ALBEMARLE®

CATALYSTS

SOxMASTER-2™ FCC ADDITIVE

Optimal SOx reduction without rare earth for partial- and full-burn units

SOx reduction additives are designed to capture and remove the oxidized sulfur compounds present in the FCC unit regenerator and release them in the FCC riser. On release, the sulfur exits the FCC unit as hydrogen sulfide, along with the cracked products in the reactor effluent. The hydrogen sulfide is processed in the gas plant downstream of the FCC unit.

Extensive studies in the 1970s looked at the absorption of SOx by various metal oxides and concluded that catalysts based on MgO, Al2O3, MgAl2O4 (spinel), La2O3 and CeO2 were most suitable for FCC operations. The introduction of hydrotalcite (Mg6Al2OH16), which is an anionic layered clay, improved the Mg/Al ratio to 3:1 from 1:2 compared with other leading technologies. The importance of the Mg/Al ratio becomes apparent when the mechanism for capture and subsequent release of sulfur via additives is considered (Figure 1). Magnesium acts as the primary capturing medium by forming magnesium sulfate in the regenerator. Sulfur is released from the magnesium sulfate in the riser. This process effectively regenerates the particle so it may capture sulfur again in the next pass through the FCC unit.

Albemarle pioneered and patented hydrotalcite-based additives and first entered the SOx additive market in the 1980s. An estimated 70% of all SOx additives used worldwide are based on hydrotalcite. Albemarle's hydrotalcite-based technology is the preferred option for reducing SOx emissions from FCC units because it offers the highest amounts of magnesium available on the market and, consequently, the highest reduction in SOx emissions.

The SOxMASTER-2 technology advantage

In addition to the hydrotalcite base, SOxMASTER-2 offers key features unavailable in competitors' products. SOx additives include an oxidation agent, and manufacturers typically choose cerium for its high performance (Figure 1). Breaking preconceived notions, SOxMASTER-2 catalyzes the oxidation of SO2, with no rare earth elements in the proprietary ingredients. The additive has high adsorption capacity and deactivates at a significantly lower rate than other additives on the market (Figure 2). The net result is that SOxMASTER-2 performs like a traditional additive in full-burn operation and is the superior additive for partial-burn operation.

Competitive additives containing cerium may be marketed for partial burn but increase carbon on regenerated catalyst, even at small concentrations in the inventory. The rule of thumb is that each 0.1 wt% increase in carbon on regenerated catalyst results in a 1 wt% reduction in conversion. Figure 3 shows how one competitive additive harmed the yields from the FCC unit by increasing the carbon on regenerated catalyst four times with less than 3% additive in the inventory. The absence of cerium in SOxMASTER-2 makes it the optimal choice for partial-burn applications.

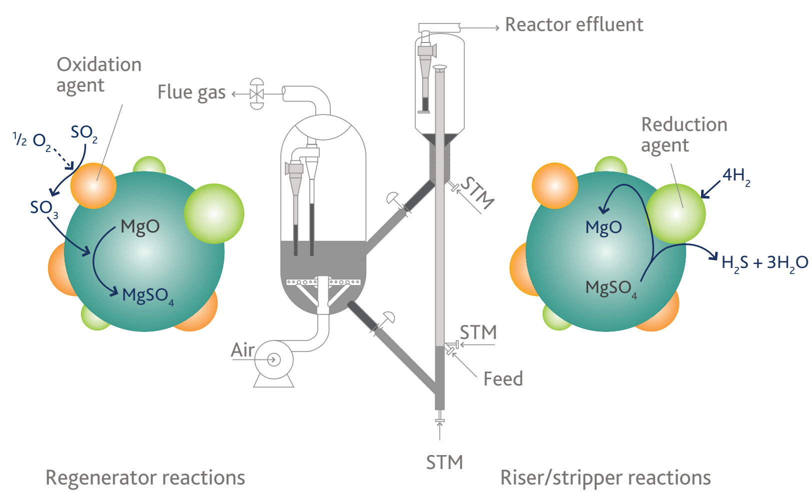

Figure 1: The sulfur capture (left) and release (right) reactions occurring during the use of Albemarle's SOx reduction additives

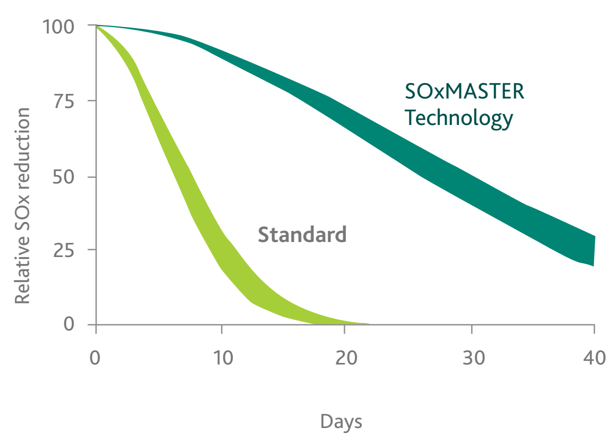

Figure 2: Its activity decay after use indicates the higher stability of SOxMASTER technology compared with standard additives

