



FÁBRICA CARIOCA
DE CATALISADORES

RESOLVE 950 Plus

Additive for sulfur reduction
in cracked naphtha



Globally, the requirements of ever more stringent sulfur specifications for gasoline have profound implications on the refineries operations and investments. Although the gasoline post-treatment process keeps on being the main option, the associated octane loss brings further restrictions for the refiners.

The **RESOLVE 950 Plus** additive is an effective solution for refiners who are interested in reducing sulfur compounds in the cracked naphtha. Its technology has been developed on the basis of a deep knowledge of the gasoline range sulfur compounds, considering the reactivity of high aromatic S content species.

Amongst the present regulatory environment, the use of additives of the RESOLVE family may be an interesting strategy, enabling the refiner to reduce the severity of the gasoline hydrodesulfurization process, thus minimizing its octane loss. Further, the additive avoids the reduction of cracked naphtha yield, and increases the flexibility in the kind of feed choice, making viable the processing of higher sulfur content petroleum oils.

Working of the RESOLVE 950 additive: a deep knowledge of the gasoline range sulfur compounds chemistry

The design philosophy of the Fábrica Carioca de Catalisadores S.A. and Ketjen for their RESOLVE 950 additive was conceived on the basis of a deep knowledge of the gasoline range sulfur compounds chemistry.

For the high hydrogen content molecules present in the gasoline light fractions, especially sulfides and simple mercaptans, our approach implies in adsorption and direct cracking to H_2S by means of a high activity system. The high hydrogen transfer is also used for minimizing the recombination of light olefins with H_2S that forms mercaptans. The sulfur compounds in the FCC gasoline average range are of very different nature, being deficient in hydrogen and of a more aromatic nature. Particularly, thiophene is an extremely stable, difficult to remove particle.

Our strategy for this kind of molecule is more complex. With the final goal of saturating some of these compounds and confer them higher chance to be converted into H_2S , the contact time becomes a critical factor. Some of the RESOLVE 950 components have improved capacity to selectively adsorb these molecules, allowing more time to perform the additional hydrogen transfer. Other components in its formulation are able to alkylate thiophene compounds. The saturated and substituted thiophenes are significantly more reactive than thiophene itself, allowing higher conversion into H_2S .

Figure 1 shows schematically the conversion products of the gasoline sulfur species.

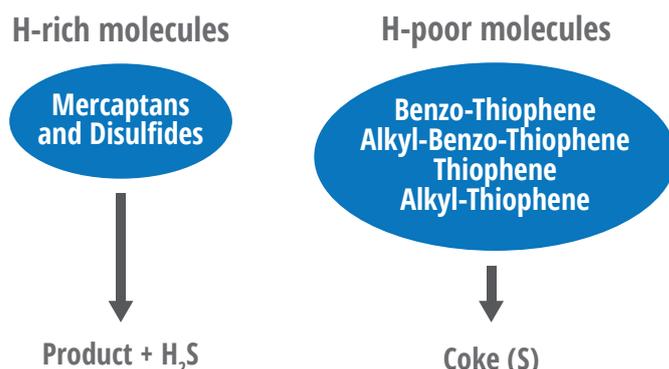


Figure 1: Conversion of H-rich (S little aromatic) and H-poor species (S aromatic).

Figure 2 depicts the RESOLVE additive performance and shows the difference in reactivity of high aromatic S-containing species compared with the low content ones, translating into higher S reduction for the latter.



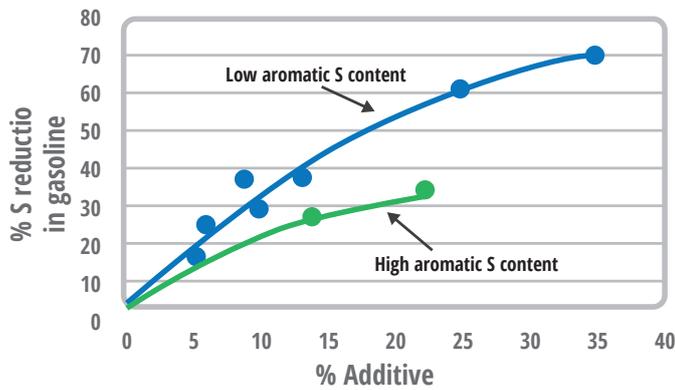


Figure 2: Reactivity of sulfur compounds

Cases of commercial success of the RESOLVE 950 additive

Figure 3 illustrates an example of the commercial application of RESOLVE 950 to a non-treated FCC feed, with a slightly lower than 1% sulfur level. In this case a sulfur reduction of 26% for a light cracked naphtha was attained (LCN, corrected end point = 340°F / 172°C).

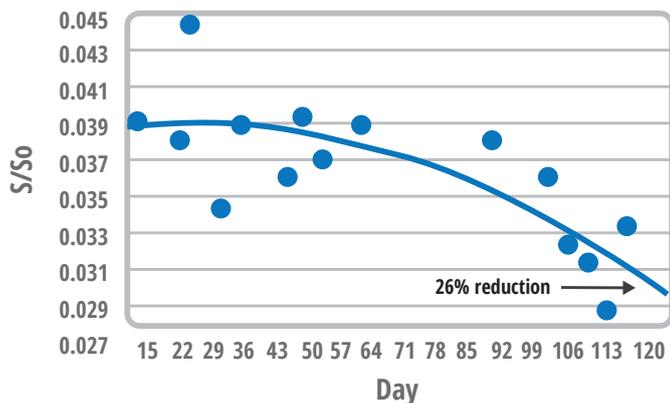


Figure 3: Example of RESOLVE 950 commercial performance. Sulfur reduction in light cracked naphtha (LCN).

