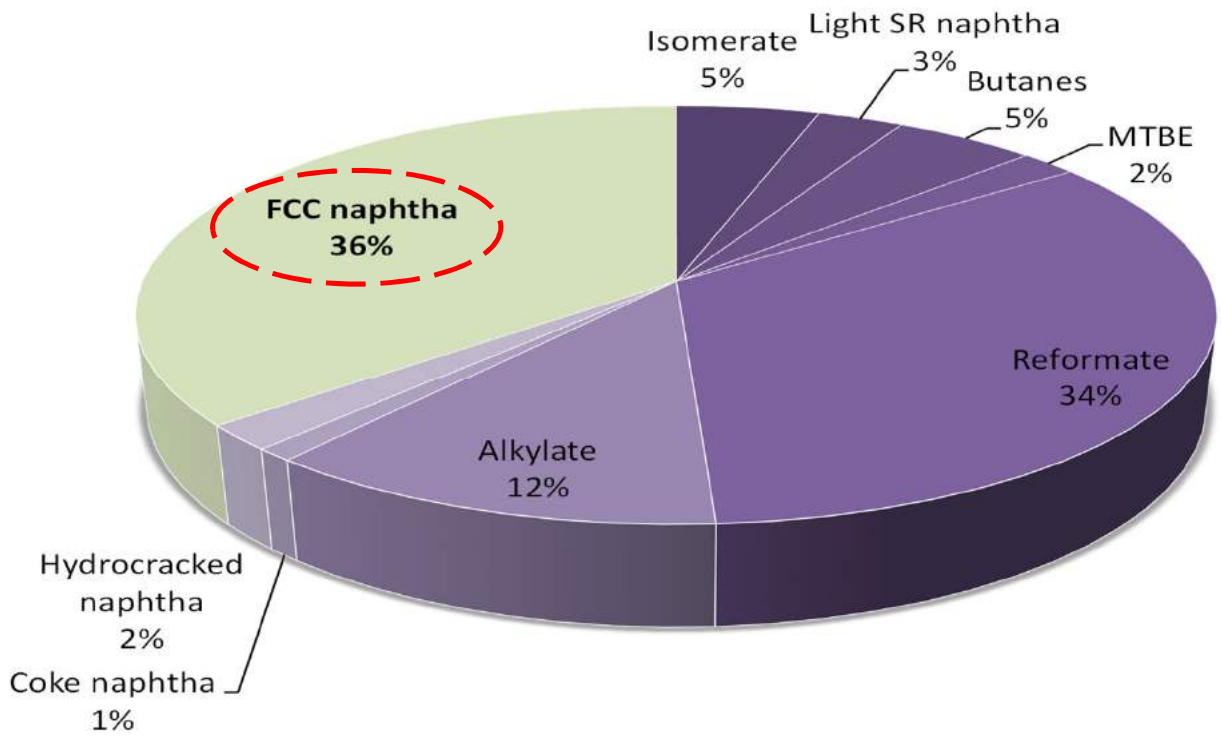
Agenda

- Why post-treatment of FCC naphtha?
- The new sulfur challenge
- Molecular understanding of FCC naphtha
- Post-treatment step-by-step
- Octane loss prediction model
- Haldor Topsoe's HyOctane Technology (HOT™)

Why post-treatment of FCC naphtha?

Typical gasoline pool composition

Percentage of blend stocks of pool volume



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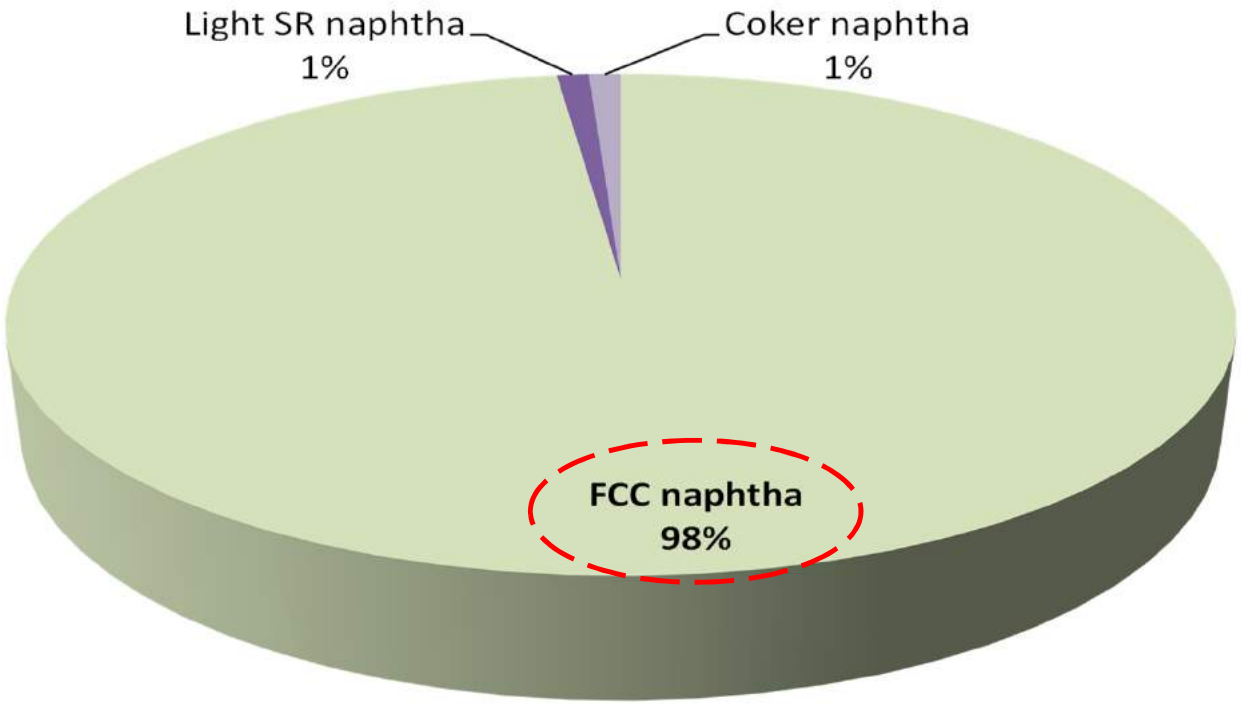
Typical gasoline pool composition

Distribution of sulfur in blend stocks



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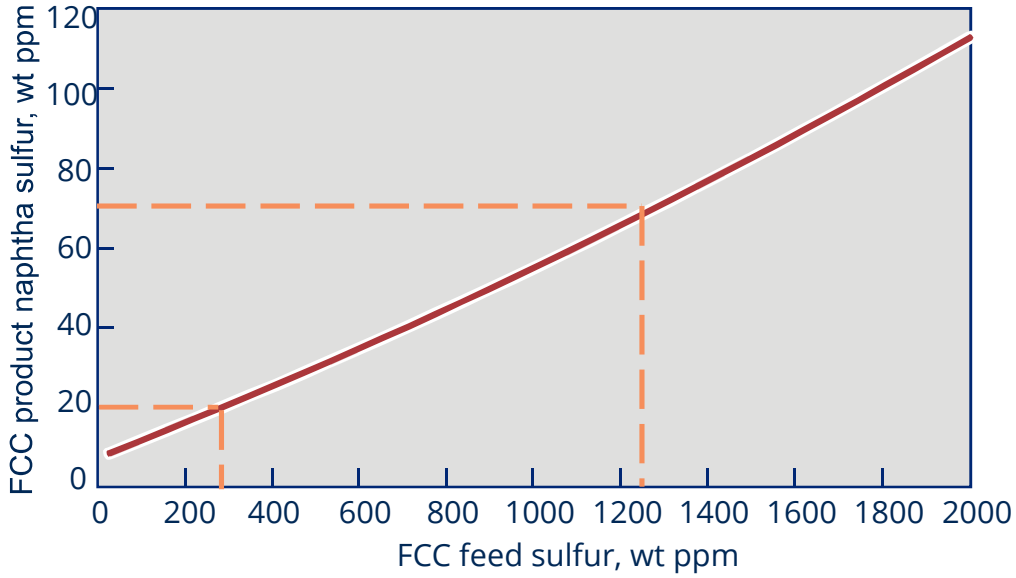
FCC feed sulfur vs. gasoline sulfur



