



Millennium™ Fluid Catalytic Cracking Catalysts

SATISFYING THE GLOBAL NEED FOR RESID FEED CATALYSTS



ENGELHARD

The Major Problem With the Use of Resids: Higher Metals Means More Coke and Gas

There is a growing worldwide trend toward the use of lower cost resid feedstocks in fluid catalytic crackers. However, there is an important constraint: Resid feeds, in addition to being heavier and more aromatic than lighter feeds, also have higher metals content. The presence of nickel and vanadium organometallics results in more coke and gas... and limited throughput.

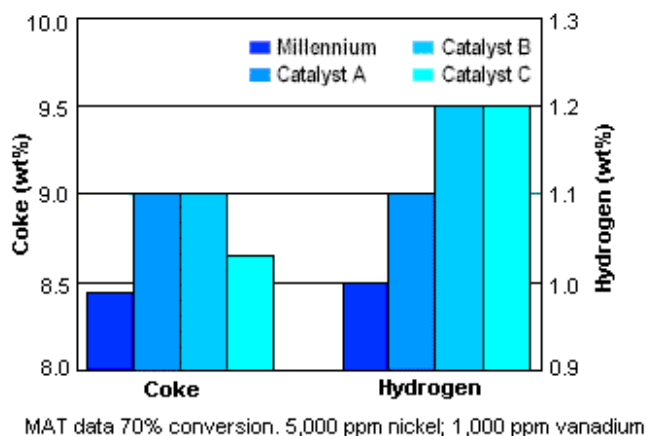
To make effective use of resids, refiners need improved FCC catalysts with better metals tolerance and the ability to retain activity in the face of severe operating conditions.

To meet their needs, Engelhard has developed Millennium, the first in a new generation of customized catalysts that passivate metals while simultaneously improving bottoms upgrading. These catalysts can provide refiners with more choices in setting FCCU operating conditions and therefore help them maximize throughput.

Engelhard specifically developed Millennium to outperform the best competitive resid catalysts (labeled A, B and C). Using these as a benchmark (Figure 6), Engelhard designed a catalyst that combines two proprietary technologies: a unique Quadra Functional matrix and PyroChem ultrastable zeolites.

Quadra Functional Matrix Lowers Coke and Gas Make in the Presence of Metals

Figure 1
Effect of Nickel on Coke and Hydrogen Make



Millennium utilizes a unique matrix design, called Quadra Functional because it:

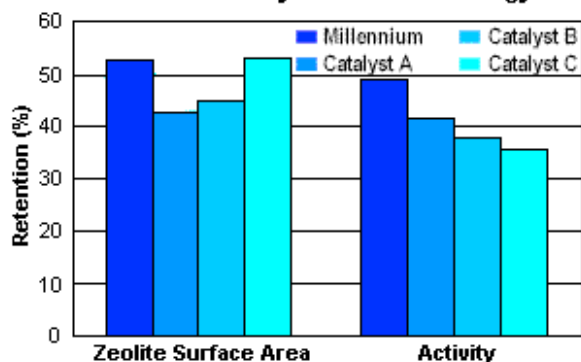
1. Passivates nickel
2. Traps and passivates vanadium
3. Facilitates large molecule access to the matrix
4. Selectively precracks resid feeds

Our proprietary technology allows diffusion of nickel organometallics to sites where the organic portion is removed, leaving the nickel chemically bound to the matrix. Because of the surface chemistry and controlled porosity, the nickel is not available to promote unwanted dehydration reactions. Figure 1 shows Millennium produces 10-20% less coke and hydrogen in the presence of nickel than competitive resid catalysts.

Compounds containing vanadium likewise diffuse, and because of proprietary chemical treatment, react with the surface to prevent further migration of the vanadium to the zeolite. The nickel and vanadium tolerance of Millennium catalysts can be tailored to meet specific customer needs.

PyroChem Process Increases Zeolite Stability

Figure 2
Benefits of Pyrochem Technology

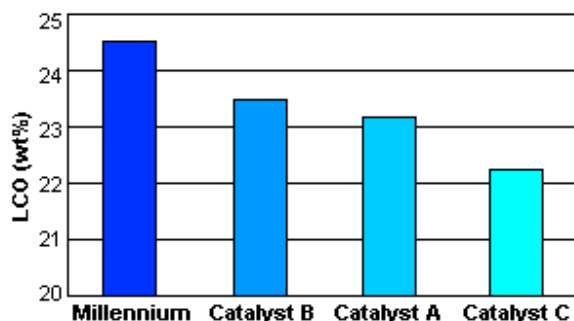


5,000 ppm vanadium; 1,000 ppm nickel

Stable zeolites with few crystal defects are especially important in the processing of resid feeds. To reduce the formation of crystal defects and provide zeolite stability in the regenerator, Millennium uses Engelhard's PyroChem zeolite ultrastabilization technology. The result: decreased catalytic coke and gas formation, plus increased gasoline selectivity. Figure 2 demonstrates that Millennium retains higher surface area and activity than three leading resid FCC catalysts.

