OIL
REFINING

Prime-G+™

The benchmark technology for ultra low sulfur FCC gasoline

Deep HDS of cracked gasoline in one sweet little process

Deep hydrodesulfurization (HDS) of FCC gasoline (the largest sulfur contributor in the gasoline pool) is required to reduce gasoline pool sulfur content. Technologies must meet the following challenges:

- Good octane retention
- Excellent gasoline yield retention
- No RVP increase
- Minimum hydrogen consumption
- Operational reliability
- Ability to co-process other sulfur-rich streams.

The commercially proven Prime-G+™ technology is the market leader for selective hydrodesulfurization of cracked naphtha. Prime-G+™ stems from Axens' extensive experience acquired in cracked naphtha HDS and selective hydrogenation of LPG and gasoline (figure 1).

COMMERCIAL EXPERIENCE

More than 250 Prime-G and Prime-G+™ units have been licensed. The total licensed capacity exceeds 6,100,000 BPSD making Prime-G+™ the leading technology for cracked naphtha desulfurization. The following shows the wide range of application of this technology:

- **Sulfur levels in feed: 100 to 4,000+ wt ppm**
- **Olefin levels in feed: 15 to 45 vol %**
- **Unit capacity: 3,500 to 110,000+ BPSD**

Although the naphtha splitter may be optional depending on the required HDS severity, the association of a Prime-G+™ selective hydrogenation unit (SHU) with a splitter for light naphtha desulfurization and sweetening ideally complements the selective HDS on the heavier fraction.

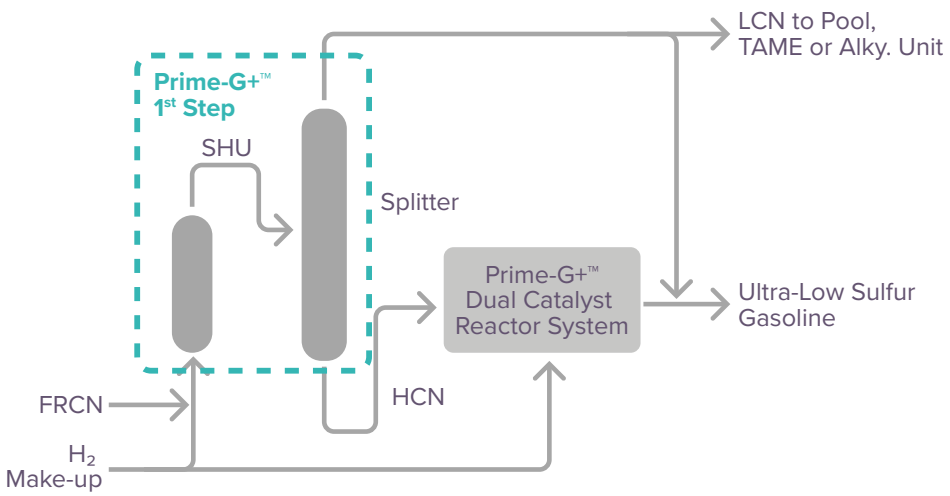


Figure 1: Prime-G+™ process flow diagram

Axens
SOLUTIONS

PRIME-G+™ 1st step: light cracked naphtha selective desulfurization

The "Prime-G+™ 1st Step" produces olefin-rich light cracked naphtha (LCN) and sulfur-rich heavy cracked naphtha (HCN). This processing arrangement provides a number of significant benefits:

- Conversion of light mercaptans and light sulfides into heavier sulfur species
- Production of low sulfur, mercaptan-free LCN stream. Prime-G+™ 1st step outperforms any other technology for LCN desulfurization
- Diolefin removal from the LCN allows direct processing in etherification or alkylation units
- Diolefin removal from the HCN stream. These compounds would otherwise cause increased pressure drop and reduce catalyst cycles in the HDS section
- No octane loss and low H_2 consumption
- Co-processing and desulfurization of other streams without additional hydrotreating (light coker, visbreaker, straight run or steam cracker naphthas).