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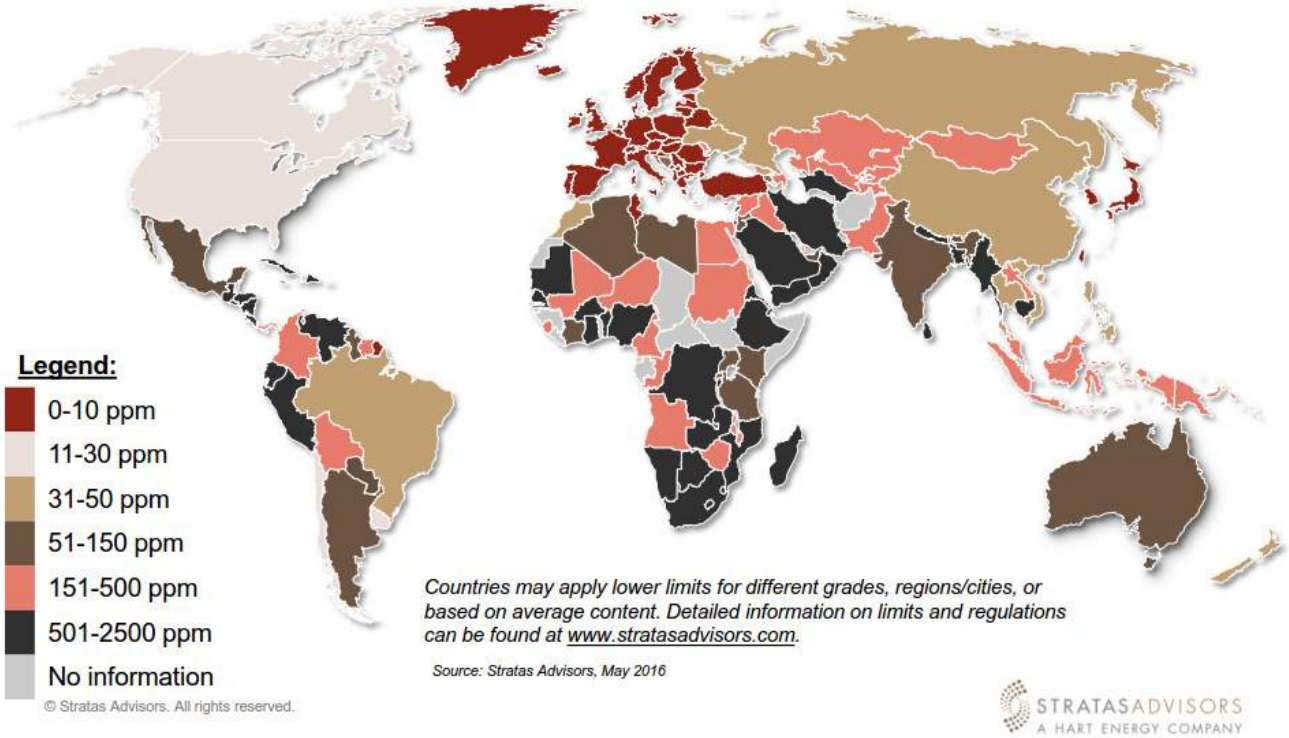
Why post-treatment?
Gasoline sulfur limits 2016



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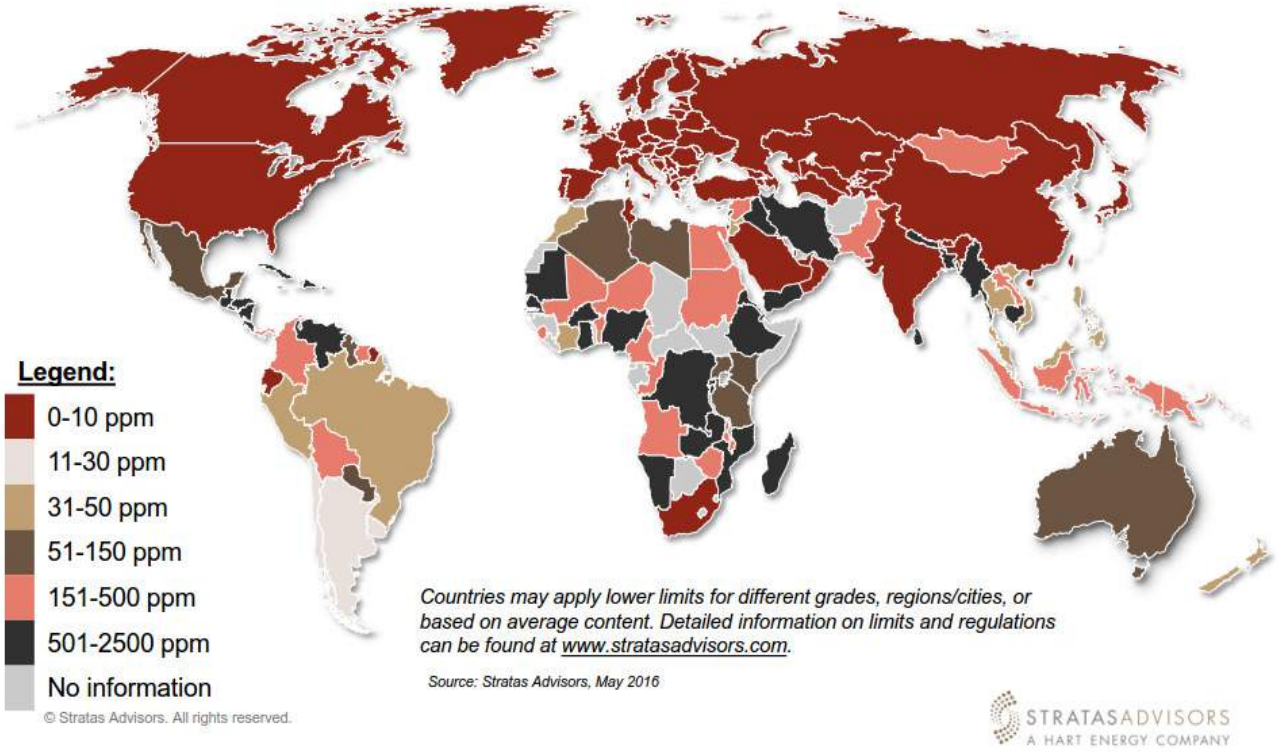
Why post treatment?
Gasoline sulfur limits 2020