The molecules of the gasoline range final fraction are even more deficient in hydrogen, and given that from 80 to 90% of the FCC gasoline sulfur are found in the final 10% of its volume, here is where the real challenge lies. Again the approach here is to use selective adsorption for having longer time for additional hydrogen transfer and cracking.

Figure 4 shows a 31% reduction in the sulfur of a heavy cracked naphtha (HCN). In this case, the cut point at 95% of the heavy naphtha is well above normal for cracked gasolines, demonstrating that RESOLVE950 also removes sulfur from the initial LCO range.

In the Example, S/So is the ratio between sulfur in a gasoline fraction (LCN or HCN) and the feed sulfur. Previous studies made by Fábrica Carioca de Catalisadores S.A. and Ketjen have demonstrated that around 10% of the sulfur present in the non-hydrotreated FCC feeds remain in the FCC gasoline. By hydrotreating the feed, however, this amount can be reduced to half. In this way, for a nearly 1% sulfur-containing feed, without hydrotreatment, the FCC gasoline contains typically around 1,000 ppm sulfur.

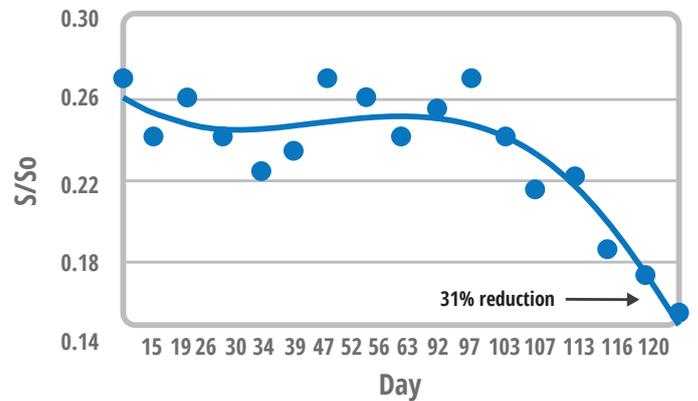


Figure 4: Example of RESOLVE 950 commercial performance. Sulfur reduction in heavy cracked naphtha (HCN).

RESOLVE 950 Plus: interesting opportunities for the refiners

The sulfur reduction promoted by RESOLVE 950 Plus may not be sufficient for all the refiners to overcome the challenges required by the new legislations. Even so, the utilization of the additive provides interesting opportunities, such as:

- Proven capacity for reducing the gasoline volume to be post-treated;
- Possibility of reducing the severity of the gasoline hydrodesulfurization process, thus minimizing its octane loss;
- Higher flexibility in the choice of the feed kind, enabling to process cheaper, higher sulfur-content petroleum oils.

RESOLVE 950 Plus finds wide application both in terms of feed quality and as concerns the target products boiling range, working effectively in the removal of sulfur compounds of the gasoline boiling range and also of LCO.

Extra SOx abatement functionality

Because of its differentiated support, RESOLVE 950 Plus has an extra functionality for SOx abatement in the regenerator, it being successfully employed both in applications where conventional sulfur oxides abatement additives exhibit low efficiency and under partial combustion operations.

In Figure 5 it is possible to observe the efficient industrial application of the RESOLVE 950 for the SOx abatement in regenerators.

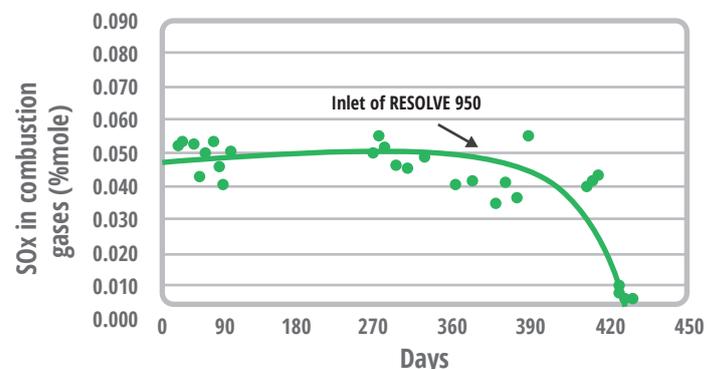


Figure 5: Example of the commercial development of RESOLVE 950 in the SOx abatement in regenerators.

RESOLVE 950 Plus is an effective solution for the refiners with interest in reducing sulfur simultaneously in products (gasoline and LCO) and SOX emitted by FCC units regenerators.

Benefits of the RESOLVE 950 Plus

The RESOLVE 950 Plus additive provides the following advantages:

- Reduction of sulfur compounds in the cracked naphtha and LCO;
- Extra SOx abatement functionality in the regenerator;
- High efficiency under partial combustion operations;
- Reduction in the gasoline volume to be post-treated and in the severity of the hydrodesulfurization process, preserving the octanes;
- Flexibility for processing higher sulfur content feeds;
- Increase in cracked naphtha production since it avoids the yield loss resulting from the removal of its end fraction;
- It does not require huge capital investments such as the post-treatment units.



**FÁBRICA CARIOCA
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**For more information, contact the FCC S.A.
Technical Services team**

ABOUT FCC S.A.

FCC S.A is a leading-edge technology company, with headquarters in Rio de Janeiro, comprising the Petrobras S.A. and Ketjen companies. Being the sole manufacturer of catalytic cracking catalysts and additives for petroleum refining in the South-American market, its consumer customers are the refineries of the Petrobras Systems, as well as the petroleum refineries of South-American countries.