

Alternatives to Rare Earth – Commercial Evaluation of REpLaCeR[®] FCC Catalysts at Montana Refining Company

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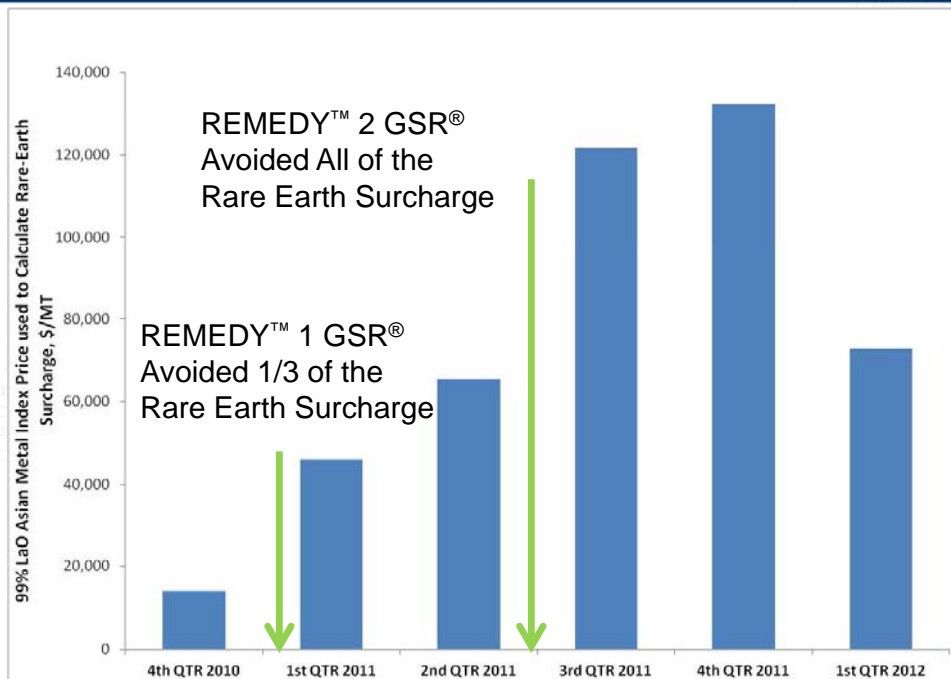
Emery Udvari – National Technical Sales Manager, W.R. Grace & Co.

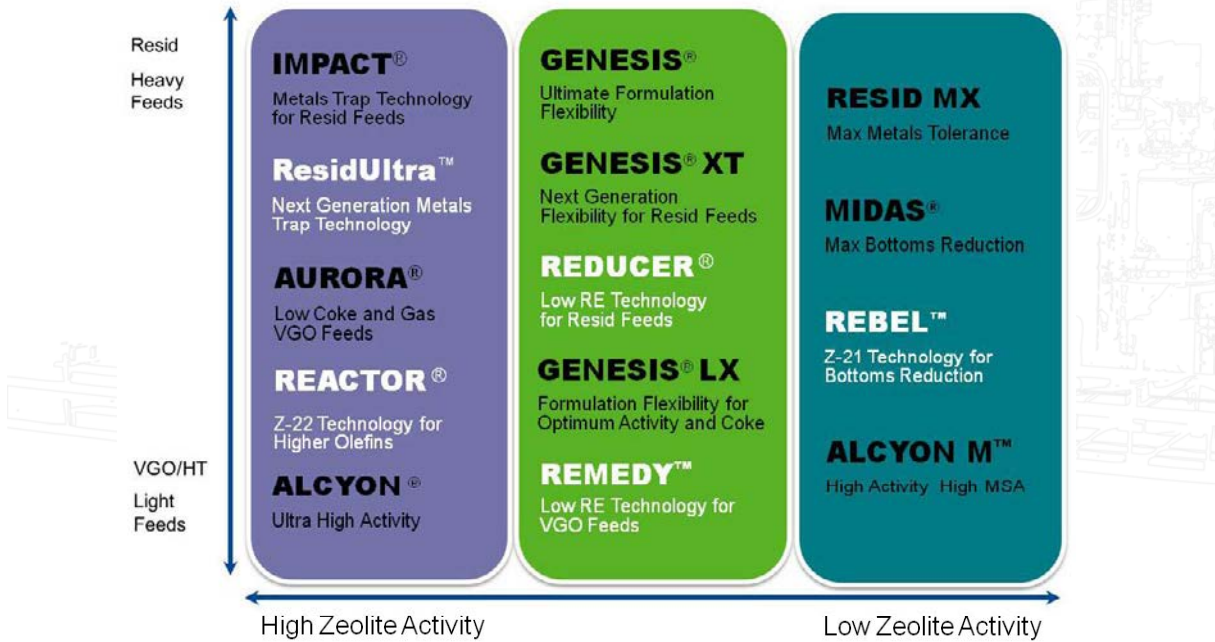
David Hunt – FCC Technical Manager, W.R. Grace & Co.




