REFCOMM BUDAPEST
2-5 Oct 2017

# Reducing octane loss – solutions for FCC gasoline post-treatment services

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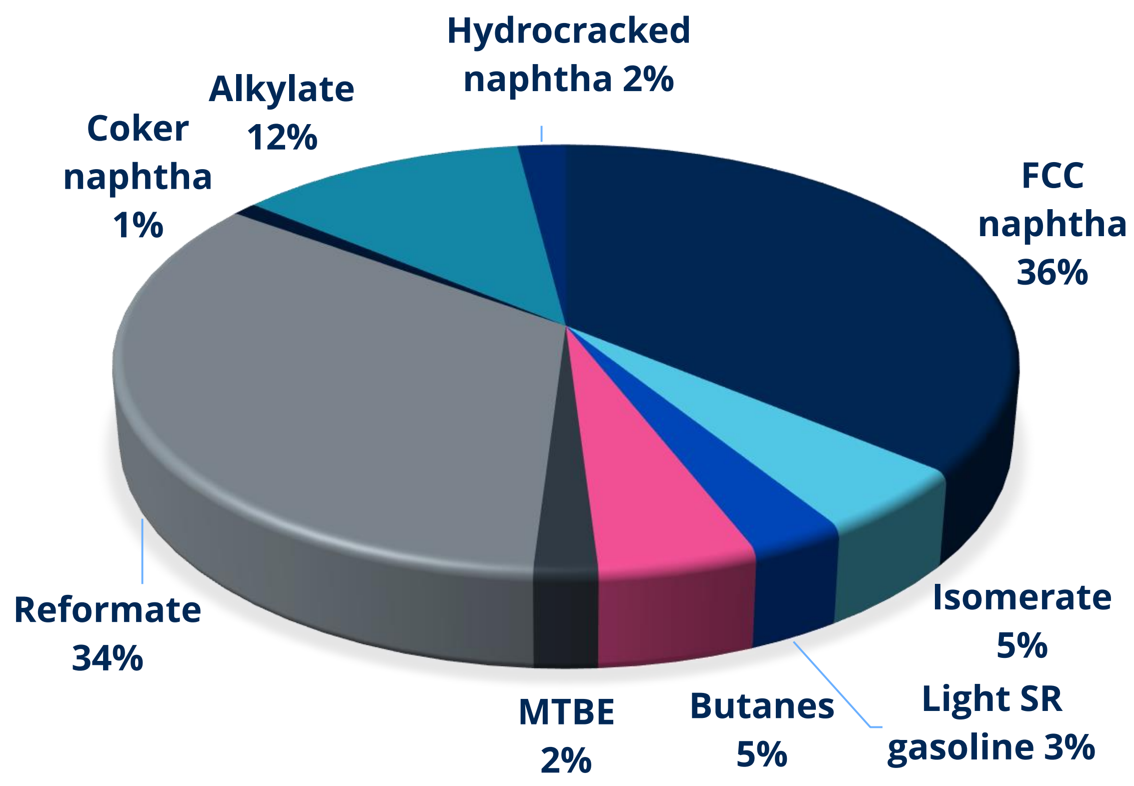
# Agenda

- Why post-treatment of FCC gasoline?
- Molecular understanding of FCC gasoline
- Post-treatment step by step
- Octane loss prediction model
- Haldor Topsoe's HyOctane Technology (HOT$^{TM}$)

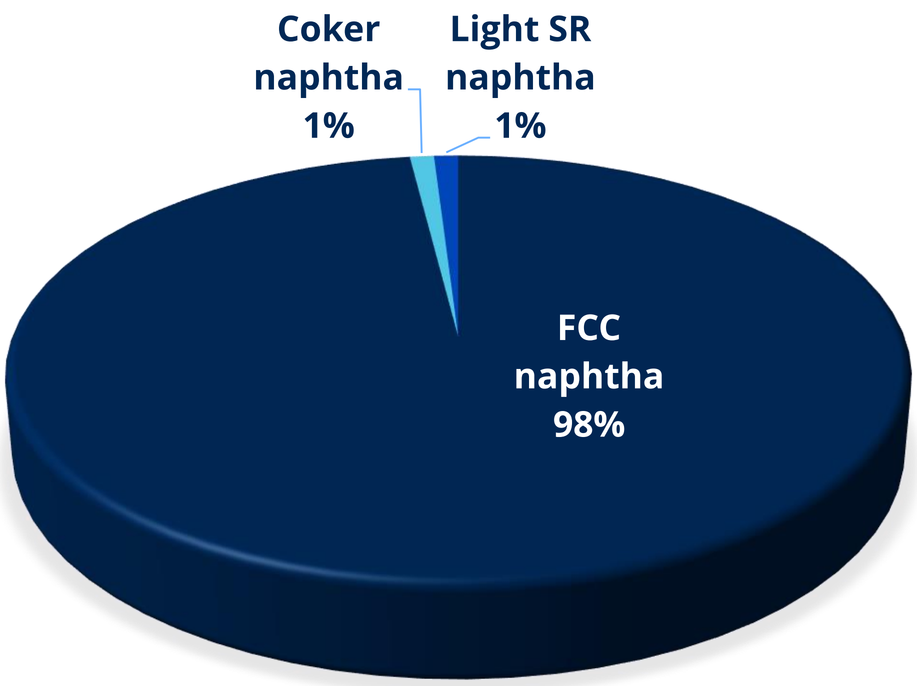
# Why post-treatment of FCC gasoline?