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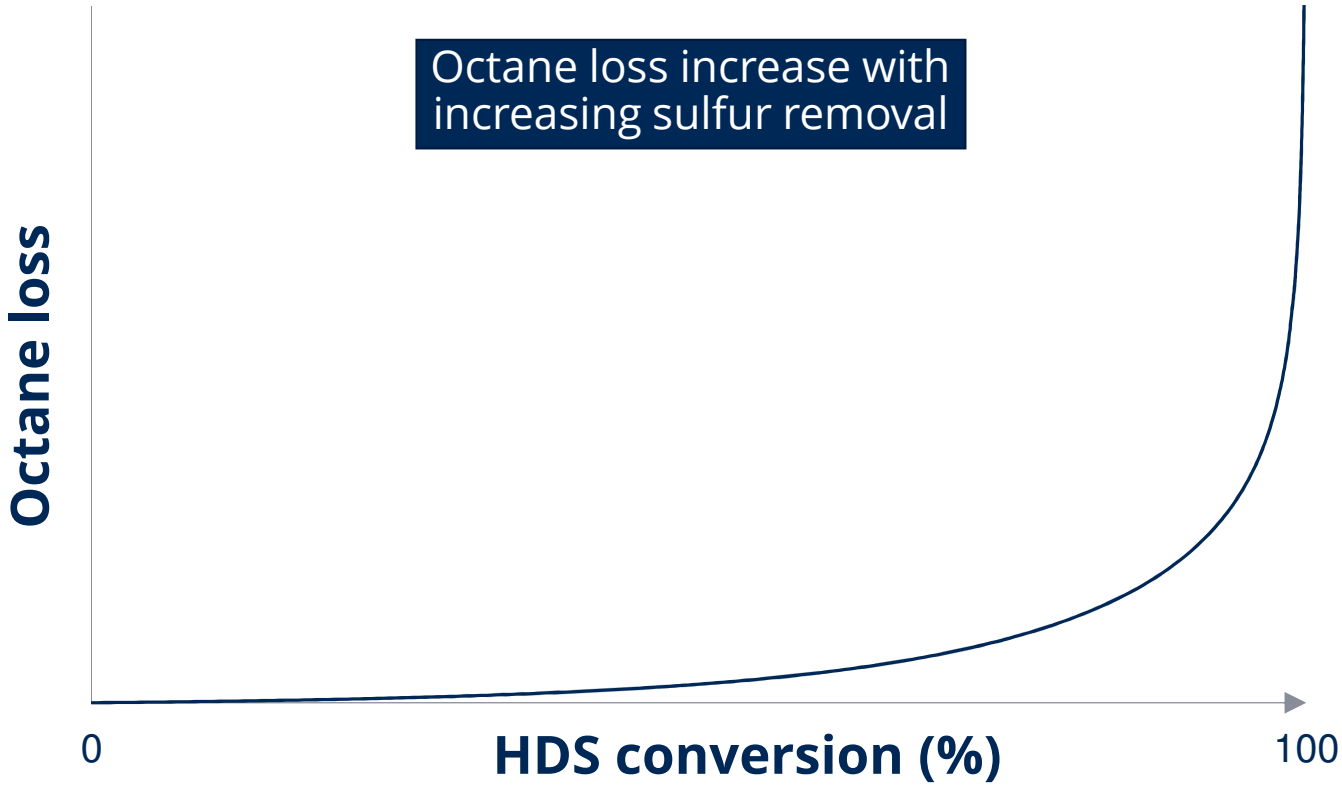
Octane loss
General trend



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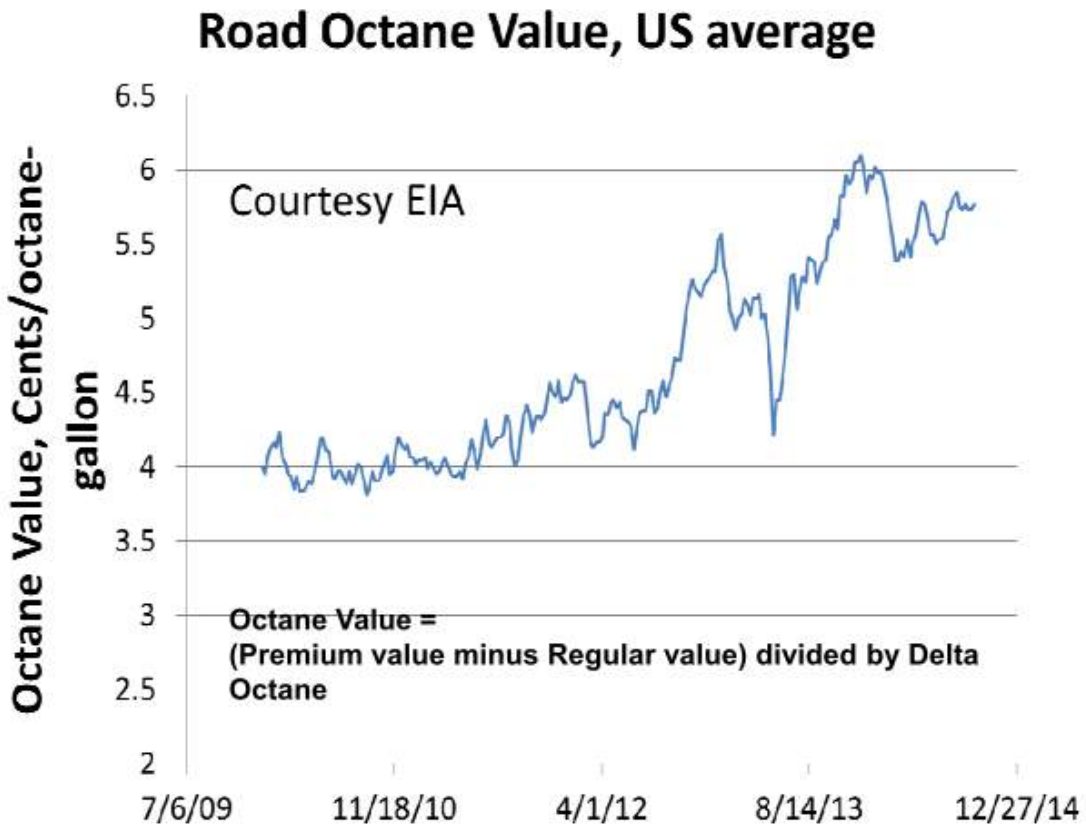
The value of octane

- Octane value increased 50% from 2010 to 2015.
- Octane value expected to continue due to lower sulfur limits.
- Octane retention during is increasingly important.



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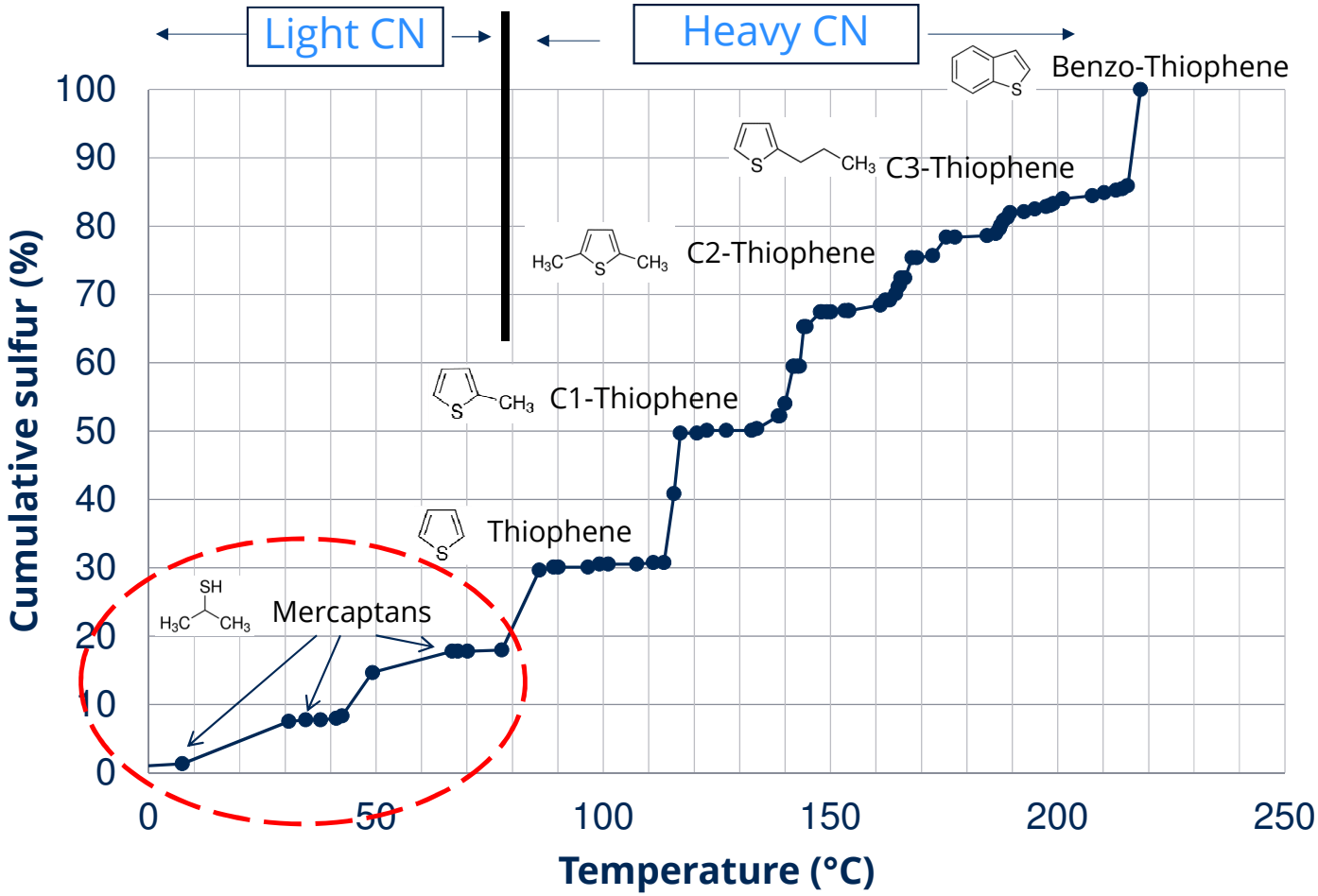
Molecular level understanding of FCC naphtha