	SHU FEED	SHU EFFLUENT	LCN (60°C)
S, wt. ppm	2015	2015	10
C_1 TO C_4 RSH, ppm	340	< 1	< 3
LIGHT SULFIDES, ppm	5	1	
DIOLEFINS, wt.%	1.6	< 0.2	
(RON+MON)/2	87.8	88.0	

↑ Table 1: Example of processing FCC naphtha in the "Prime-G+™ 1st Step"

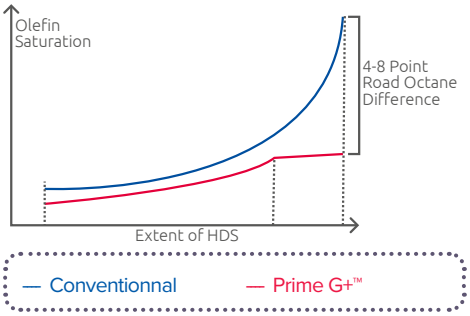
Prime-G+™ selective catalyst system™: the bifunctionaldual-bed HDS

Prime-G+™ selective HDS outperforms all other processes. The unit employs operating conditions and catalysts tailored to maximize selectivity and minimize olefin saturation while deeply desulfurizing.

PROCESS FEATURES	BENEFITS
VERY HIGH HDS LEVEL (98+ %)	ACHIEVES TOUGHEST GASOLINE POOL SULFUR SPEC. – 10 PPM
LOW OLEFINS AND NO AROMATICS HYDROGENATION	LOW HYDROGEN CONSUMPTION LOW OCTANE PENALTY
NO CRACKING REACTIONS	LIQUID YIELD GREATER THAN 100% WITH NO RVP INCREASE

↑ Table 2: Benefits of the Prime-G+™ Sweet Catalyst System

Two catalysts were developed to tackle this problem. The lead catalyst, which achieves the bulk of the desulfurization reactions, has been tailored to minimize olefin saturation reactions while having sufficient activity to desulfurize the most refractory sulfur species encountered in the gasoline boiling range. The finishing catalyst is a polishing catalyst exhibiting practically no olefin saturation activity but able to achieve the last step of the desulfurization while reducing product mercaptans. As a result, extremely low product sulfur levels can be achieved in a single-stage unit with excellent octane retention and low product mercaptans (figure 2).



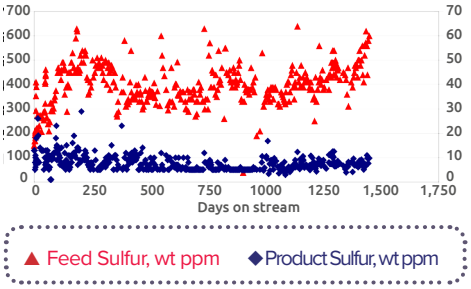
↑ Figure 2: Octane loss by olefin saturation for Prime-G+™ process compared to conventional FCC gasoline HDS technology

The technology lends itself to the reuse of idle units (thirty references for naphtha HDT or semi-regenerative reformer revamping).

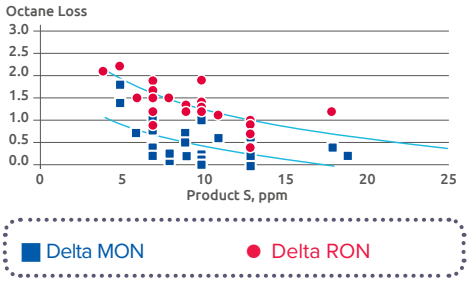
Commercial experience at 10 ppm

In order to meet future gasoline sulfur regulations, German refineries have pioneered the implementation of the ultra low-sulfur gasoline desulfurization technology and many of them selected the Prime-G+™ technology to reach less than 10 wppm in the gasoline pool since end 2002.

Since then, 125 units have been put on stream with design provisions to meet 10 wppm (Euro V) sulfur in the reformulated gasoline pool. Prime-G+™ technology has demonstrated ability to produce ULS (Ultra Low Sulfur) gasoline during periods of time exceeding FCC turnaround cycles (more than 5 years) and with low octane loss (figure 3)



↑ Figure 3: Inlet and outlet sulfur content vs. time



↑ Figure 4: Prime G+™ Octane Retention

Prime G+™ technology comforts Axens' leading position in hydroprocessing (diesel and kerosene hydrotreating: Prime-D™, Prime-K™ and benzene hydrogenation: Benfree™) and in olefins upgrading (etherification -TAME and TAEE- oligomerization with Selectopol™, OATS™ (BP) and Polynaphtha™ technologies, hydrogenation with Alkyfining® and purification with AxSorb® products).