AdE-Sulfur™

Catalytic Sorbent for Ultra-Deep Desulfurization

Advanced Energy Materials, LLC. (ADEM) has developed a new catalytic sorbent "**AdE-Sulfur™**", for ultra-deep desulfurization applications like ULSD production of fuels with <1 ppmw. AdE-Sulfur™ utilizes catalytic compositions that can keep active metals in zero-valent state and nanowire based materials for high activity towards ultra-deep desulfurization.

ADEM introduces its new generation of sorbent products "AdE-Sulfur™" made with improved production techniques and proven R&D scaleup studies. AdE-Sulfur™ contains highly dispersed, increased number of active metallic sites. Keeping the active metals in

the zero valent state makes it high capacity 'S' sorbent. AdE-Sulfur™ specifically removes 'S' containing chemicals and retains 'S' with in the sorbent without releasing any H_2S. AdE-Sulfur™ can reduce the 'S' levels from 50-200 ppmw in the feed to down to 1 ppmw in the product. AdE-Sulfur™ is also active in dearomatization by hydrogenating the aromatics in feed.
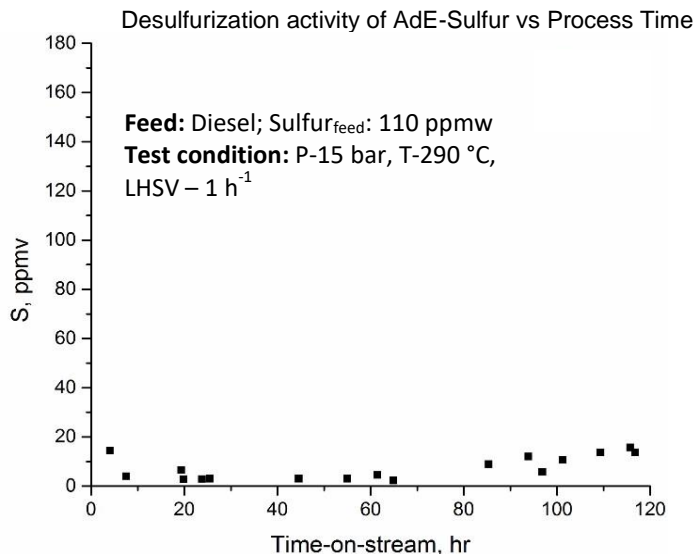
AdE-Sulfur™ has been demonstrated to operate at milder conditions (pressure ~ 5-15 bar and temperature ~ 200-290 °C) and low hydrogen requirement (H_2/Oil – 280 - 560 SCFbbl). This makes it more suitable for refiners having issues to meet 'S' specifications for ULSD and other fuels. Since no H_2S released using AdE-Sulfur™, recombination of H_2S and olefins forming mercaptans can be avoided.

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ADVANCED ENERGY MATERIALS

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Test results with AdE-Sulfur™

Feed	Diesel, kerosene, Naphtha, Jet fuel
Sulfur, ppmw	50-150
H_2 pressure, bar	5-30
H_2/Oil, SCFbbl	280-560
LHSV, hr^{-1}	1-6
Temperature, °C	200-290
Product Sulfur, ppmw	≤ 10

Desulfurization activity of AdE-Sulfur vs Process Time

Feed: Diesel; $Sulfur_{feed}$: 110 ppmw
Test condition: P-15 bar, T-290 °C, LHSV – 1 h^{-1}

Application Areas

Feedstocks: Ultra-deep desulfurization of various fuel streams such as diesel, naphtha, kerosene, jetfuel, natural gas, biofuels, biogas and waste lube oil re-refiners.

Oil Refineries: AdE-Sulfur™ is developed specifically for use in small to medium scale refineries who are not able to revamp the hydrotreaters to meet the fuel specifications because of high CAPEX. Refineries can implement AdE-Sulfur™ in the add-on reactor next to the hydrotreater. The use of ULSD unit with AdE-Sulfur™ will allow for the primary hydrotreater at much less severe conditions than usually required for bringing the sulfur down to 100 ppm. The remaining 'S' irrespective of the refractory species involved will be cleaned by AdE-Sulfur™ in the polishing step downstream to reach to <1 ppm. Test data shown above proves that AdE-Sulfur™ is a highly active S sorbent, and its 'S' removal capacity is 26 g of S (0.8 mol of S) per 100 g of the product.

Upgrading Fuel Quality: AdE-Sulfur™ enables to upgrade the fuel quality even in presence of sulfur by hydrodearomatization of aromatics and PNAs present in diesel and selectively opens the ring structure. This improves the cetane number by 8-10 units and most of the H_2 goes to fuel results in volume swell.

Waste lube oil re-refining: AdE-Sulfur™ has proven to be an excellent catalytic sorbent for desulfurization, when applied in waste lube oil re-refining and cracking waste lube oil -to -diesel, specifically for those with low hydrogen availability, to produce oil with S < 15 ppmw.

Cetane index measurements using ASTM D86 and ASTM 4737

Feed	Process	Density (g/ml, at 15°C)	Cetane Index
LCO from Refinery (900 ppm 'S')	Measured as received	0.83	46±1
LCO from refinery (900ppm 'S)	After desulfurization using AdE-Sulfur™	0.82	55±1
Diesel	Measured as received	0.84	47±1
Diesel 120ppm 'S'	After desulfurization using AdE-Sulfur™	0.83	57±1

Natural gas desulfurization: Based on regulations, pipe line gas contains 6-10 ppm of organic sulfur, COS added as odorants and H_2S. AdE-Sulfur™ can desulfurize gas in a single step, eliminating problems associated with two-step conventional HDS process. AdE-Sulfur™ requires none to minimal hydrogen for the gas desulfurization, resulting in no byproducts like H_2S.

Regeneration Spent sorbent can be regenerated and recycled for desulfurization process.

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