Distribution of sulfur



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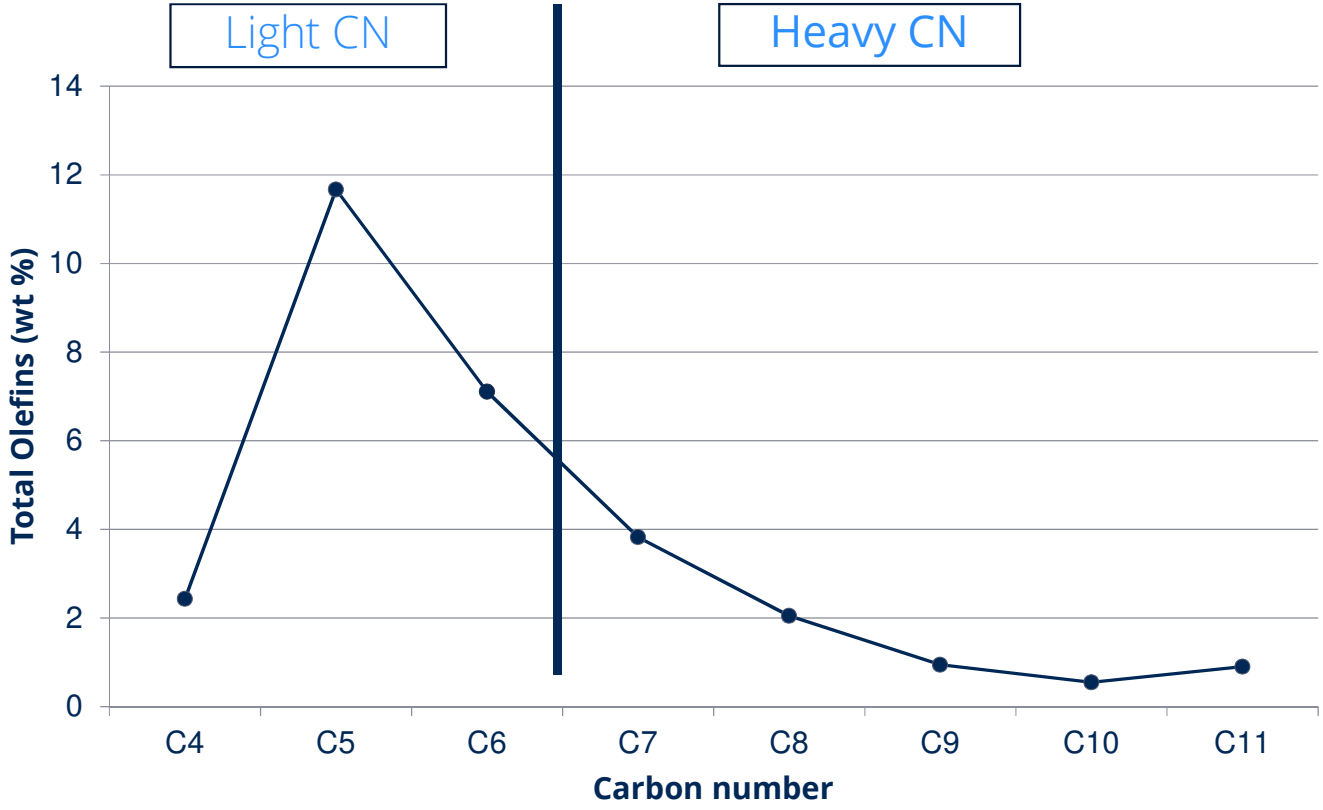
Distribution of olefins

Light fraction

- High olefin concentration
- Low sulfur concentration
- Mercaptan sulfur

Heavy fraction

- Low olefin concentration
- High sulfur concentration
- Thiophenic sulfur



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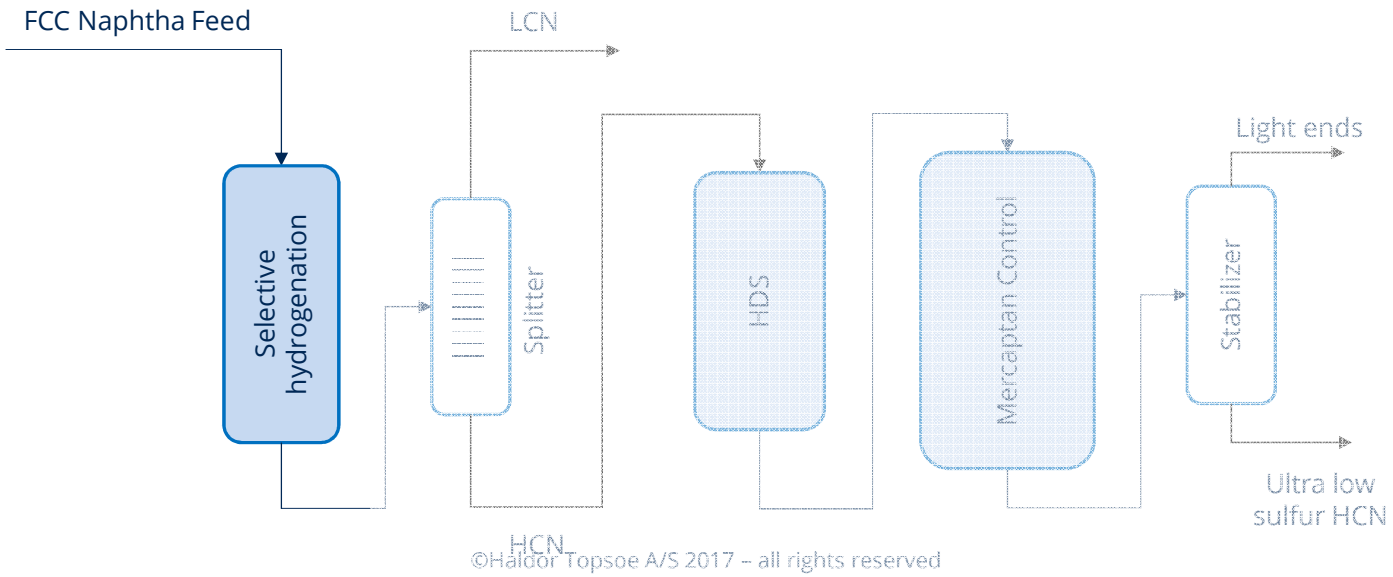
Post-treatment step-by-step

