ALBEMARLE®

Quantifying FCC catalyst accessibility

Accessibility defined

Accessibility is related to the mass-transfer characteristics of an FCC catalyst. Albemarle has developed a quantitative laboratory test that measures the accessibility of FCC catalyst particles: the first such measurement in the history of FCC. This test has dramatically altered the way refiners select and evaluate catalysts. Moreover, it is another example that demonstrates Albemarle's continuing leadership in maximizing and exploiting the benefits of FCC catalyst mass transfer. Additionally, the company has developed and introduced modifications to its manufacturing technologies that further increase the accessibility of its catalysts.

The Albemarle Accessibility Index (AAI)

The AAI test is quantitative and directly measures the dynamic diffusion of high-molecular-weight molecules into an FCC catalyst particle.

The accessibility measurement is relevant to refinery operations, where Albemarle's AAI test has multiple applications, including

- unit optimization
- unit troubleshooting
- catalyst selection
- feed slate selection.

Unit optimization

Empirical observations consistently demonstrate that many refiners experience a "critical accessibility level". This critical level is extremely unit specific and is a function of feed quality, feed–catalyst contact efficiency, riser residence time, equilibrium catalyst metal levels and regenerator conditions. Operating with accessibility levels below this point results in large losses in FCC unit conversion and transportation fuel production. This is not reflected in traditional equilibrium catalyst laboratory testing.

The AAI test is the only tool available for measuring accessibility and establishing critical accessibility levels. As an example, FCC unit yields are directly related to accessibility. Figures 1 and 2 show the effect of accessibility on FCC gasoline and unit conversion. The inflection point in the curve (denoted by the vertical line) determines the critical accessibility required to maintain optimal unit performance. In this specific case, the critical AAI is about 4. It is notable that, in some cases, there are significant yield benefits for exceeding the critical AAI.

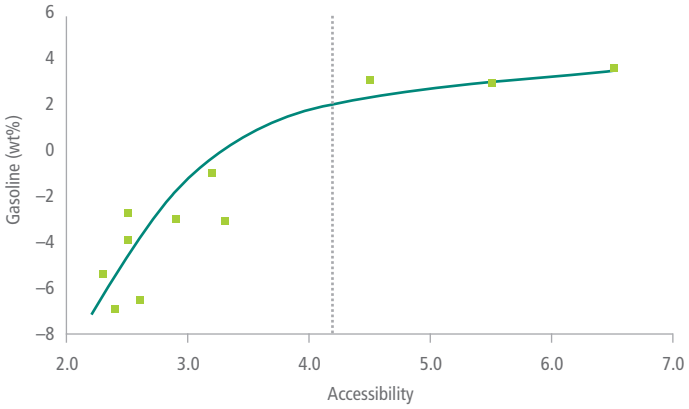

Figure 1: Accessibility influences gasoline production.

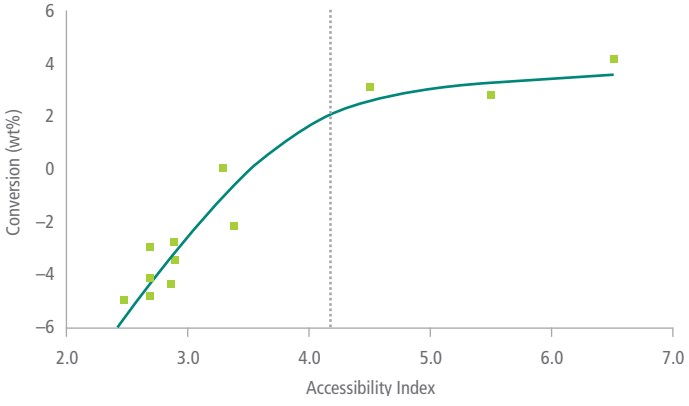

Figure 2: Accessibility influences conversion.

Unit troubleshooting

Several refiners have observed large drops in unit conversion after processing high-metal feedstocks (e.g., with high levels of Ca, Ni, V, Fe and Na) or after suffering upsets on crude unit desalters. The AAI test is useful in providing conclusive evidence for root-cause analysis. This can be observed in Figure 3, which demonstrates the relationship between total equilibrium metals and catalyst accessibility. This refiner experienced conversion loss below a critical AAI of approximately 3. The refiner was able to correlate this loss of accessibility to metal levels. To recover the loss of conversion and profitability, this refiner changed to a higher-accessibility Albemarle catalyst.

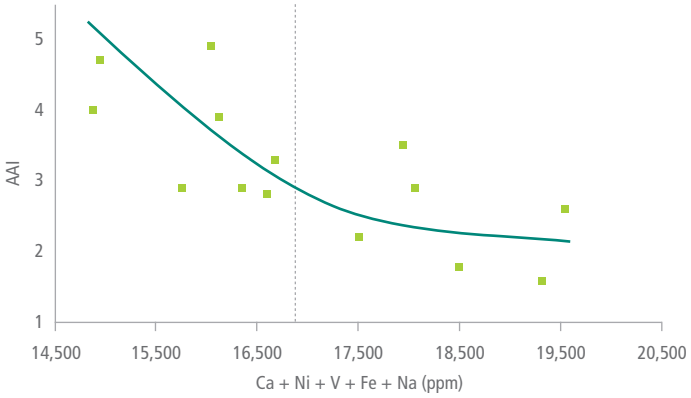

Figure 3: The effects of metals on accessibility.

Catalyst selection

The ability to measure the effect of accessibility in a laboratory test unit is directly related to the oil residence time in the unit. As the contact time increases, the capacity for distinguishing catalyst accessibility differences diminishes. The effect of mass-transfer resistance is reduced as the oil's contact time with the catalyst increases. This is especially troublesome for the many long-contact-time laboratory test units used throughout the industry. Such tests are incapable of properly evaluating the mass transfer or accessibility of catalysts. However, the AAI test enables a mass-transfer-limited refiner to compare the effective accessibility of competitive catalysts. This is a necessary aid in selecting the best technology catalysts in the market.

Feed selection

The AAI test enables a refiner to test the ability of its current catalyst system to crack an opportunity feedstock or an intermittent stream in the refinery. In this application of the AAI test, the catalyst is kept constant and the feed type is changed. The relative diffusion rates of the different feedstocks are measured. This use of the AAI test will notify the refiner of a potentially refractory and uneconomic feed for the current catalyst. The refiner has the option to change to a higher AAI catalyst to facilitate the processing of refractory, opportunity feedstocks.

Albemarle's service

Albemarle desires to provide refining solutions that deliver the best economic returns to its customers. The cutting edge of FCC catalysis is no longer defined simply by the type and rare earth level of the zeolite, and the type and amount of active alumina, but also by the catalyst's accessibility to sterically hindered, heavy feed molecules, as measured by the AAI test. Albemarle's line of catalysts has undergone a paradigm shift in the way they are assembled, which has resulted in a full range of particle accessibility. This provides a powerful tool for optimizing catalysts on the basis of unit design, feed quality and equilibrium catalyst metal levels.

Albemarle has commercialized several new high-accessibility catalysts including ACTION™, AMBER™, AFX™, GO-ULTRA™, RUBY™, CORAL™ SMR and UPGRADER™. UPGRADER features by far the highest accessibility in industry. These catalysts enhance Albemarle's portfolio of performance products.

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

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