# Typical gasoline pool composition

Percentage of blend stocks of pool volume




Distribution of sulfur in blend stocks





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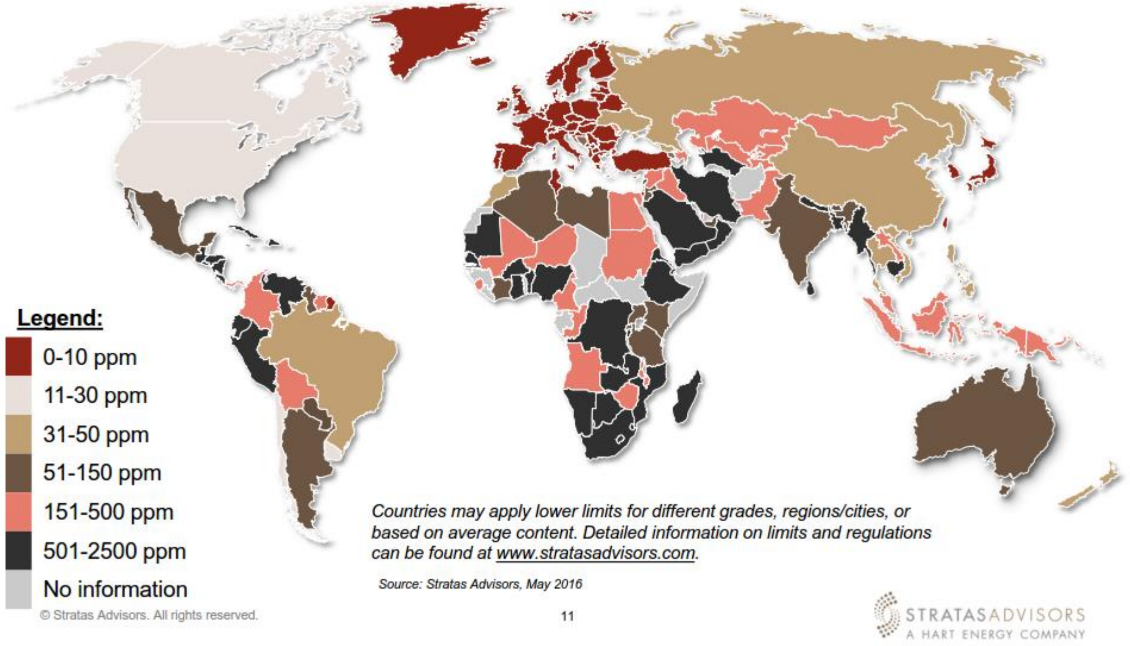
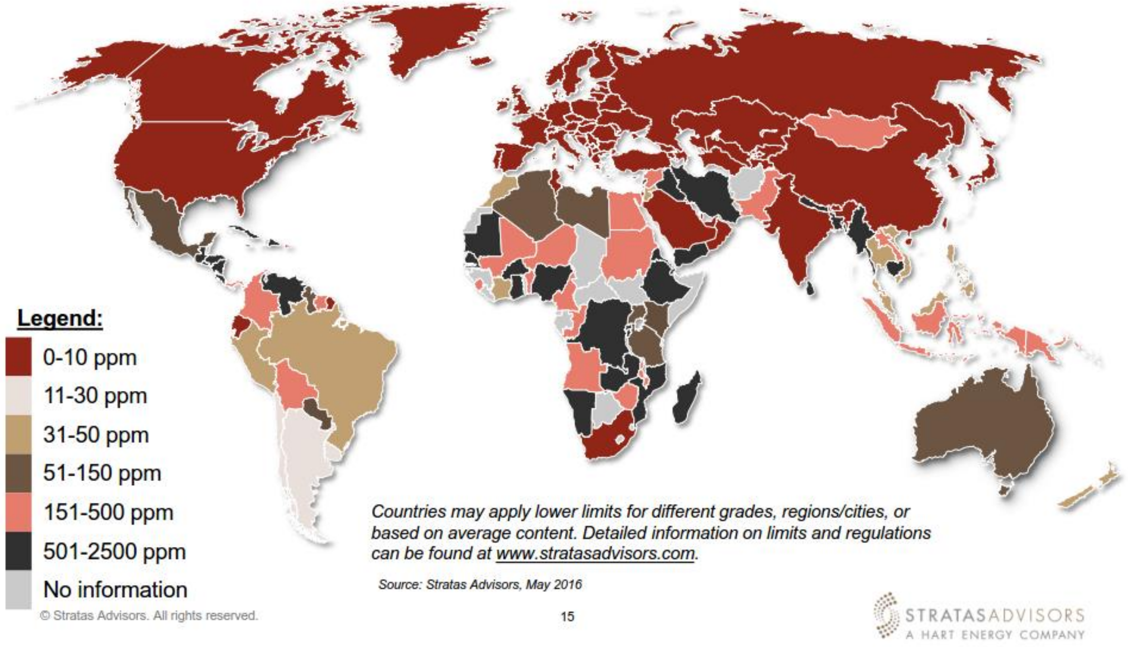
# Why post-treatment?