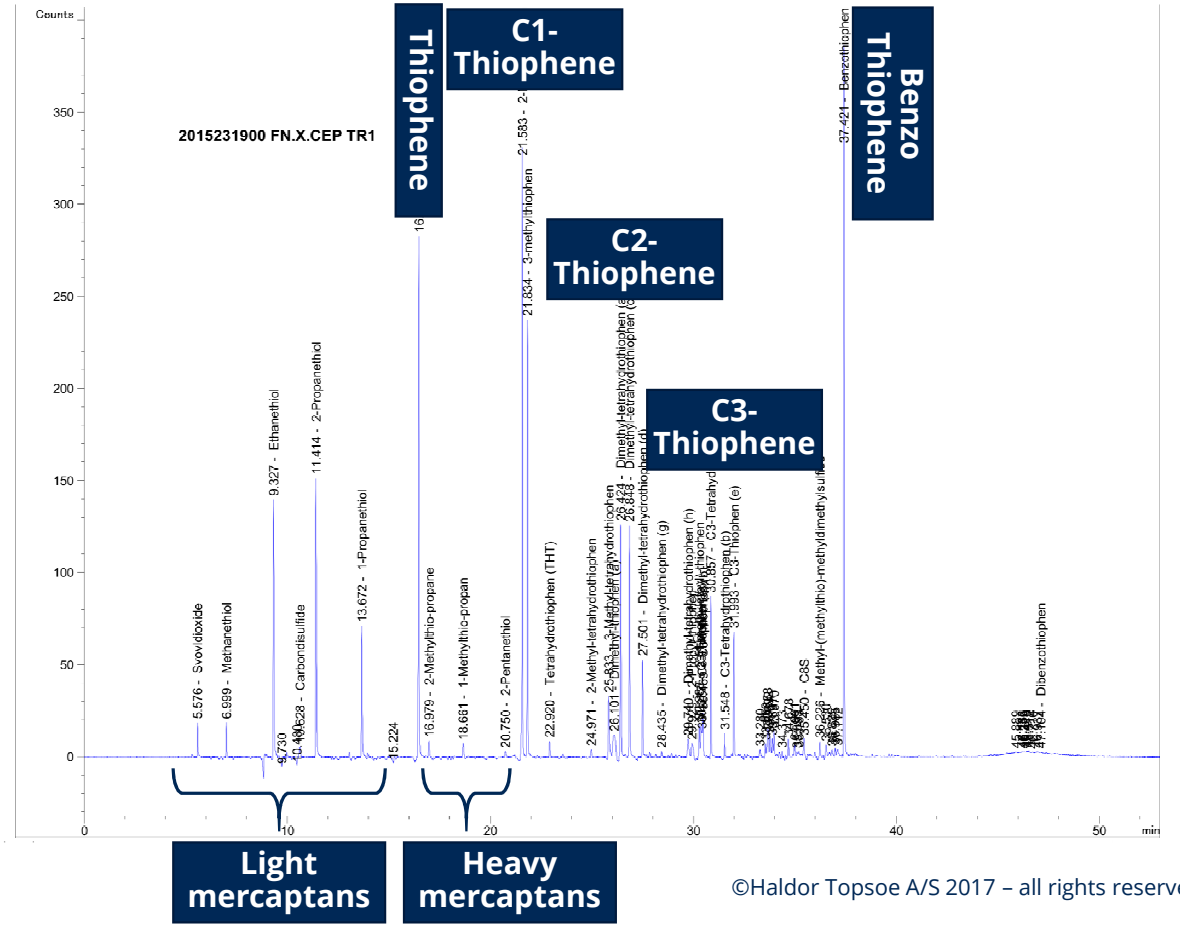
Main function of the selective hydrogenation unit

- Selectively hydrogenation of di-olefins
  - Prevent fouling in downstream HDS reactors
- Transform light sulfur in to heavy sulfur
  - Low sulfur light fraction out of splitter



FCC naphtha

Sulfur speciation – SHU feedstock



- Gas chromatogram
- Sulfur specific detector (GC-AED)

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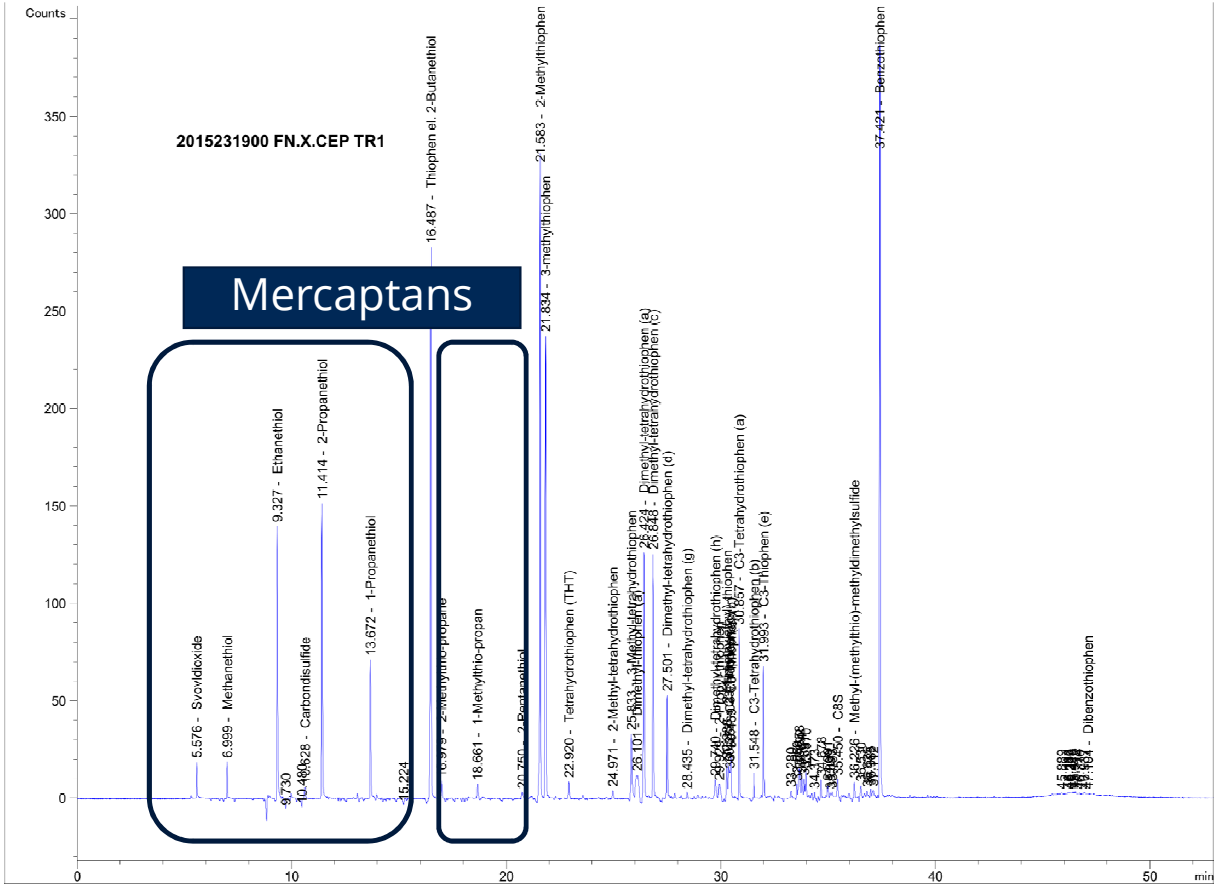
Pilot plant test, Haldor Topsoe catalyst TK-703 HyOctane™