Galveston, TX May 2012

Rare Earth Prices Increased Sharply in 2011





Application No.	% RE Reduction	Ni plus V, ppm	V plus Na, ppm
1	100	56	2,700
4	100	250	3,500
21	100	2373	5,276
23	100	4743	5,466
24	80	1798	4,714
25	80	8263	9,478
47	30	8229	7,759
52	20	11195	5,810

- Low metals VGO to High Metals Resid Applications
- Rare Earth Reduction 100% to 20%

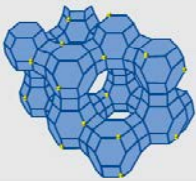
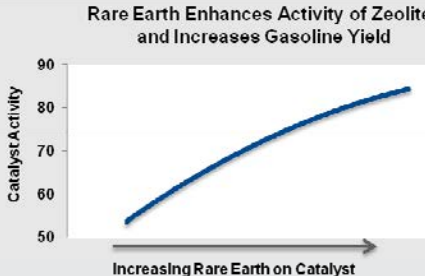
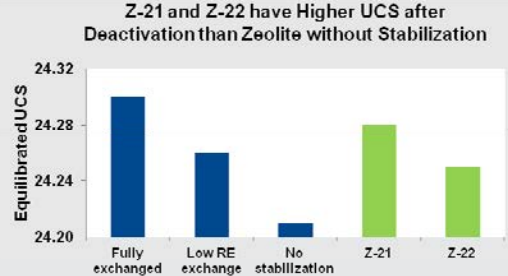
RE Free Catalysts

Z-22 Technology REACTOR™	<ul style="list-style-type: none"> • Z-22 zeolite in REACTOR™ is Stabilized with a Proprietary Element • REACTOR™ matches Activity and Selectivity of Equivalent RE containing Alumina Sol Formulations • Full scale Production Commenced in 2Q'11 • 40 Commercial Applications and Growing
Z-21 Technology REBEL™	<ul style="list-style-type: none"> • REBEL is Formulated with Proprietary Grace Alumina and Z-21 Zeolite • The Activity and Selectivity of REBEL™ is similar to RE containing High Matrix MIDAS® Catalyst • Commercial Production commenced early 2Q'11 • Z-21 Technology is in 25 Commercial Applications