Gasoline sulfur limits **2016**

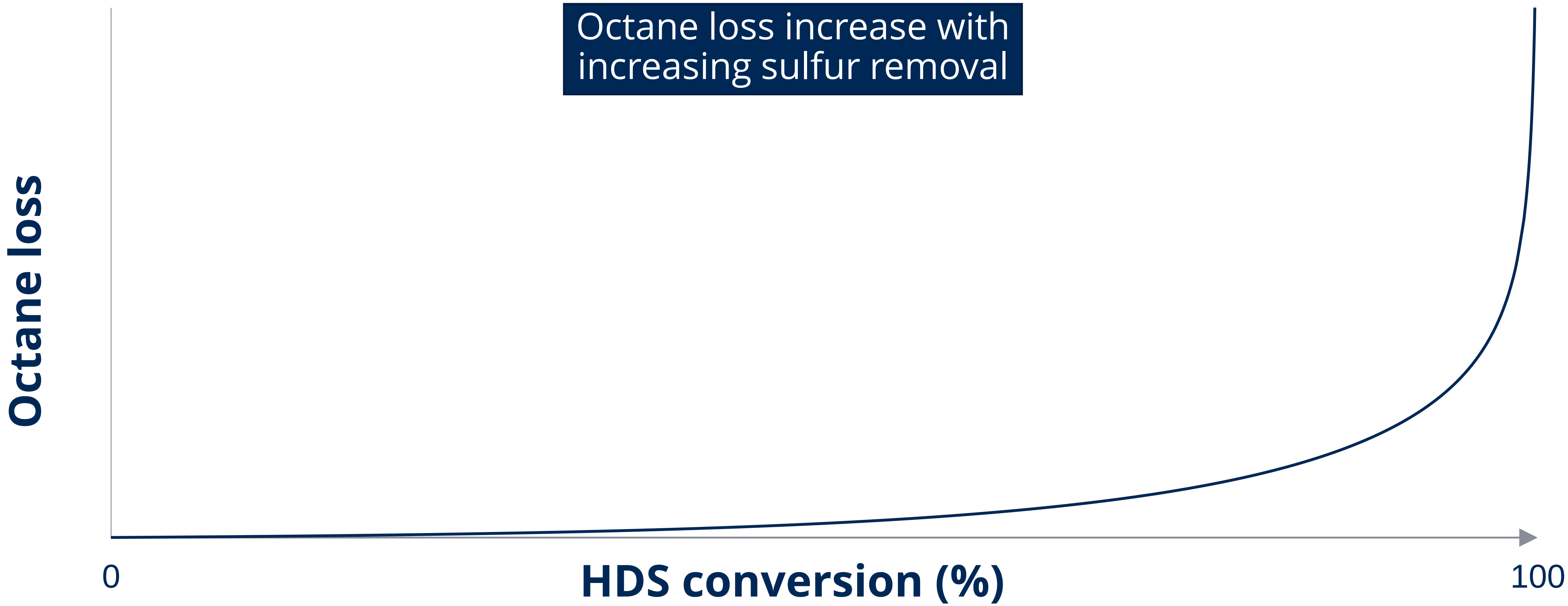



Gasoline sulfur limits **2020**



# Octane loss

## General trend





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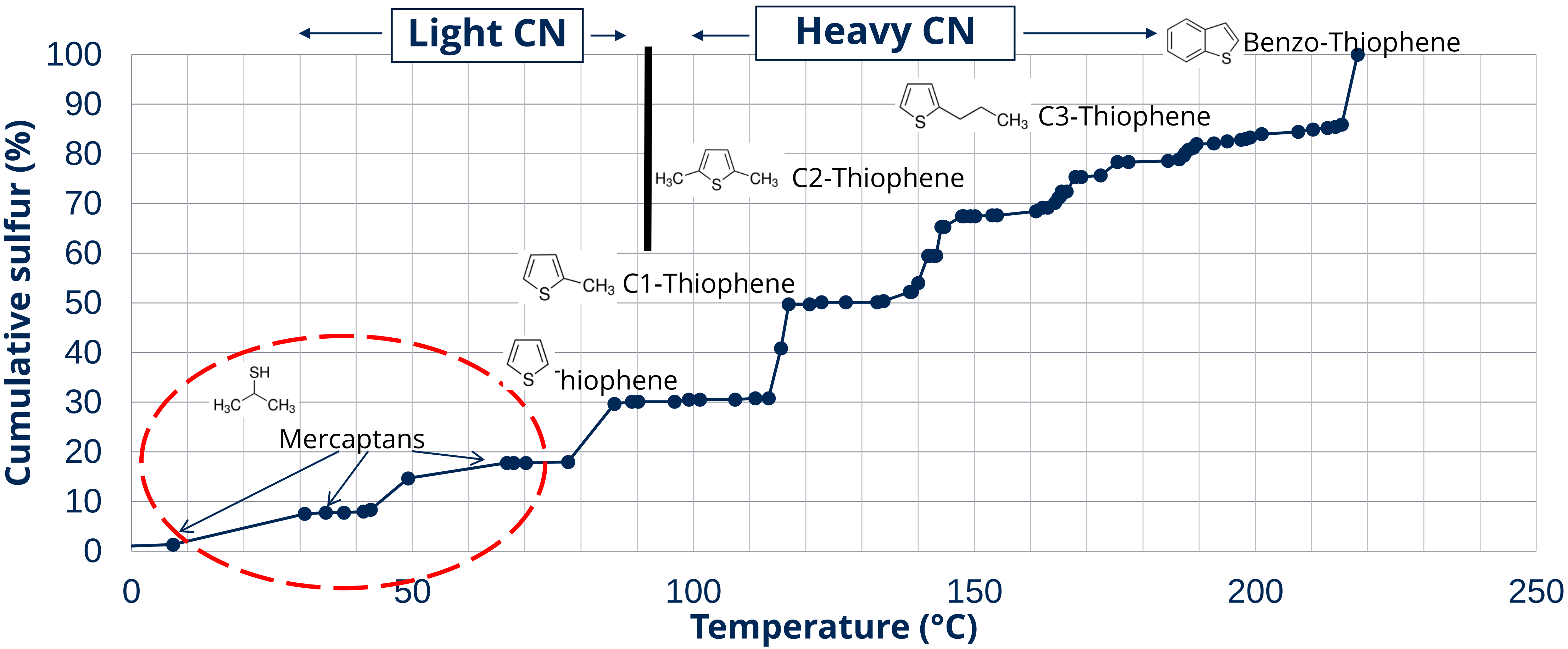
# Molecular level understanding of FCC naphtha

# Distribution of sulfur





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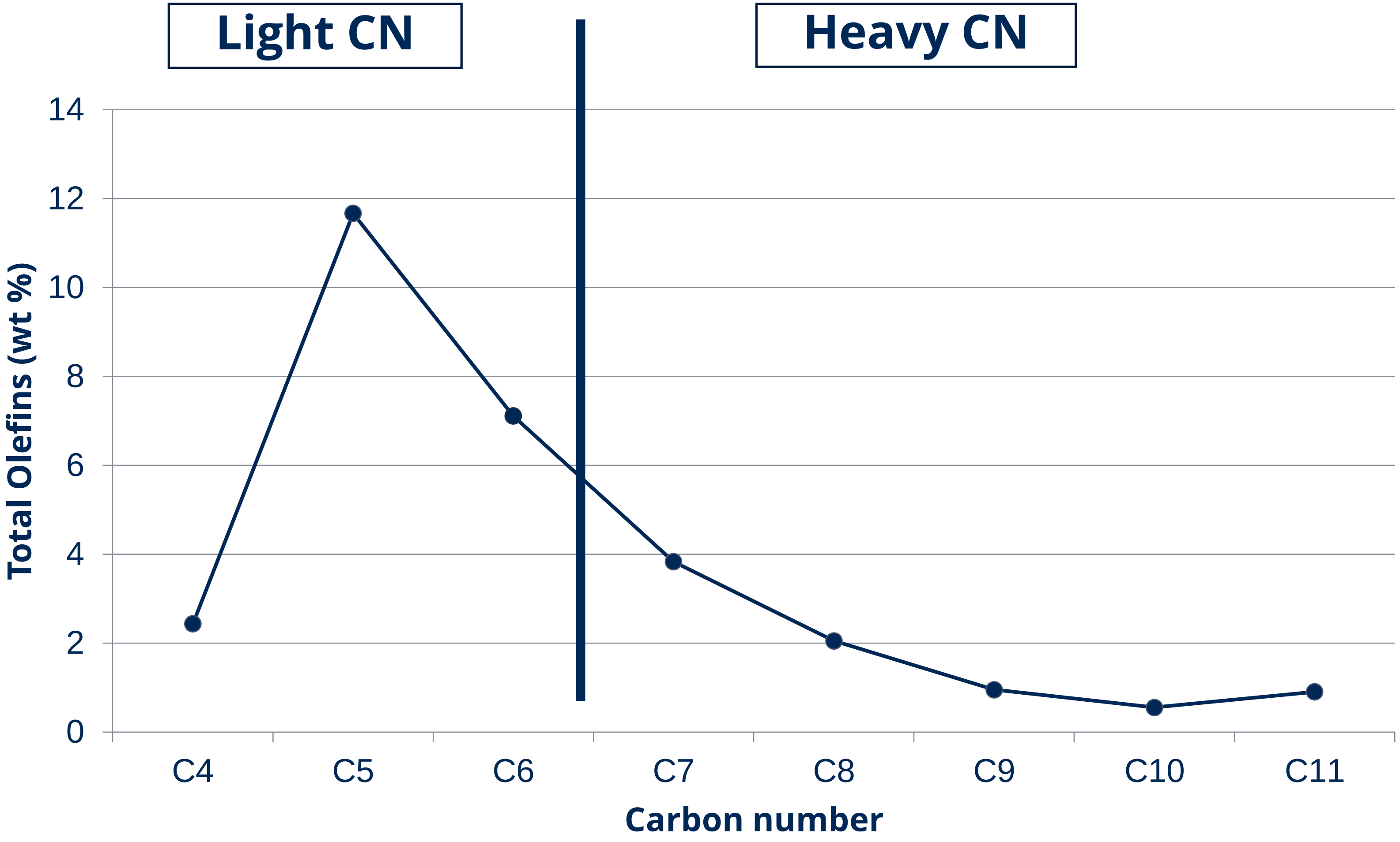
# Distribution of olefins