Selective Hydrogenation Unit (SHU), sulfur speciation – feedstock



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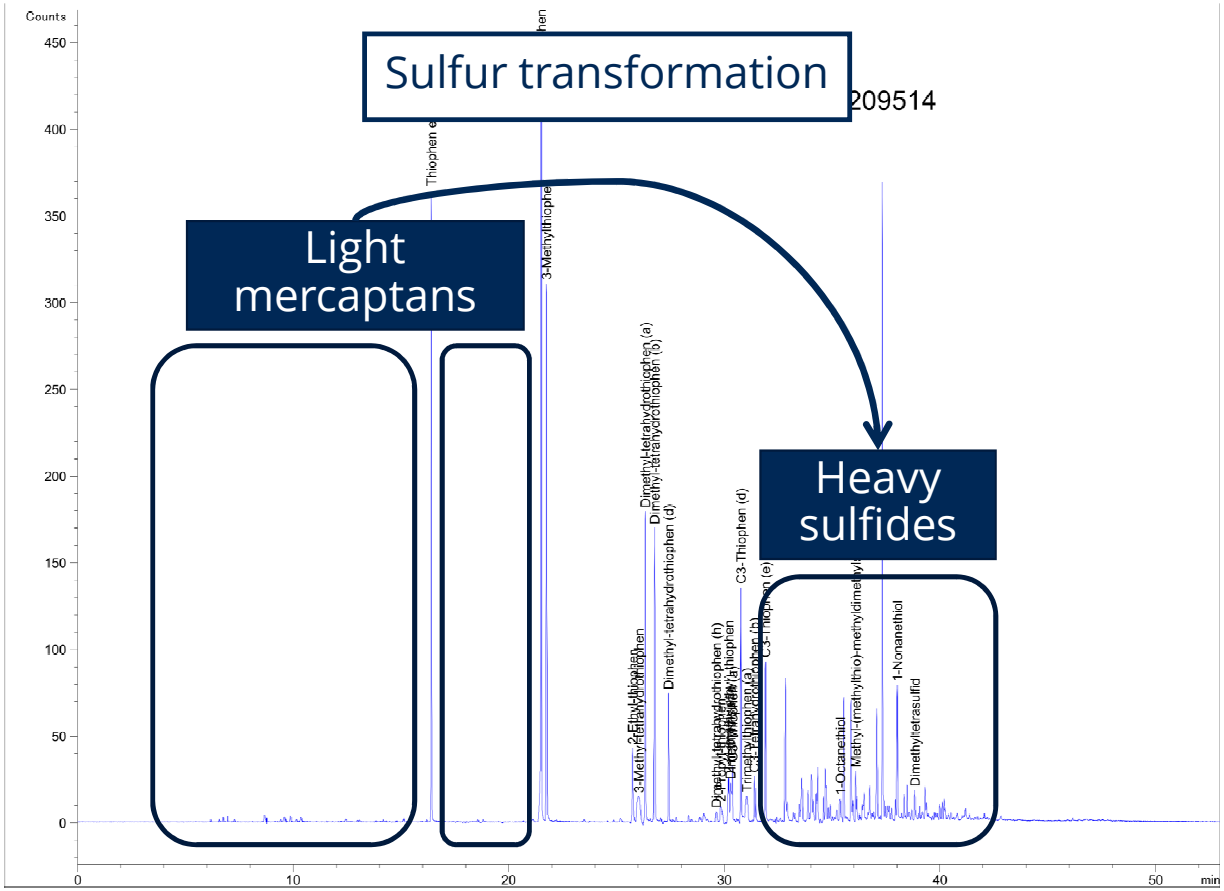
Pilot plant test, Haldor Topsoe catalyst TK-703 HyOctane™

Selective Hydrogenation Unit (SHU), sulfur speciation – product



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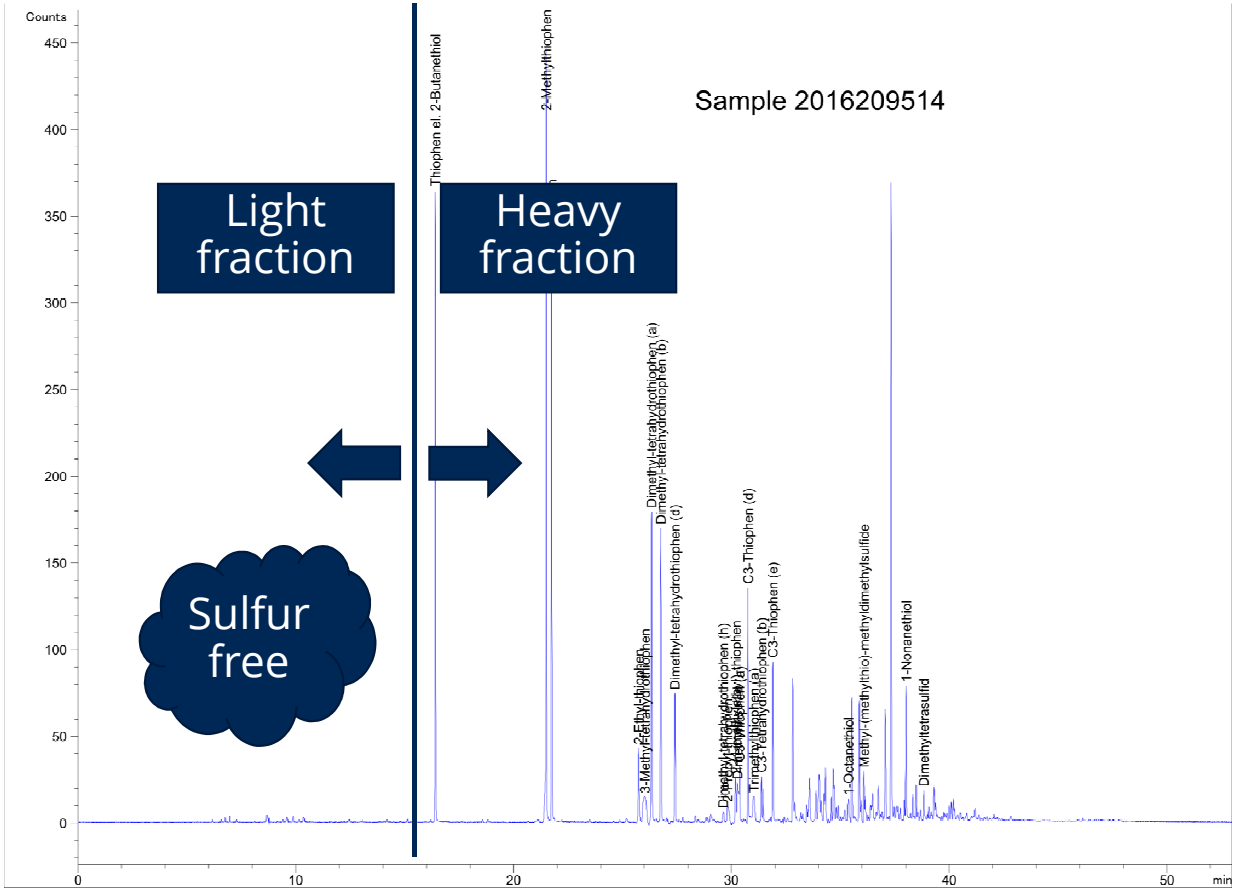
Pilot plant test, Haldor Topsoe catalyst TK-703 HyOctane™

Selective Hydrogenation Unit (SHU), sulfur speciation – product



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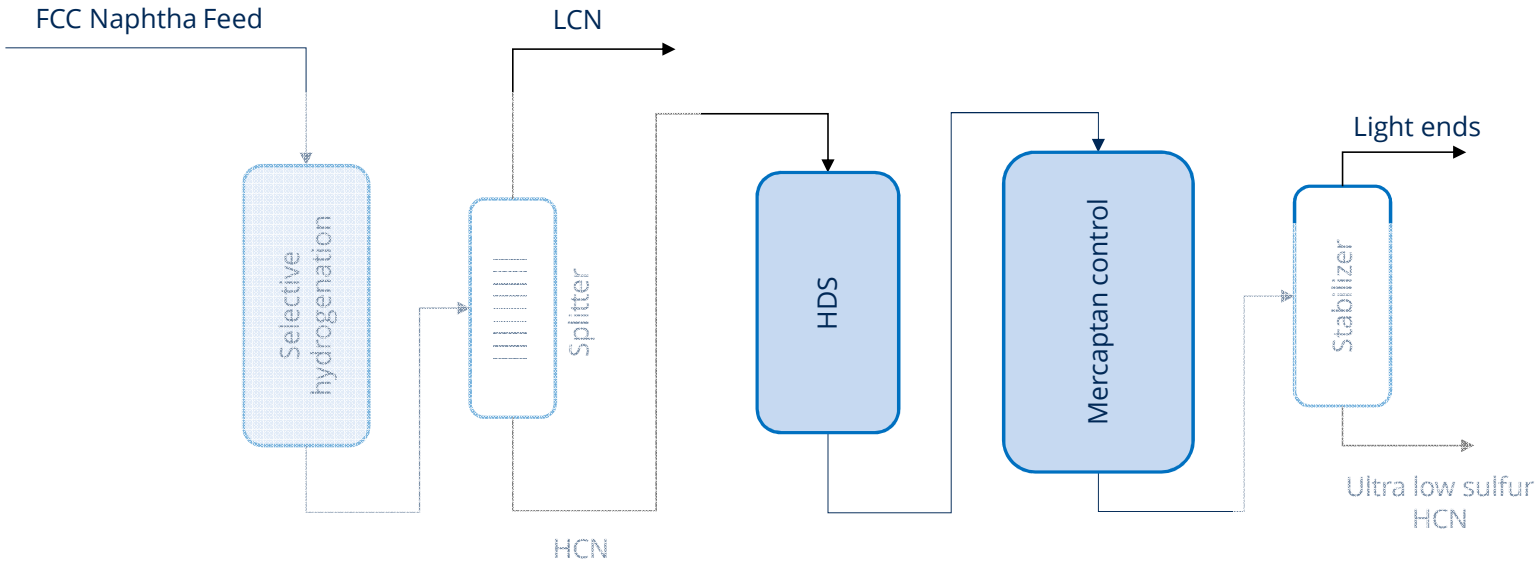
Heavy naphtha desulfurization

