



# R-975™ – Sulfur reduction without capital expenditure or octane or selectivity loss

Many streams contribute to the overall gasoline pool of a refinery, but naphtha from the FCC unit is, in most cases, the largest contributor of sulfur. Consequently, even small reductions in fuel sulfur levels from the FCC unit can translate into large gains for refiners.

Fuel sulfur reduction (FSR) additives have undergone constant development since their introduction in the late 1990s. The first generations offered only modest sulfur reduction, and usually just from the hydrogen-rich sulfur compounds in the lighter end of the gasoline range.

Subsequent efforts have focused on understanding the relationship between the catalytic composition of active additive components and the reaction pathways of the individual sulfur species present in the full range of FCC transportation fuel products.

A successful FSR additive reduces the entire spectrum of sulfur species in the FCC naphtha without detrimental effects on octane or selectivity. Non-capital alternatives, such as undercutting, significantly diminish the naphtha yield and the octane from the FCC unit. Capital-intensive FSR alternatives include feed hydrotreating and naphtha post-treating. Feed hydrotreating is quite effective; however, the capital expenditure associated with commissioning a feed hydrotreater is significant. Because post-treaters only need to process a fraction of

the FCC feed volume, the associated capital expenditure is less, but not insignificant. The primary disadvantage of post-treaters is octane loss, which can be up to two or more octane numbers.

R-975 FSR additive is commercially proven to offer refiners lower fuel sulfur levels without capital expenditure, octane or selectivity loss. It works with paraffinic, aromatic, hydrotreated and non-hydrotreated feeds. R-975 contains a customizable system of zeolite, matrix and selective metal components combined in an attrition-resistant architecture to provide superior sulfur reduction characteristics in any situation.

## How R-975 works

R-975 removes fuel-range sulfur compounds by two primary routes (Figure 1). Mercaptans and alkyl-thiophenes are hydrogen-rich sulfur-containing molecules that occur in the lighter fractions of FCC-range gasoline. R-975 selectively cracks the sulfur out of these and releases it as hydrogen sulfide ( $H_2S$ ) in the riser. It also minimizes the recombination reaction of  $H_2S$  into mercaptans and thiophene.

Heavier, more hydrogen deficient, and aromatic naphtha-range compounds such as benzothiophene are selectively captured and converted to coke. The sulfur-rich coke is transported into the FCC regenerator where it is burned. This selective coking does not affect the overall coke or delta coke make because the mass of the additional coke is insignificant relative to the mass of coke required by the heat balance of the FCC unit.

To combat potential increases in  $SO_x$  from combustion of the sulfur-rich coke, R-975 contains integral active  $SO_x$  reduction sites. In all cases of R-975 use,  $SO_x$  emissions are equal to or significantly lower than the base case.

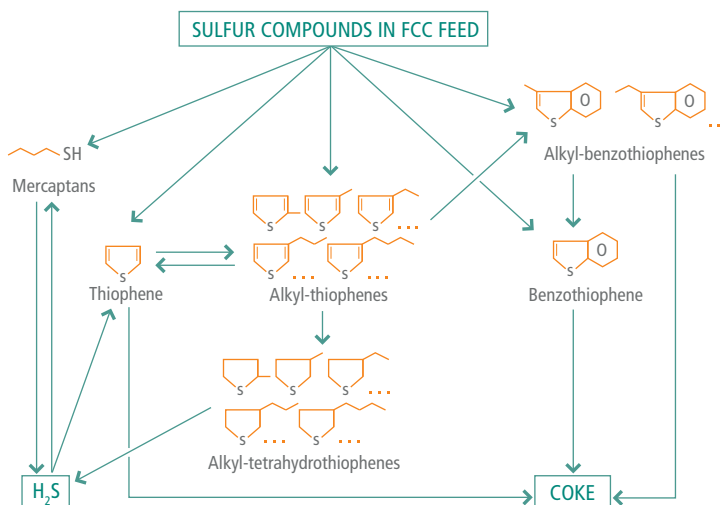


Figure 1: The mechanisms for fuel sulfur reduction with R-975.