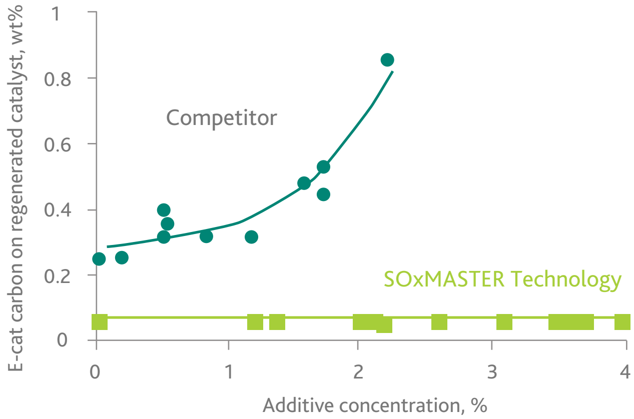

Figure 3: In partial-burn, a competitive additive increased carbon on regenerated catalyst and negatively impacted yields

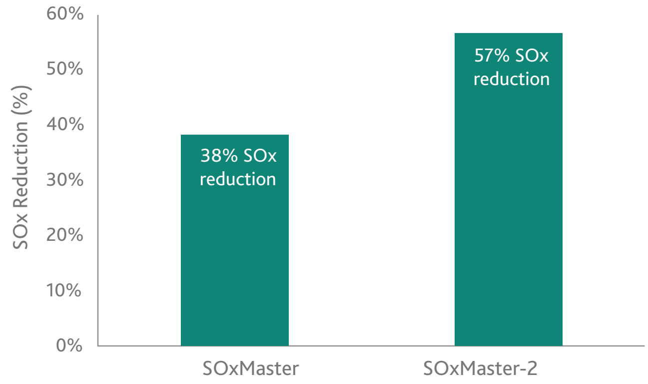

Figure 4: Under equal operating conditions in a partial-burn FCC unit, SOxMASTER-2 provides a new standard of performance

SOxMASTER-2: Transformative improvements

Original SOxMASTER showed refiners that excellent SOx control could be achieved in both partial- and full-burn applications. SOxMASTER-2 raises the standard with transformative improvements. Attrition is lower by approximately 33%, and surface area is higher by approximately 23%. The combination of improved sulfur pickup and improved physical properties translates to equal or better performance with lower additive usage for refiners. SOxMASTER-2 is a cost-effective tool to help refiners meet their environmental compliance goals.

Commercial successes with SOxMASTER-2

The benefits of SOxMASTER-2 have been commercially proven in both partial- and full-burn applications. Figure 4 illustrates one refiner's benefit when switching from original SOxMASTER to SOxMASTER-2.

Under deep partial burn, this refiner witnessed a 38% reduction in SOx with original technology. In comparable operating conditions, the refiner observed 57% SOx reduction when using SOxMASTER-2.

Figure 5 illustrates performance at a second refinery operating under full burn. This refiner traditionally operated with a cerium-based additive. Following the switch to SOxMASTER-2, the refiner observed a sulfur pickup of 94% compared to the incumbent additive. This second refiner is now positioned to easily utilize Albemarle's rare-earth free technology pending market conditions.

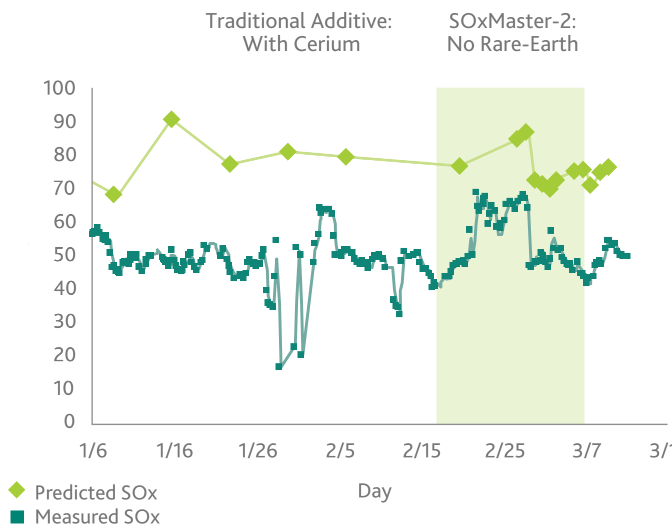

Figure 5: Back-to-back trials of SOxMASTER-2 and a traditional additive containing cerium in a full-burn FCC unit

Typical product analyses	
Additive name	SOxMASTER-2
Application	SOx reduction
Attrition index, wt%	2
Average bulk density, g/ml	0.84
Surface area, m2/g	185
Particle size distribution (0–40), %	10
Particle size distribution (0–20), % 1	1

FOR MORE INFORMATION ON THIS OR OTHER ALBEMARLE PRODUCTS AND TECHNOLOGIES, PLEASE CONTACT YOUR ALBEMARLE REPRESENTATIVE.

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