Hydrodesulfurization of HCN
Layout



Topsoe's TK-710 HyOctane™ and TK-747 HyOctane™ catalysts are well proven in the HDS reactor and the Mercaptan control reactor

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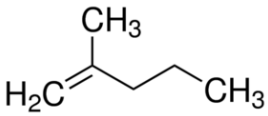
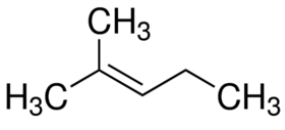
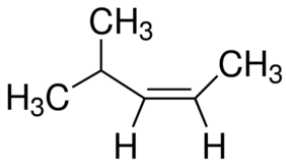
Octane loss prediction model

Octane loss prediction model

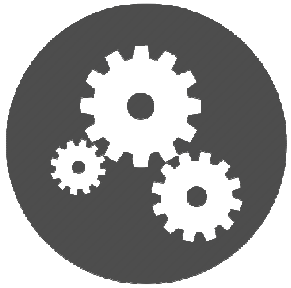






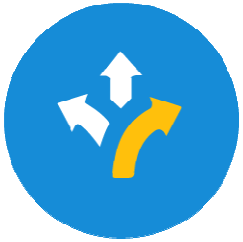
Foundation

- Based on molecular understanding.
- Large database with detailed chemical analysis (759 components) of commercial and pilot plant feed and product samples.
- Intelligent reduction of complexity by the discovery of a manageable number of key reaction paths that govern octane loss.



Model flexibility

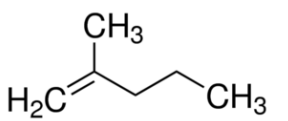
- Unit design (splitter, number of HDS reactors).
- Final boiling point of feed.
- Feed and Product sulfur



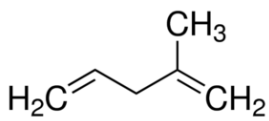
Key reaction path example

Making 2-methylpentane

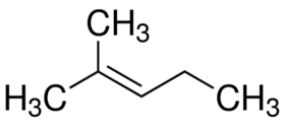
Reactants, average RON = 100



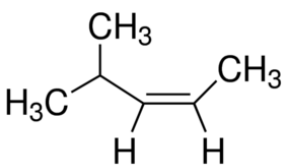
2-methylpentene-1



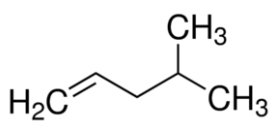
2-methyl-1,4-pentadiene



2-methylpentene-2



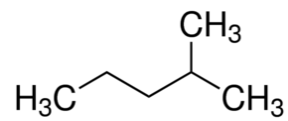
4-methylpentene-2
(*cis* and *trans*)



4-methylpentene-1

ΔRON = -24

Product, RON = 76



2-methylpentane

Abundant + high impact reaction path

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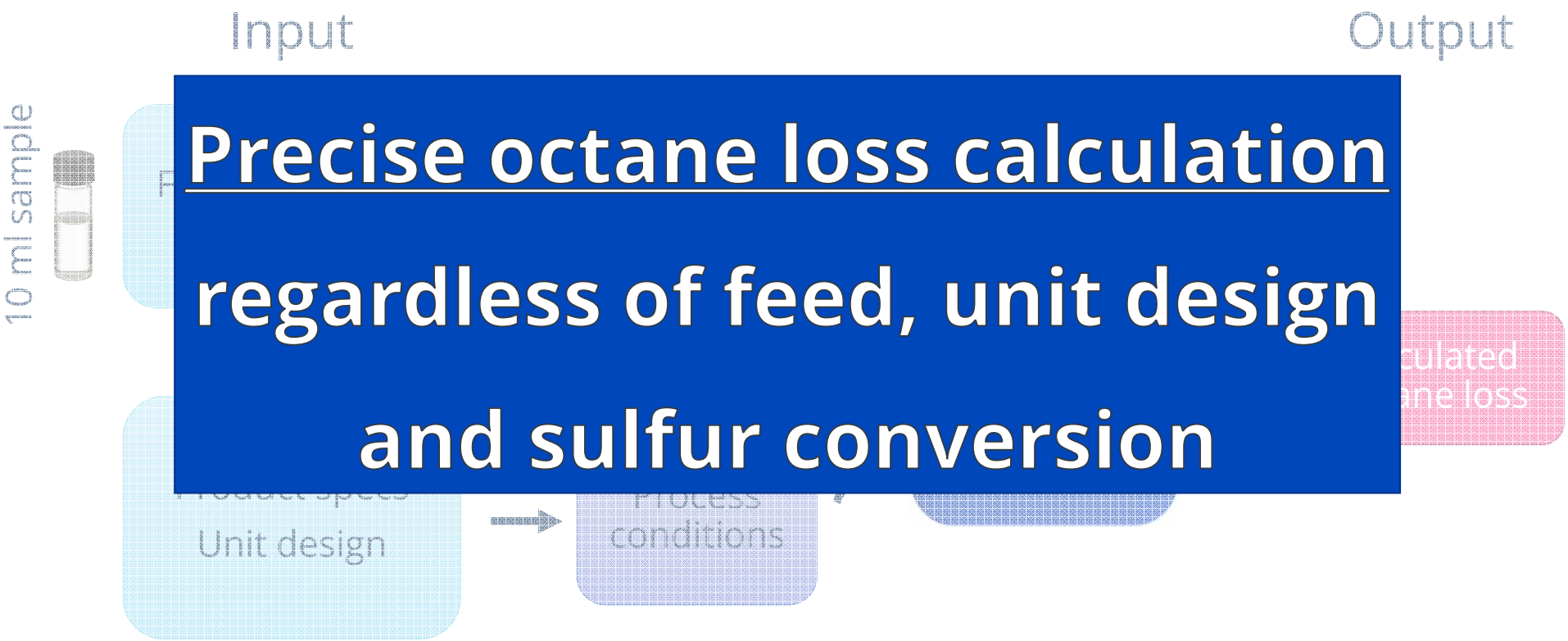
Model usage



Precise octane loss calculation regardless of feed, unit design and sulfur conversion

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The Topsoe HyOctane Technology HOT™ Process