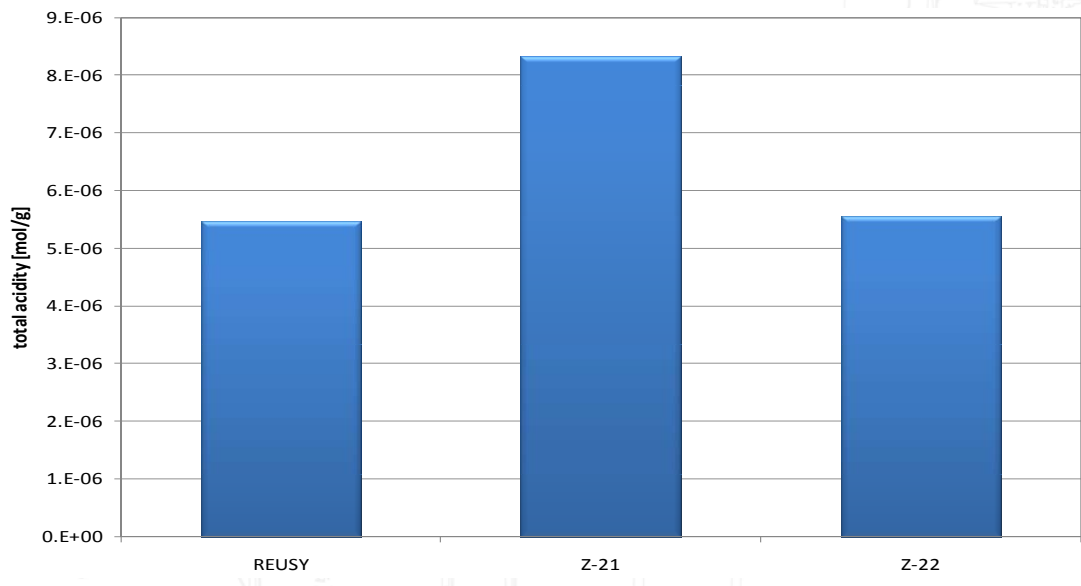
Low RE Catalyst Systems

REMEDY™ Low RE Technology for VGO/HT feeds	REDUCER™ Low RE Technology for resid feeds
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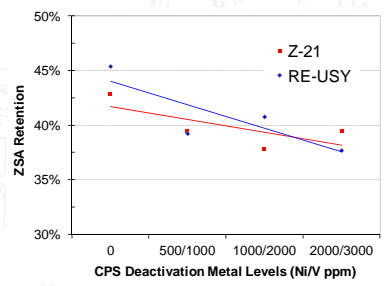
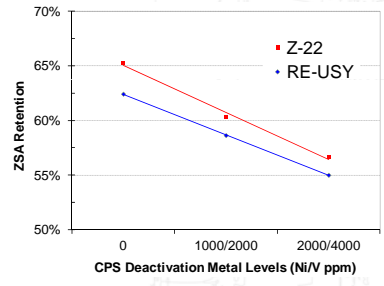
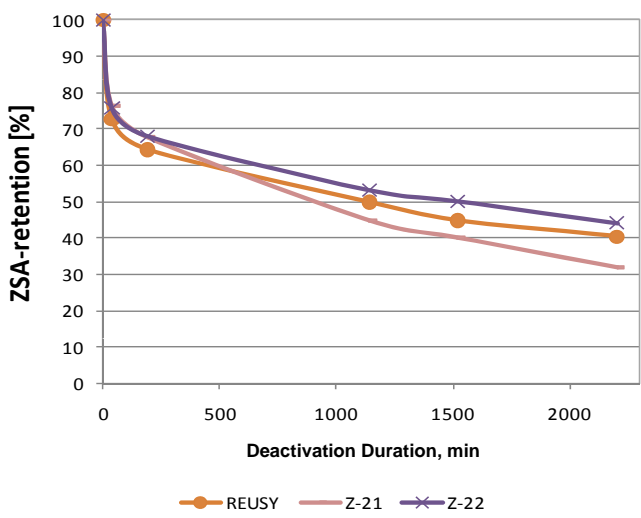
Alternate Zeolite Stabilization Technology Z-21 and Z-22

Stabilization with Rare Earth (RE)	Proprietary Grace non-RE Stabilization
<ul style="list-style-type: none"> ▪ Rare Earth impact on Zeolite <ul style="list-style-type: none"> – Prevents De-Alumination – Stabilizes the structure ▪ Rare Earth controls Zeolite <ul style="list-style-type: none"> – Activity – Selectivity – Hydrogen transfer ▪ Prevents Metals Deactivation <ul style="list-style-type: none"> – Very Effective Vanadium Trap <div style="text-align: center;">  <p>Unit cell size 24.32 Å Si/Al = 12 15 Al atoms/unit cell</p> </div>	<ul style="list-style-type: none"> ▪ Alternate Methods are used to Stabilize the Zeolites in Grace's RE-free Catalyst <ul style="list-style-type: none"> – Proprietary Stabilizing Compounds – Unique Manufacturing Processes ▪ Alternative materials provide activity and stability similar to RE containing catalysts <ul style="list-style-type: none"> – Similar UCS as RE containing Zeolites – Truly RE-free, without Stabilization, would yield a very low UCS and Activity
<p style="text-align: center;">Rare Earth Enhances Activity of Zeolites and Increases Gasoline Yield</p> 	<p style="text-align: center;">Z-21 and Z-22 have Higher UCS after Deactivation than Zeolite without Stabilization</p> 