Light fraction

- High olefin concentration
- Low sulfur concentration
- Mercaptan sulfur

Heavy fraction

- Low olefin concentration
- High sulfur concentration
- Thiophenic sulfur



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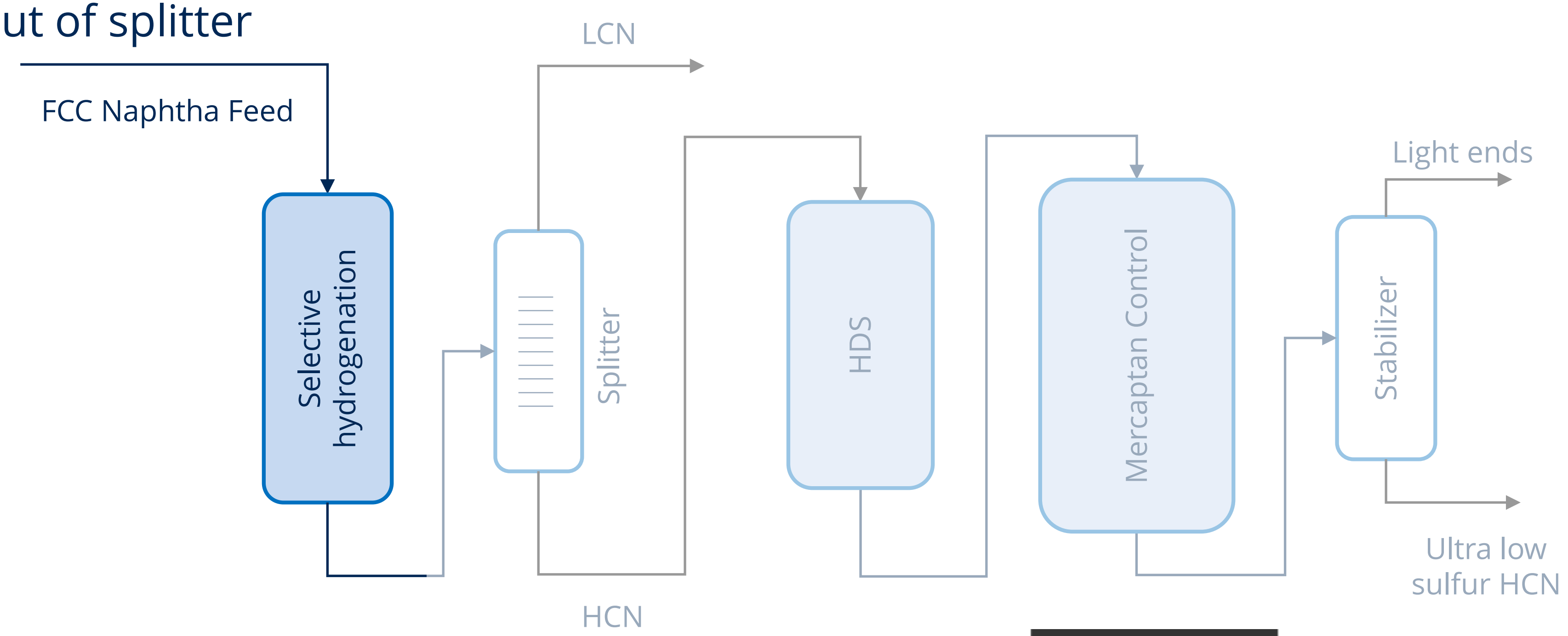
# Post-treatment step by step

# Main function of the selective hydrogenation unit

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





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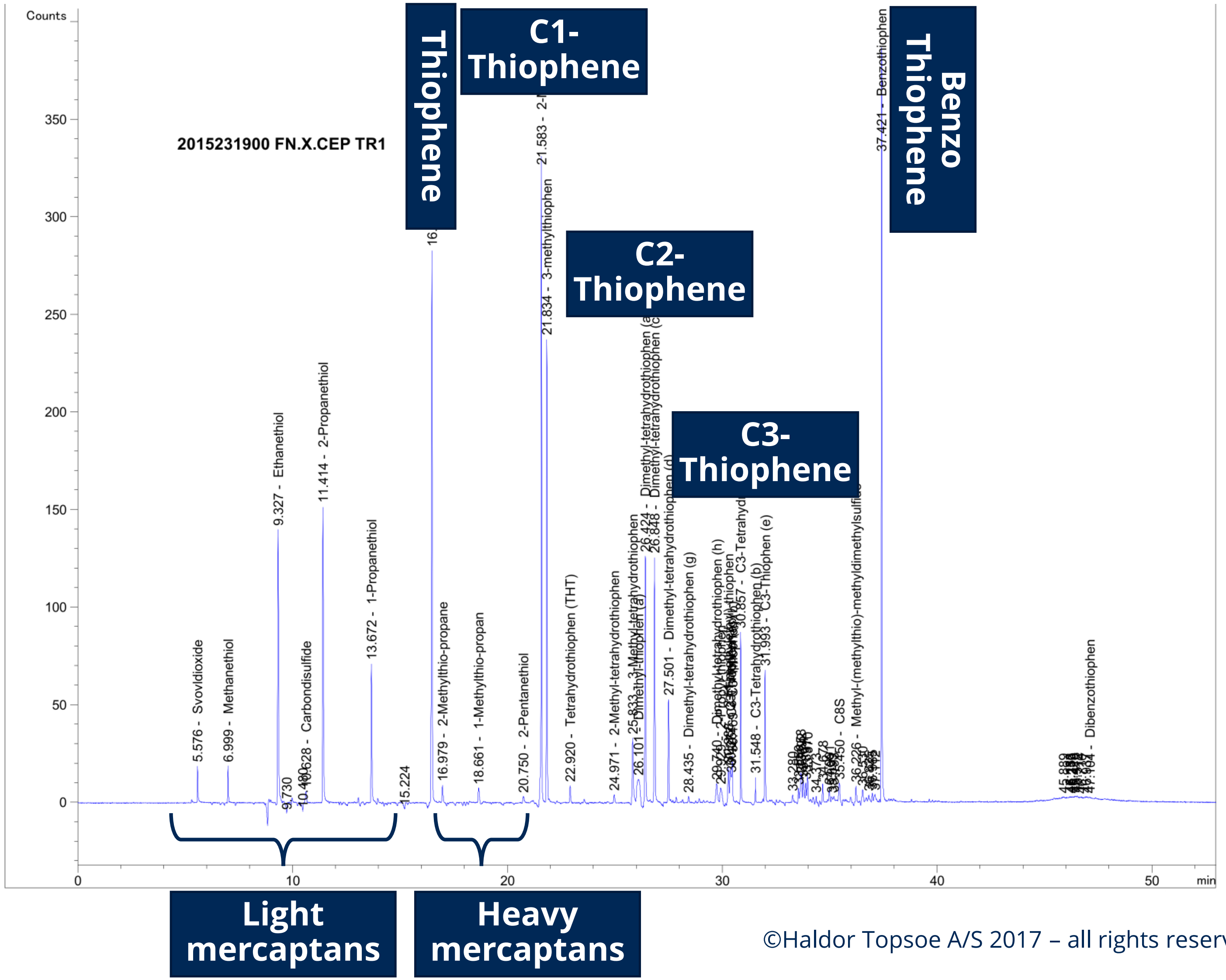
# FCC naphtha