The Topsoe HyOctane Technology HOT™ Process

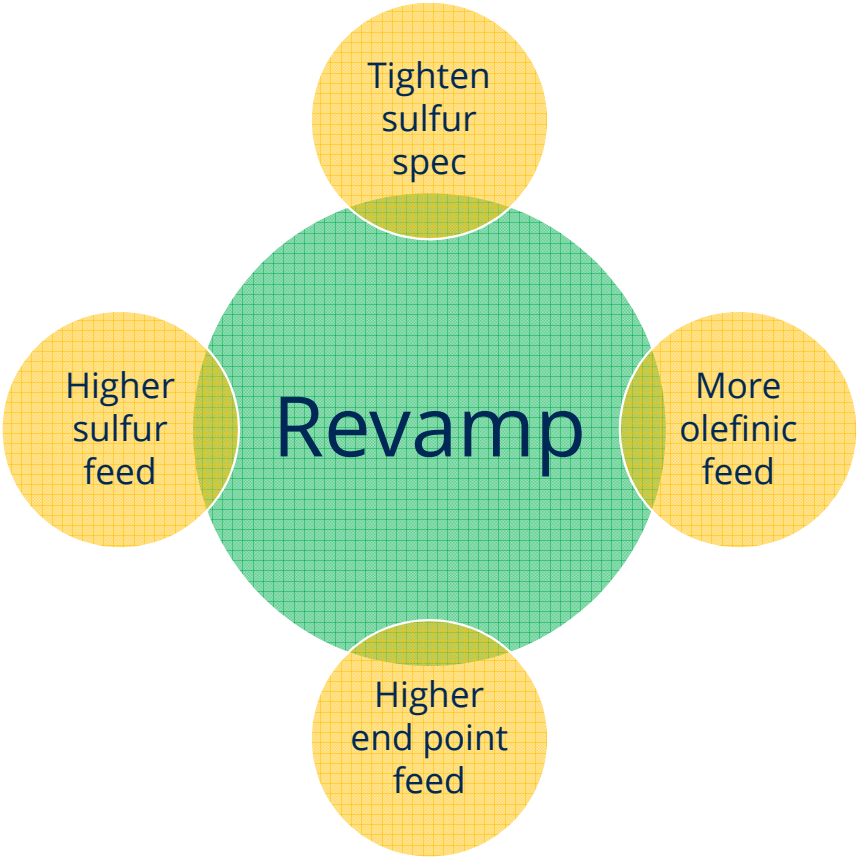
The new technology leap

- Deep catalyst understanding
- Deep kinetics and equilibrium understanding
- Extensive pilot work
- Use of process model for octane prediction
- Hydrotreating engineering capabilities
- Invention resulting in unmatched octane retention

Where does it apply?

New Refinery Configuration

Grassroots



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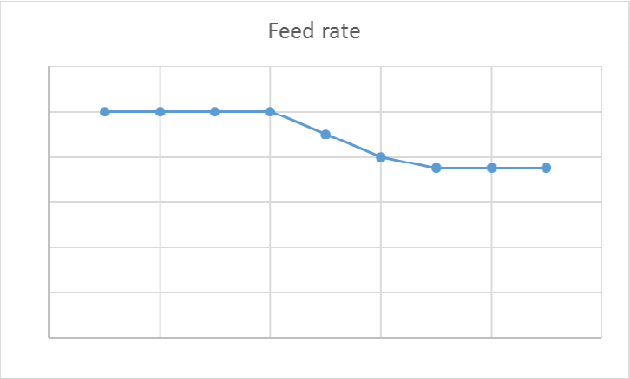
Changing operation from 30 to 10 wppm S gasoline in the traditional technology

Much higher RON loss with your existing process technology

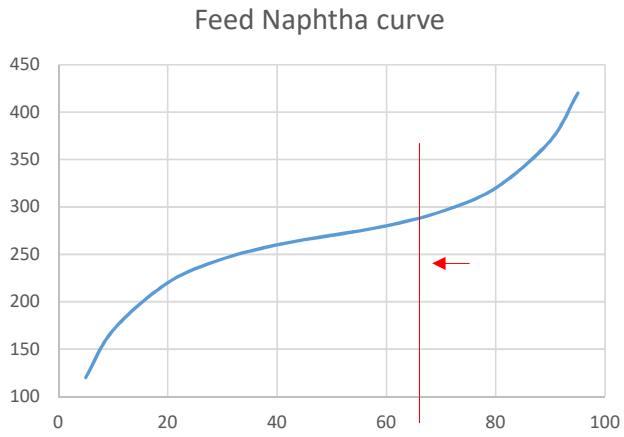
Consequence

Cut feed rate



And/or

Cut end point of feed



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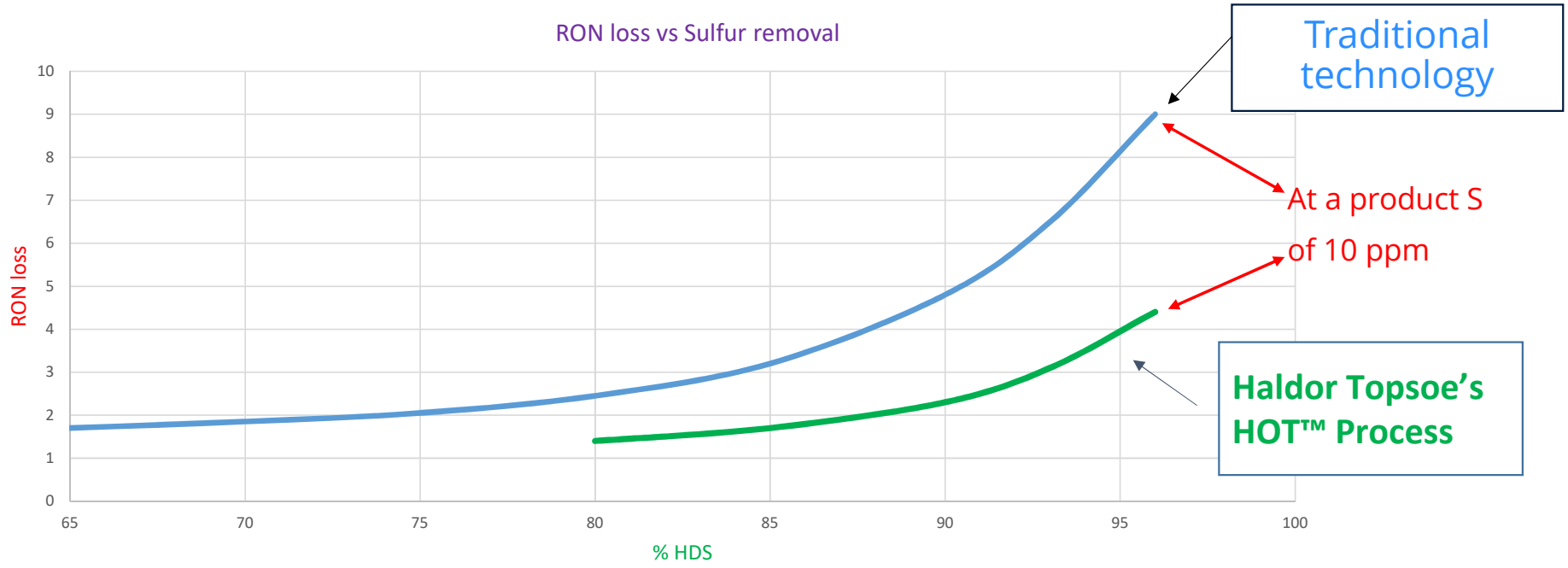
The clear Octane advantage with the Topsoe HOT™ Process

The Octane vs HDS relation



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Conclusion

- Topsoe' HOT™ process reduces the octane loss for same product sulfur by 50-65%
- No need for reducing endpoint resulting in higher gasoline production
- Possible to process more higher sulphur crudes
- Possible to reduce the operating severity of the FCC pretreat unit
- Possible to cut deeper into the LCO to make more gasoline gasoline

Unmatched octane retention in your gasoline pool

Summary

- Sulfur reduction in the gasoline is being regulated to 10 wtppm in many parts of the world
- Sulfur reduction result in additional octane loss
- Haldor Topsoe's model is capable of calculating the octane loss accurately by looking at the octane loss for each molecule and its reaction pathway
- Our HyOctane™ catalyst portfolio is well proven in today's gasoline post treatment units
- Haldor Topsoe's new and innovative HyOctane Technology (HOT™) for grassroot units and revamps will reduce the octane loss by 50-65% at the same product sulfur.