RE-Free Technology - Acidity After Metals-Free Deactivation



RE-Free Technology – Stability



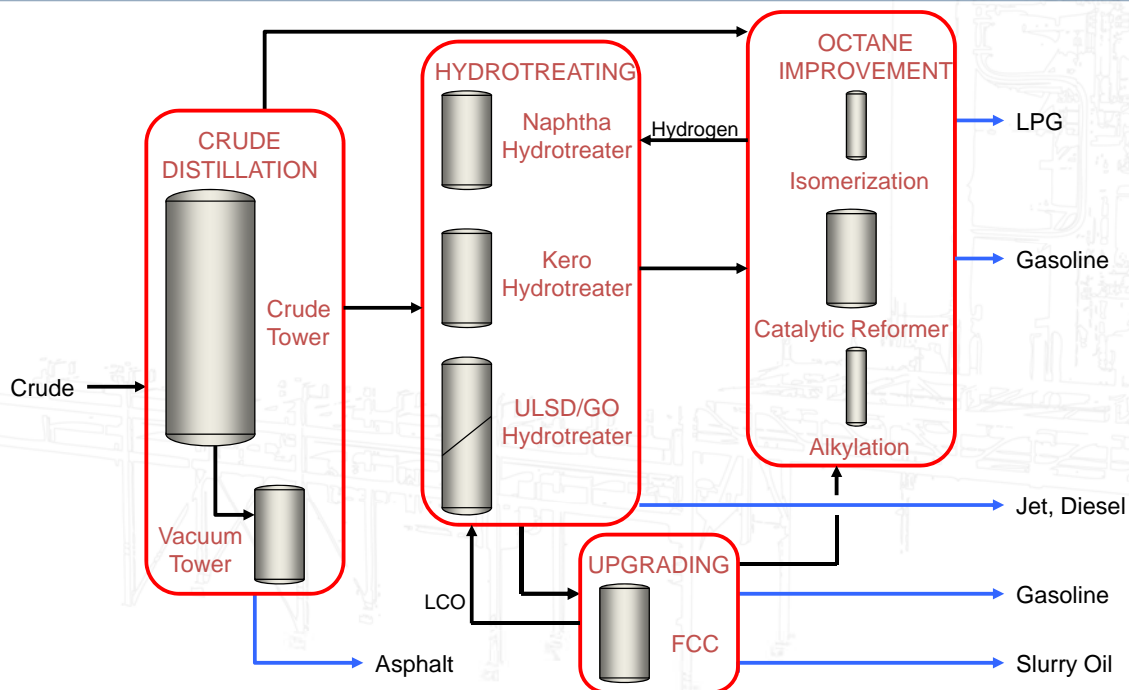
Z-21 and Z-22 Technologies Exhibit Excellent Stability Even without RE

MRC – Refinery in Great Falls, MT

- Located on the Missouri River
- Crude Rate ~10k bpd
- Nelson Complexity Factor -9.3
- Sour Canadian and Local Crudes
- Products
 - Low Sulfur Gasoline
 - ULSD
 - JET
 - Asphalt



MRC Block Flow Diagram



MRC's FCC Operation

- UOP Stacked Unit
- Feed Rate ~3000 bpd
- Hydrotreated VGO – Feed Sulfur ~0.2 wt%
- Maximum LCO Mode – Reactor Temperature ~940°F
- Full Combustion – Regenerator Temperature ~1280°F
- Tertiary Particulate Control Device - none
- SO_x - Controlled to 25 ppm with Super DESOX[®] OCI
- Gasoline Hydrotreater - none
 - Rely on 30% Gasoline Sulfur Reduction via Grace SuRCA[®] Technology to maximize VGO/ULSD HDT Run length



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Two FCC Catalyst Reformulations Were Made in 2011 at MRC

	GENESIS [®] GSR [®]	REMEDY [™] 1 GSR [®]	REMEDY [™] 2 GSR [®]
Reformulation		January 2011	August 2011
Activity, Wt. %	80	80	80
RE ₂ O ₃ , Wt. %	1.50	1.00	Trace
Al ₂ O ₃ , Wt. %	51	51	47
Zeolite Surface Area, m ² /gm	200	200	220
Matrix Surface Area, m ² /gm	90	90	75
0 to 40μ, %	13	13	13
Gasoline Sulfur Reduction	30%	30%	30%

- Each REMEDY[™] Formulation Was Designed for Similar Yields and Catalyst Additions, but Lower Rare Earth

REMEDY[™] 2 GSR[®] Eliminated the Rare Earth Surcharge



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Catalyst Technology Comparison

- REACTOR[®]
- REBEL[™]
- SuRCA[®]

REMEDY[™] 2 GSR[®]

- AURORA[®]
- MIDAS[®]
- SuRCA[®]

