Quantifying FCC gasoline sulfur reduction

The next step into deep space

Refiners everywhere have to comply with government-mandated fuel specifications, in particular dramatically lower gasoline sulfur levels. While post-treating remains an option, the associated octane loss creates additional constraints for refiners, particularly those who are hydrogen limited. Regardless of whether your refinery is post-treatment or hydrogen constrained, a gasoline sulfur reduction additive such as Albemarle's RESOLVE line can reduce reliance on post-treating or alternatively, help recoup investment capital. However, due to changes in feed quality, cut point, and catalyst (additive) addition rate to the FCCU, measurement of gasoline sulfur reduction from the FCCU becomes difficult to quantify. This bulletin strives to clarify the process.

There are essentially three techniques: comparison to base-line performance, normalization for feed sulfur and cut point, and testing with constant feed. While the results should all support the same conclusions, namely that gasoline sulfur is being reduced, the actual reduction measured can vary.

In the first technique, it is essential to gain base-line performance of gasoline sulfur quantification by D-86 T-90 and normalized for feed sulfur. A large database is best: roughly 50 data points will provide sufficient range of data for feed quality shifts. One simply normalizes gasoline sulfur to the feed sulfur without an additive in use in the FCCU. This is correlated to the D-86 T-90 point through a linear relationship (Figure 1).

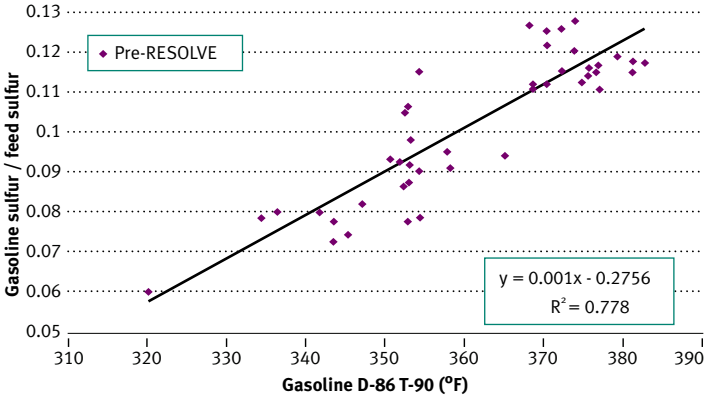

Figure 1: Gasoline D-86 T90 vs feed normalized gasoline sulfur.

This allows the refiner to calculate what the expected gasoline sulfur concentration (normalized for feed sulfur) would be without an additive. Then, subtracting the expected from the actual feed normalized gasoline sulfur and dividing by the expected would result in the ability to monitor sulfur change with time (Figure 2).

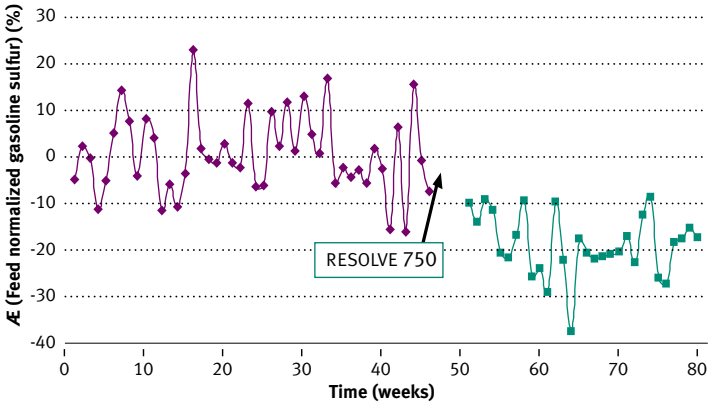

Figure 2: Gasoline sulfur reduction with time.

Replotting the feed-normalized gasoline sulfur with D-86 T-90 both without and with RESOLVE reveals that the lines are not parallel, but that the sulfur reduction remains constant across the cut point for additive systems that reduce sulfur across the full-range of gasoline boiling points (Figure 3).

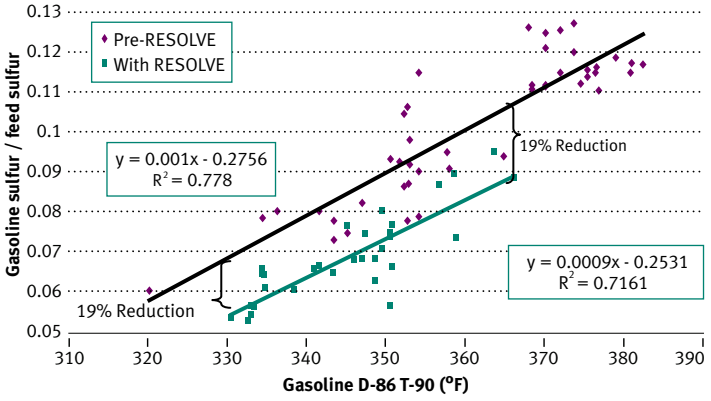

Figure 3: Gasoline D-86 T90 vs feed normalized gasoline sulfur.