## Sulfur speciation – SHU feedstock




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





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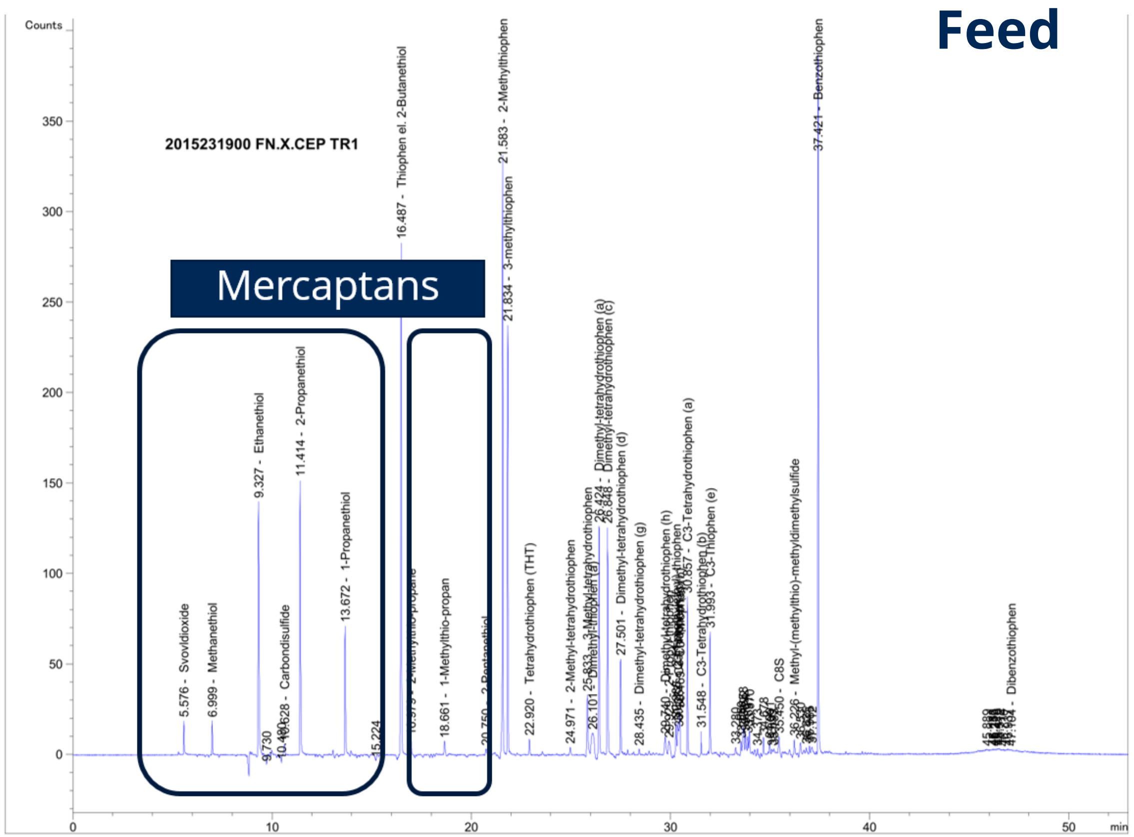
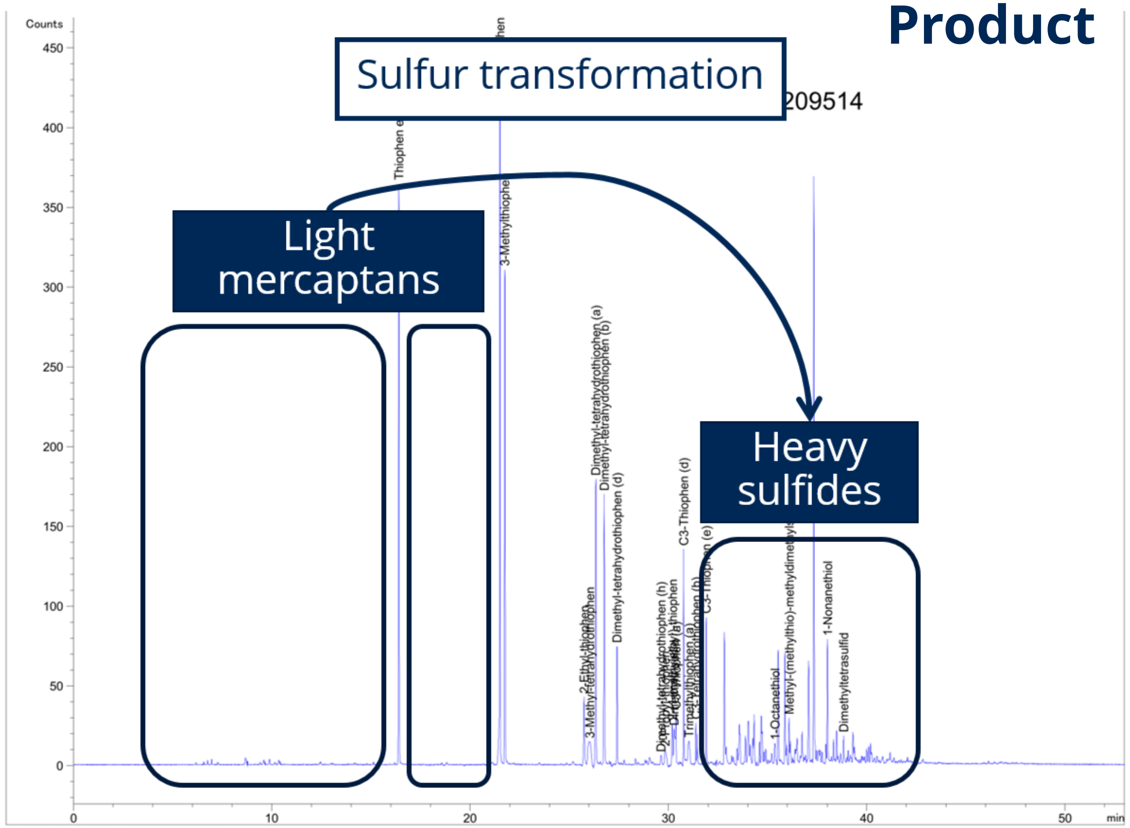
# Pilot plant test, Haldor Topsoe catalyst TK-703 HyOctane™