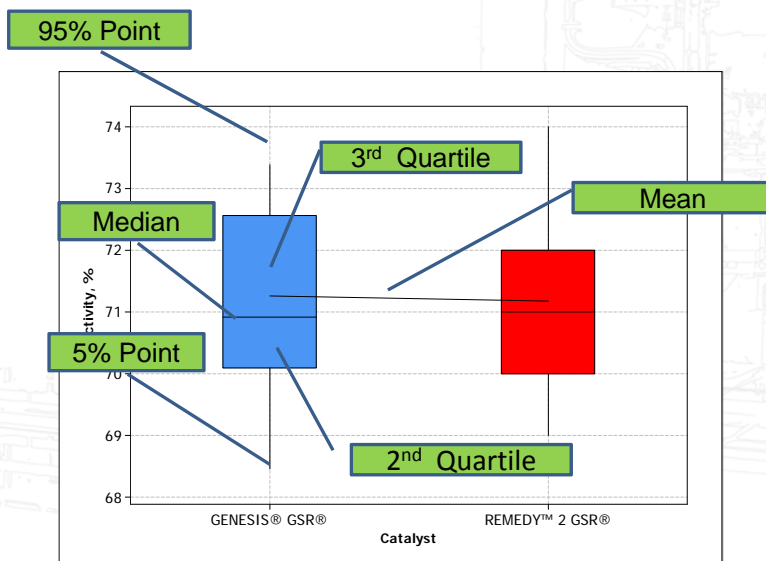
GENESIS[®] GSR[®]

REACTOR[®] and REBEL[™] Rare Earth Free Technologies Used in REMEDY[™]
Both Catalysts Incorporated Gasoline Sulfur Reduction Functionality



Box Plots Basics

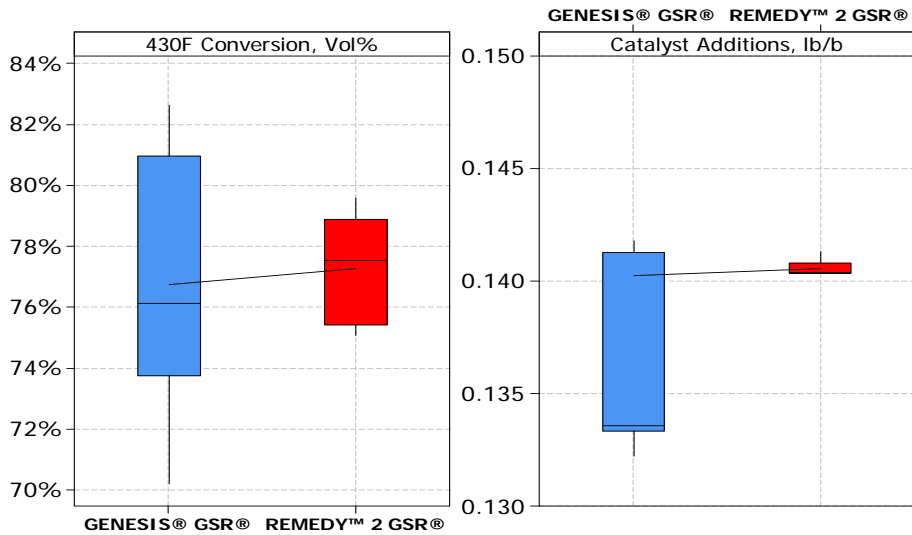
- Represents the Data Distribution
- Allows a Quick Comparison between Datasets