**AN ATTRITION-RESISTANT ARCHITECTURE PROVIDES SUPERIOR SULFUR REDUCTION CHARACTERISTICS IN ANY SITUATION.**

## How refiners take advantage of R-975

Refiners can realize the benefits of R-975 by

- reducing the naphtha sulfur at constant endpoint
- increasing the FCC feed sulfur at constant product sulfur and endpoint
- increasing the product endpoint, which thereby increases the product volume at constant naphtha sulfur and feed sulfur levels
- any combination of the above.

It is important to understand how the benefits of R-975 additive will be taken advantage of at your refinery. A change in how the benefit is realized is often mistakenly perceived as poor product performance.

## In conjunction with other FSR options

Refiners use R-975 in two ways: as part of everyday operations (structural use) and to meet short-term criteria (opportunistic use).

### Structural use

- As a low-cost alternative to large capital hydrotreating projects
- To delay or postpone the installation of feed hydrotreaters or post-treaters while maintaining regulatory compliance
- When installing a smaller feed hydrotreater or post-treater to offset total capital outlay
- For reducing hydrotreating costs, mainly hydrogen consumption
- For increasing the throughput through the FCC and the hydrotreater train

### Opportunistic use

- To minimize the throughput impact during a hydrotreater outage
- To increase the run length of onstream hydrotreaters
- So higher sulfur feedstocks can be sent to the FCC unit while maintaining regulatory compliance
- To increase the refinery gasoline pool's octane by bypassing part of the FCC naphtha streams around post-treaters to make up for octane shortfalls

These just some of the ways refiners employ Albemarle FSR additives such as R-975 to meet fuel sulfur regulations and drive up the profitability of the FCC unit. Albemarle anticipates that R-975 can offer significant improvements relative to the base conditions at your refinery.

Typical product properties	↘
Additive name	R-975
Application	Fuel sulfur reduction
Attrition index, wt%	3
Average bulk density, g/ml	0.88
Surface area, m <sup>2</sup> /g	170
Particle size distribution (0–40), %	12
Particle size distribution (0–20), %	1

↘ For more information on this or other Albemarle products and technologies, please contact your Albemarle representative.

### AMERICAS

2625 Bay Area Blvd  
Suite 250  
Houston, TX 77058  
USA

Tel: +1 281 480 4747  
Email: [catmaster@albemarle.com](mailto:catmaster@albemarle.com)

### EUROPE, MIDDLE EAST, INDIA AND AFRICA

Nieuwendammerkade 1–3  
1030 BE Amsterdam  
The Netherlands

Tel: +31 20 634 7300  
Email: [catmaster@albemarle.com](mailto:catmaster@albemarle.com)

### ASIA PACIFIC

Room 2208, Shui On Plaza  
No. 333 Huai Hai Zhong Rd  
Shanghai 200021  
China

Tel: +86 21 6103 8666  
Email: [catmaster@albemarle.com](mailto:catmaster@albemarle.com)

### JAPAN

16F, Fukoku Seimei Building  
Uchisaiwai-cho, 2-2-2  
Chiyoda-ku  
Tokyo 100-0011  
Japan

Tel: +81 3 5251 0793  
Email: [catmaster@albemarle.com](mailto:catmaster@albemarle.com)

[www.albemarle.com](http://www.albemarle.com)

The information presented herein is believed to be accurate and reliable, but is presented without guarantee or responsibility on the part of Albemarle Corporation. It is the responsibility of the user to comply with all applicable laws and regulations and to provide for a safe workplace. The user should consider any information contained herein, including information about any health or safety hazards, only as a guide, and should take those precautions that are necessary or prudent to instruct employees and to develop work practice procedures in order to promote a safe work environment. Further, nothing contained herein shall be taken as an inducement or recommendation to manufacture or use any of the herein described materials or processes in violation of existing or future patents.

© 2011 Albemarle Corporation. All rights reserved worldwide.

Cat-221332-0111.