## Selective Hydrogenation Unit (SHU), sulfur speciation





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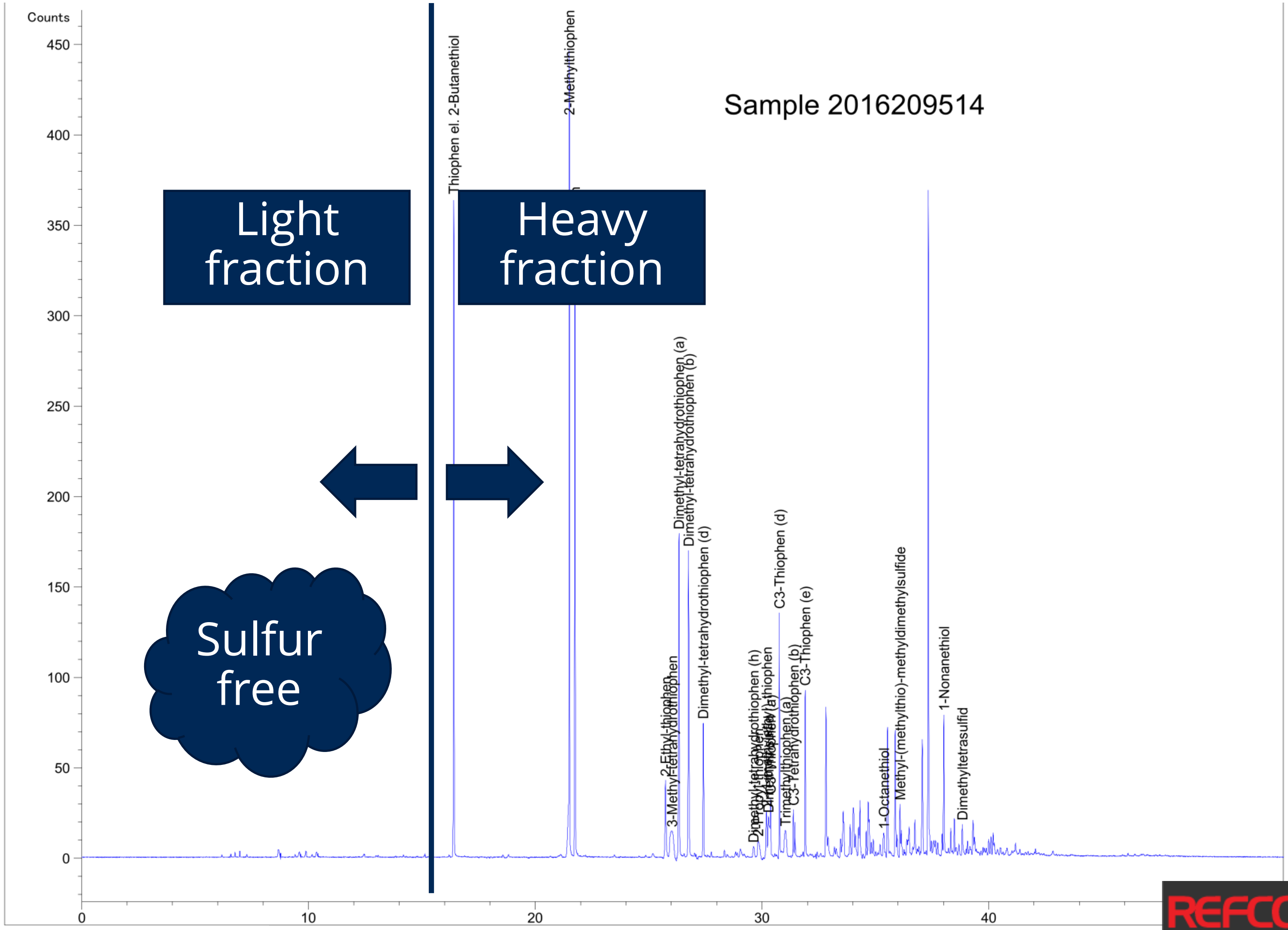
# Pilot plant test, Haldor Topsoe catalyst TK-703 HyOctane™

Selective Hydrogenation Unit (SHU), sulfur speciation – product





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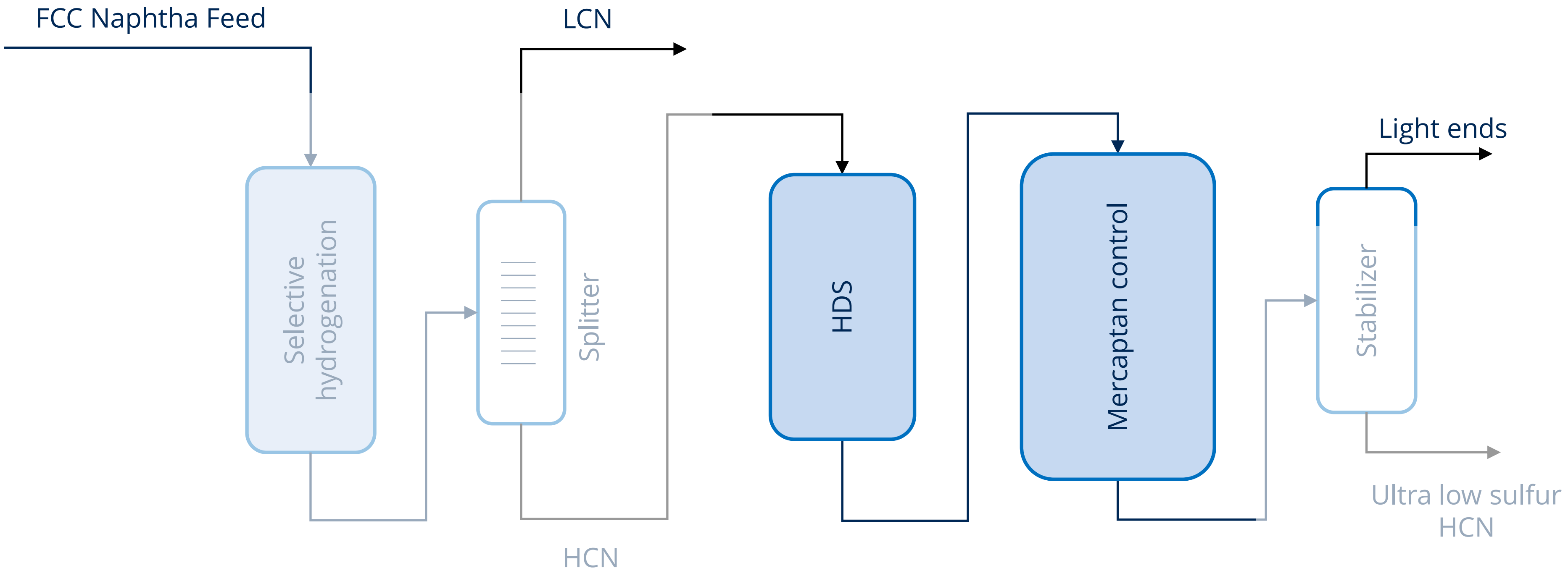
# Heavy naphtha desulfurization