Dual-Structure Matrix Improves Bottoms Upgrading

Figure 3
Improvement in Light Cycle Oil



Constant conversion. 5,000 ppm vanadium; 1,000 ppm nickel

With resids, 60% of all oil molecules in the feed are too large to fit into the 8-angstrom zeolite openings. Therefore, some precracking outside the zeolite must occur prior to selective zeolite cracking to lighter products. Thus, the rates of diffusion to an active matrix site become important. Millennium matrix structure facilitates diffusion to active matrix sites. As a result, Millennium provides superior bottoms upgrading, as measured by the increase in light cycle oil at constant conversion (Figure 3), while minimizing coke and gas, as described above.

Millennium Consistently Outperforms Competitive Catalysts for Resid Feedstocks

Figure 4
Performance in the Presence of Cracked-on Metals

Content (wt%)	Millennium	Catalyst A
Hydrogen	0.43	0.53
Coke	5.5	5.9
Gasoline	51.4	51.1
LCO	22.3	22.6

70% conversion

Millennium was designed to exceed the performance of today's benchmark resid processing catalysts. Extensive comparative testing was done under a variety of conditions, with gas oil and resid feeds, and using cracked-on and Mitchell method metal deposition technologies. These tests were conducted in fixed fluidized bed, as well as Mat units.

Figure 5
Performance on Resid Feed in Fixed Fluidized Bed Units

Content (wt%)	Millennium	Catalyst B
Hydrogen	0.19	0.44
Coke	5.7	7
Dry Gas	1.7	2.1
Gasoline	54.8	52.1
LCO	20.6	21.1

70% conversion, Mitchell Method

Figures 4 and 5 show results obtained in various tests comparing metallated and fresh Millennium catalysts with the competitive resid catalysts. These tests typically show reductions of 10% to 20% in coke and 20% to 40% in hydrogen...with better gasoline production.

Fine-tuned Performance to Meet Your Needs

Figure 6
Typical Properties

	Millennium	Catalyst A	Catalyst B	Catalyst C
Content (wt%)				
Al ₂ O ₃	37.0	37	37	30
Na ₂ O	0.3	0.4	0.3	0.4
Surface Area (m²/g)				
Total	240	240	244	206
Zeolite	164	179	170	150
Matrix	76	61	74	56

There are wide differences in resid feedstocks, unit operating conditions and performance requirements. Millennium catalysts can be customized to provide refiners with the performance characteristics required to meet their specific needs.

Your Engelhard representative and the resources of Engelhard's Technical Service and R&D laboratories are available to help in the specification of catalysts customized to precisely fit your resid feedstocks, FCCU constraints and operating requirements.

An Expanding Line of FCC and Other Catalysts

Millennium catalysts are the newest members of the Engelhard family of petroleum catalysts and services. We provide many other high-performance products for use in hydrocarbon processing. These include FCC catalysts, moving bed catalysts, synthetic- and mineral-based sorbents. And through Acreon (an Engelhard/Procatalyse joint venture in North America), process technology and catalysts for reforming, isomerization, hydrotreating and selective hydrogenation are available.

In addition, Engelhard catalysts are the mainstay of a wide range of industries, including chemical, petrochemical, petroleum refining, food, power generation, automotive and mining including:

Chemical Catalysts: A range of catalysts and sorbents for the chemical, petroleum, petrochemical, pharmaceutical, edible oils and detergent industries, including catalysts used by the petroleum industry for lube oil and wax percolation and purification, olefin and aromatic hydrogenation and BTX purification.

Environmental Catalysts: For the control of emissions from on- and off-road vehicles, power generators and industrial motors, as well as to control emissions of nitrogen oxides, carbon monoxide and unburned hydrocarbons from refinery boilers, heaters and gas turbines.

Engelhard maintains sales and technical service facilities worldwide. For information, contact the Engelhard Sales Office nearest you.

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