GDF ↓.15 HJK ↑ 1.25 RTY 1.23 IOP ↑.85 BNM 12.0 XCV ↓.20 QEW ↓.65



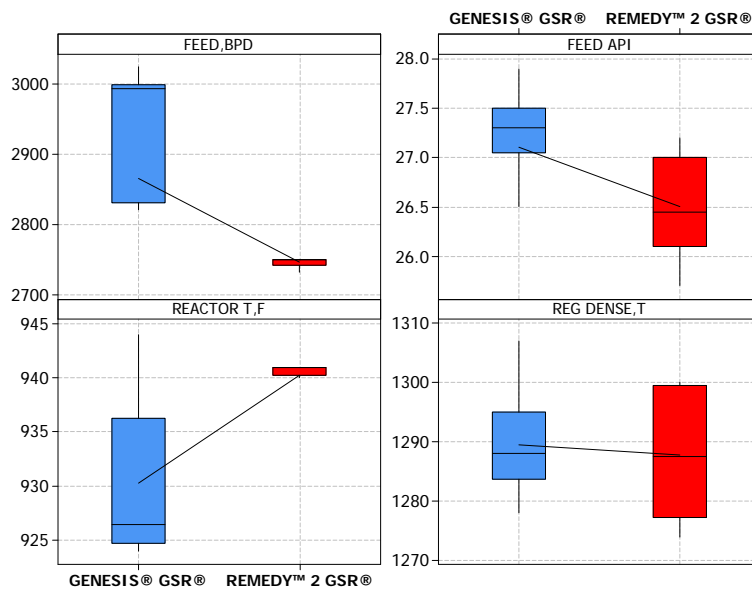
FCC Conversion and Catalyst Additions



Conversion was Maintained without Rare Earth at Similar Catalyst Additions



MRC FCC Operating Conditions

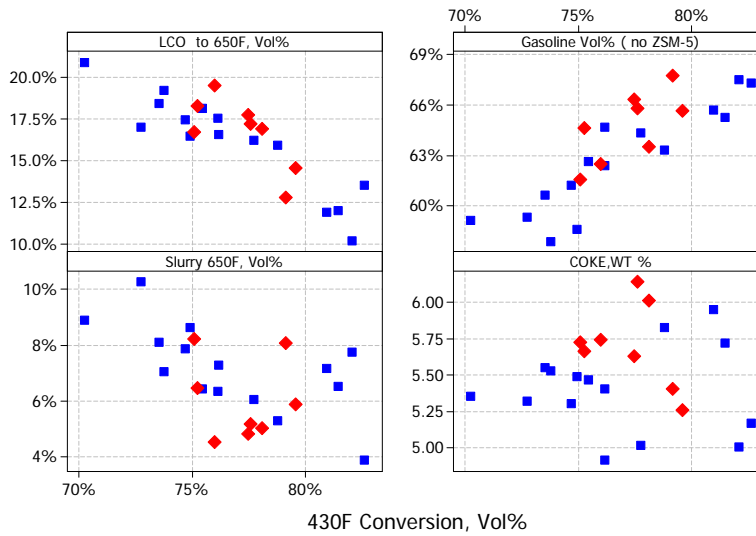


Changes in Operating Conditions Resulted in Less than 0.25 vol% Conversion



REMEDY™ Enhanced Selectivities and Profitability

- GENESIS® GSR®
- ◆ REMEDY™ 2 GSR®

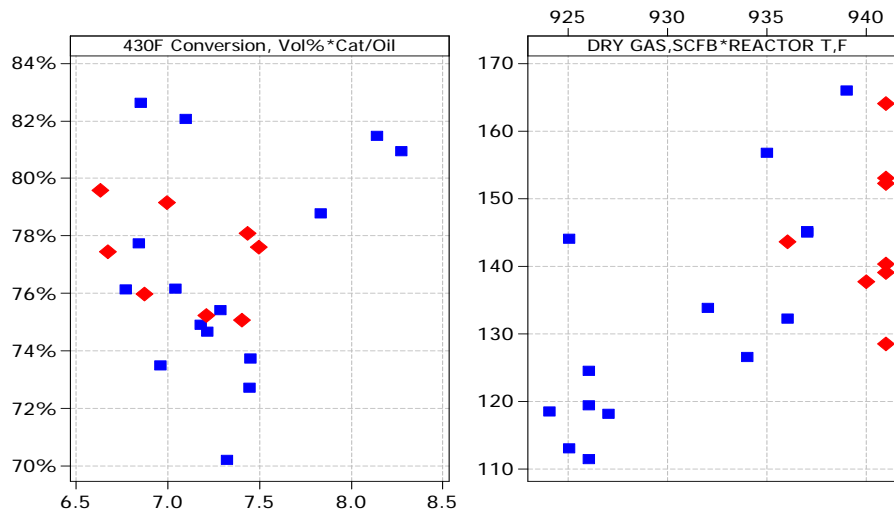


REMEDY™ Increased Gasoline Selectivity and Bottoms Conversion at Similar Coke



Unit Activity and Dry Gas Production

- GENESIS® GSR®
- ◆ REMEDY™ 2 GSR®

