ALBEMARLE®

REFINING SOLUTIONS

AFX™ CATALYSTS

Increasing propylene production from fluid catalytic cracking units

New technology to meet propylene demand

Fluid Catalytic Cracking (FCC) units are playing an increasingly important role in meeting the growing worldwide demand for propylene. To help refiners meet this demand better, Albemarle has introduced the innovative AFX catalyst technology and catalyst family, which are designed specifically for operation at high-propylene yield.

Before AFX, propylene production from an FCC unit with a traditional catalyst was limited. ZSM-5 based additives can help boost the conversion to propylene; however, the base catalyst determines what level of propylene is ultimately achieved. AFX catalysts are technologically advanced and designed to maximize the propylene potential from FCC units, both when used alone and when supplemented with an olefins-octane additive.

The unique design of AFX, with its optimized balance between micro-, meso- and macro-activity, proprietary specialty zeolites and high accessibility, minimizes secondary cracking reactions, such as hydrogen transfer, and maximizes propylene production. AFX can be applied in both conventional and the latest FCC unit designs to increase propylene production to at least 12 wt%. AFX can be formulated for the entire range of feedstocks, from heavy residues to hydrotreated gas oils.

Understanding the chemistry

Refiners that want to maximize propylene production from an FCC unit most commonly apply ZSM-5 additives, which selectively crack olefins in the gasoline range to propylene. As the amount of ZSM-5 additive in the catalyst inventory increases, the increment of propylene produced per percent of additive decreases. At a certain point, propylene production plateaus at a level determined by several factors: feedstock, catalyst and hydrocarbon partial pressure in the reactor each play important roles. The main issues are competing reactions that take place in the pores of the catalyst and the additive. Hydrogen transfer and over-cracking reactions consume the valuable gasoline-olefins precursors, thereby eliminating an important source for propylene formation.

The challenges for the refiner and the catalyst manufacturer are to maximize the conversion of the feed molecules to gasoline olefins precursors, maximize the subsequent cracking of the precursors to propylene and minimize the undesirable competing reactions that consume the propylene precursors (Figure 1).

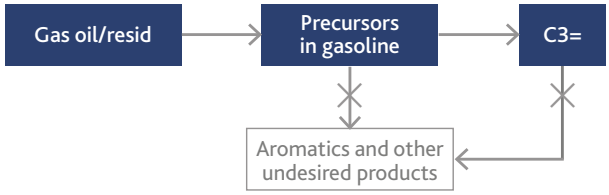

Figure 1: The reactions involved in propylene formation

Through their unique porosity, high accessibility and unsurpassed bottoms conversion, AFX catalysts meet that challenge and deliver unsurpassed propylene yield. Figure 2 shows an example from Albemarle's worldwide equilibrium catalyst database that illustrates how AFX catalysts, by employing Albemarle's high accessibility technology, reduce undesirable hydrogen transfer. (Refer to hydrogen transfer index (HTI) — which is defined as the ratio of isobutane to total C4.)

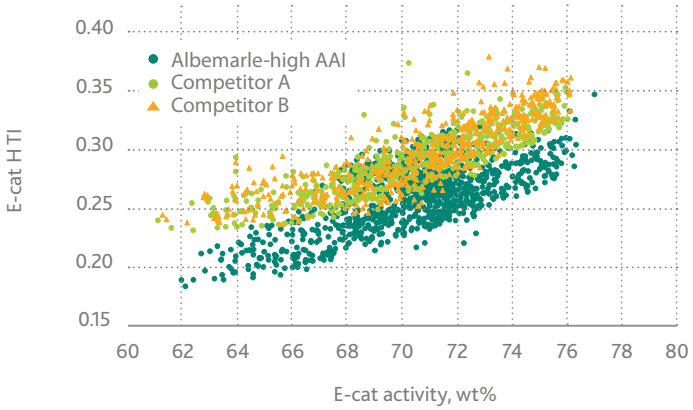

Figure 2: AFX catalysts reduce hydrogen transfer reactions by employing Albemarle's high accessibility technology

Proven success

AFX has successfully been used in several FCC units, some of which process heavy residues. One of those applications is a residue FCC unit processing 100% residue at a reactor temperature of 543°C (1009°F) and running at design throughput. A propylene yield of 10.5 wt% was achieved shortly after start-up with the new AFX catalyst (Table 1). Unit and catalyst optimization would undoubtedly increase the propylene yield further.

Commercial experience	
Unit	RFCC
RXT, °C/°F	543/1009
RGT, °C/°F	708/1306
CTO, kg/kg	8.7
Fresh feed rate	Design
SG/API	0.931/20.4
CCR, wt%	4.7
S, wt%	0.38
Nitrogen, ppm	1266
E-cat activity, wt%	67
E-cat Ni/V, ppm	2900/5200
Propylene, wt%	10.5

Table 1: AFX yields record C3 = volume on residue feed

In a second example, the FCC unit processes mild hydrocracker bottoms and operates at 545°C (1013°F). Albemarle's high-accessibility catalyst technology was applied with a very clean feed and achieved a record yield of 12 wt% (Table 2). Under these conditions, the gasoline still contained an adequate amount of gasoline olefins, which could potentially lift the propylene yield much further.

Commercial experience	
Unit	FCC
RXT, °C/°F	545/1013
RGT, °C/°F	712/1314
CTO, kg/kg	7.5
Fresh feed rate	Design
SG/API	0.899/25.8
CCR, wt%	0.1
S, wt%	0.1
Nitrogen, ppm	280
E-cat activity, wt%	71
E-cat Ni/V, ppm	20/110
Propylene, wt%	11.8

Table 2: Record propylene yields achieved on a clean feedstock

AFX™ delivers breakthrough performance

Do you need to make high propylene yield from your FCC unit? Then AFX is the solution for you. With its unique design, it maximizes propylene production by both minimizing unwanted secondary cracking reactions and maximizing selective cracking to propylene. It has had several successful applications and can increase propylene production to at least 12 wt%. No matter what the quality the feedstock is, from light gas oils to heavy residues, Albemarle's AFX catalysts deliver breakthrough performance.

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

AMERICAS: 13100 Space Center Blvd • Houston, TX 77059 • USA • Tel: +1 281 480 4747 • Email: catmaster@albemarle.com
EUROPE AND AFRICA: Nieuwendammerkade 1–3 • 1030 BE Amsterdam • The Netherlands • Tel: +31 20 634 7300 • Email: catmaster@albemarle.com
MIDDLE EAST AND INDIA: PO Box 293774 • 6W Block A, Office 512 • Dubai Airport Free Zone • Dubai • Tel: +971 4 701 7770 • Email: catmaster@albemarle.com
ASIA PACIFIC: Room 2208, Shui On Plaza • No. 333 Huai Hai Zhong Rd • Shanghai 200021 • China • Tel: +86 21 6103 8666 • Email: catmaster@albemarle.com

www.albemarle.com

The information presented herein is believed to be accurate and reliable, but is presented without guarantee or responsibility on the part of Albemarle Corporation. It is the responsibility of the user to comply with all applicable laws and regulations and to provide for a safe workplace. The user should consider any information contained herein, including information about any health or safety hazards, only as a guide, and should take those precautions that are necessary or prudent to instruct employees and to develop work practice procedures in order to promote a safe work environment. Further, nothing contained herein shall be taken as an inducement or recommendation to manufacture or use any of the herein described materials or processes in violation of existing or future patents.

© 2017 Albemarle Corporation. All rights reserved worldwide.