In order to meet mandated average gasoline sulfur levels, refiners often "undercut" to compensate for feed swings and unit upsets. Recombination of the gasoline and LCO fractions from the FCCU at the yield ratios off the FCCU (typically 3:1, v:v, gasoline:LCO) and redistillation to full-range gasoline for comparison to the feed sulfur can provide refiners a deeper understanding of the additive performance (Figure 4).

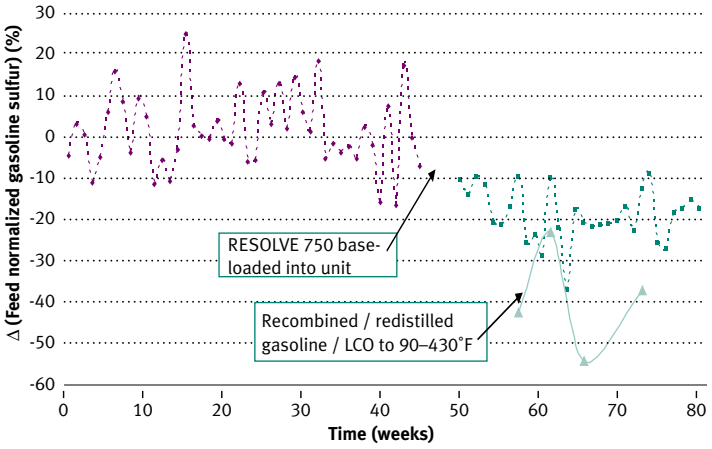

Figure 4: Gasoline sulfur reduction with time: recombined, redistilled samples.

Finally, a potentially even more definitive measurement of gasoline sulfur reduction can be determined through testing. For this, a common feed can be used to measure product sulfurs from equilibrium catalysts both prior to additive use and once the additive is in use (Figure 5).

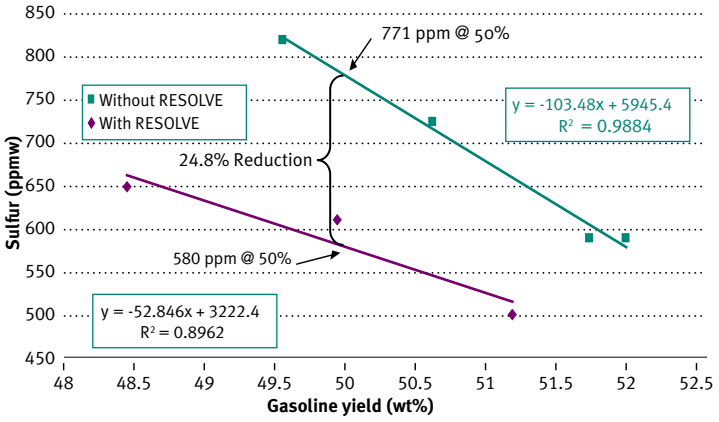

Figure 5: Sulfur in gasoline, testing analysis.

Albemarle routinely provides all of these services in our unit monitoring program at no extra cost to the refiner. The data taken for this paper were from our RESOLVE 750 line of additives. We have found that additional sulfur reduction can be achieved, depending on feed quality, with other RESOLVE products. For that reason, we customize solutions according to feed quality and swings (Figure 6).

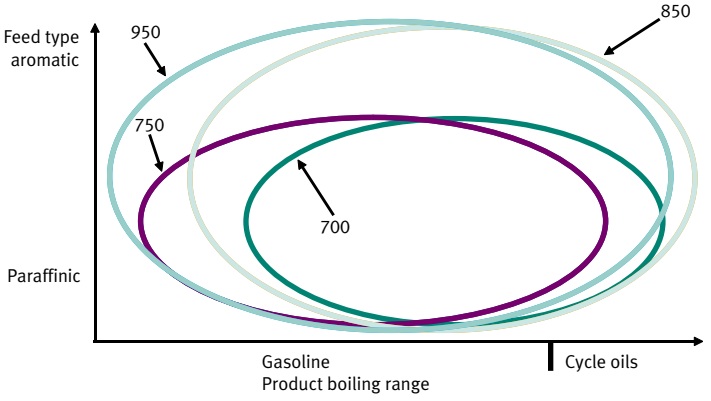

Figure 6: RESOLVE applicability.

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

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