# 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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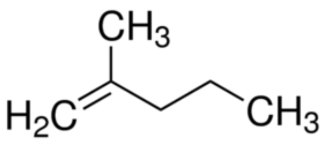
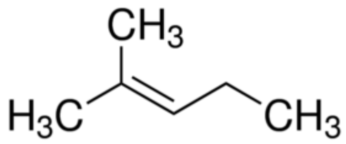
# Octane loss prediction model

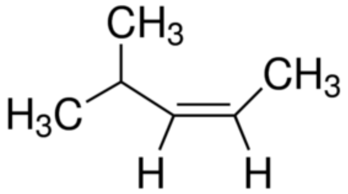
# Octane loss prediction model

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



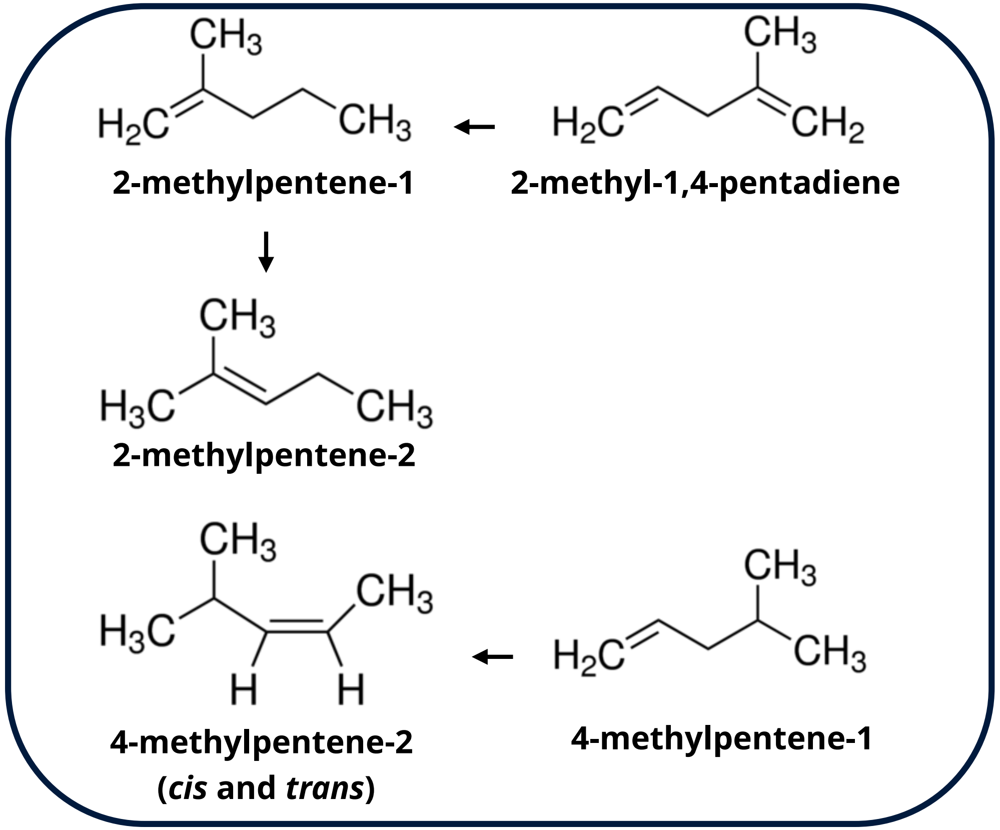

Model flexibility

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

# Key reaction path example

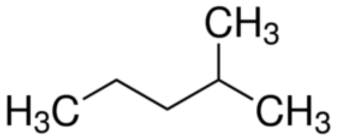
## Making 2-methylpentane

Reactants, average RON = 100




**ΔRON = -24**

Product, RON = 76



**2-methylpentane**

Abundant + high impact reaction path

# Model usage

Input

Output

10 ml sample

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

culated
ane loss

Unit design

conditions





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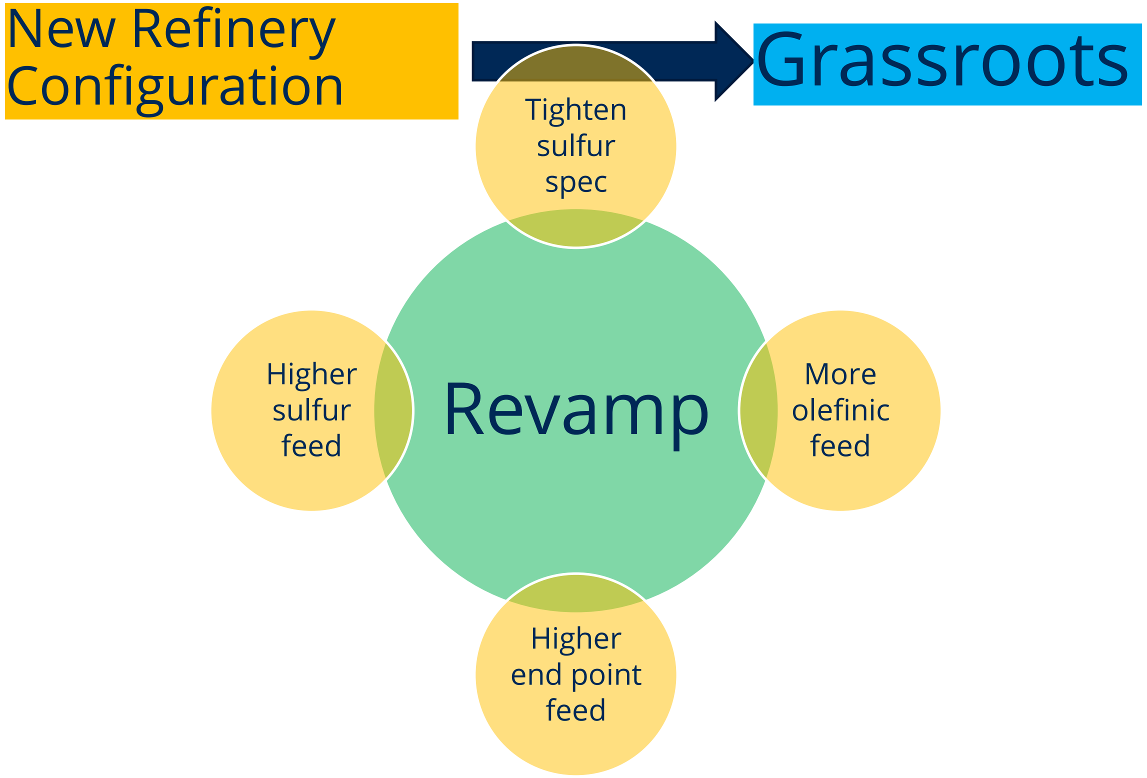
# The Topsoe HyOctane Technology HOT™ Process