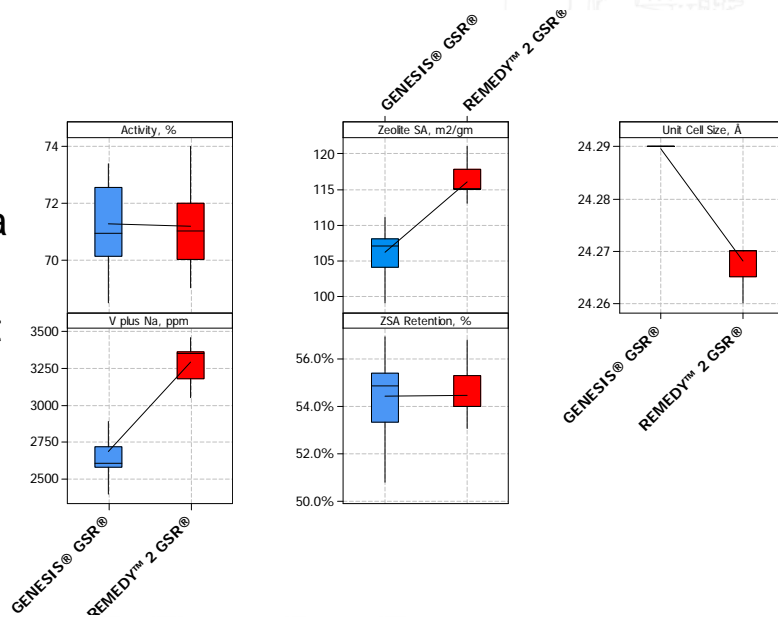


REMEDY™ Provided Similar In-Unit Activity and Produced Low Dry Gas Rates



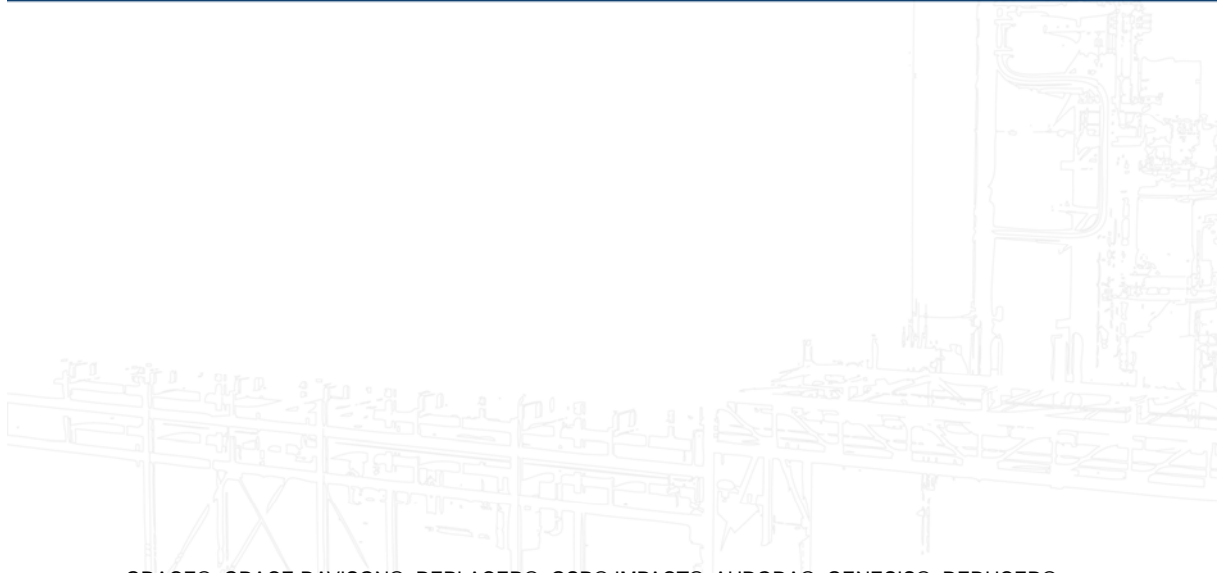
Equilibrium Catalyst Shifts with REMEDY™

- Similar Activity and Zeolite SA Retention
- Additional V+Na Levels
- Lower UCS, but Higher than an Un-Stabilized Zeolite



Final Remarks

- Rare Earth Free REMEDY™ was a Success at MRC
 - Similar Conversion Levels at the Same Catalyst Addition Rate
 - Low Dry Gas and Slurry Yield
 - High Gasoline Selectivity at Similar Octane
 - Coke Selectivity Was Maintained
 - Gasoline Sulfur Reduction Maintained
 - No Increase in Flue Gas Opacity



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