# 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**



# Changing operation from 30 to 10 wtppm S gasoline
## Traditional technology

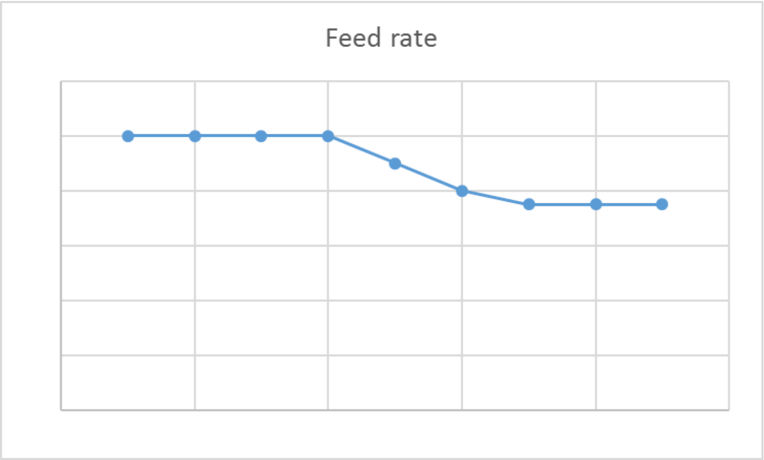
- Much higher RON loss with your existing process technology

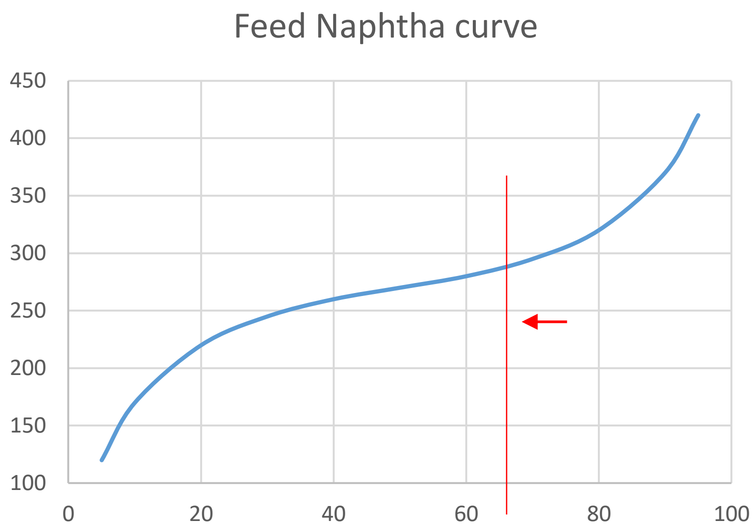
Consequence

**Cut feed rate**

And/or

**Cut end point of feed**





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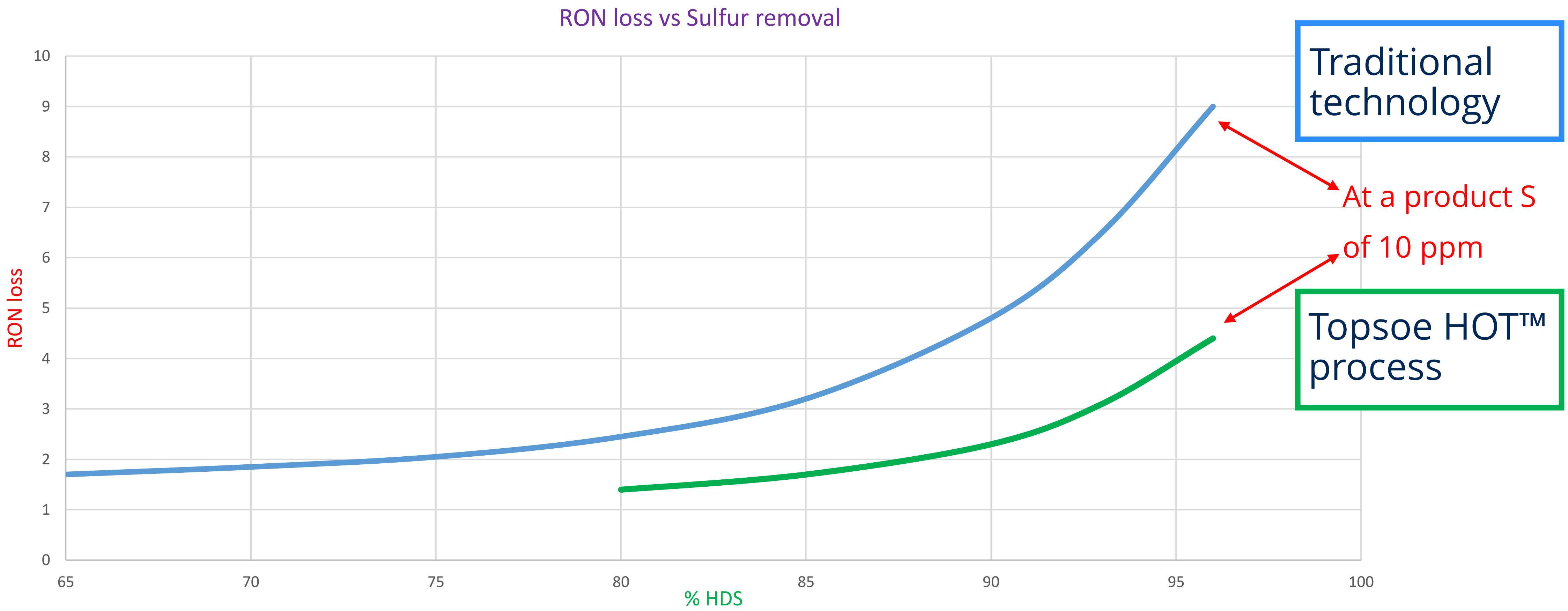
# The clear octane advantage with the Topsoe HOT™ process
## The octane vs HDS relation





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# Conclusion

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