FCC Catalyst Technical Report- Sample:50107695

Sample Overview

Item	Detail
Unit ID	313
Sample ID	50107695
Sampling Date	2024-11-11 00:00:00
Received Date	2025-01-22 00:00:00
Unit Name	CITGO - CORPUS CHRISTI (NEW), TX, US
Lab Code	C
Anomalous Parameters	Al_2O_3, CaO, K_2O, MgO, Mn, P_2O_5, RE_2O_3, Sb/Ni Ratio, ZnO

Key Observations

- Multiple severe catalyst poisons (CaO, K_2O, Mn, ZnO) are significantly above their acceptable limits, indicating persistent or escalating contamination from feed or external sources.
- The critical metal passivators, P_2O_5 and Sb/Ni ratio, are severely deficient, with P_2O_5 being significantly low and the Sb/Ni ratio at zero, compromising nickel and vanadium passivation.
- Elevated Al_2O_3 and RE_2O_3 suggest a potential increase in fresh catalyst addition rate or a change in fresh catalyst type, which could alter cracking characteristics and regenerator performance.
- MgO content is lower than expected, possibly due to a shift in fresh catalyst formulation or feed characteristics, influencing coke selectivity and catalyst stability.

Parameter-by-Parameter Interpretation

Parameter	Status	Diagnostic Summary
Al_2O_3 (wt%)	Exceeds Limit	Al_2O_3 content is above the acceptable limit, signifying an alteration in the catalyst's fundamental composition. This elevation can modify catalyst activity, selectivity, and hydrothermal stability, potentially shifting the unit away from optimal FCC performance.
CaO (wt%)	Exceeds Limit	CaO concentration is above its acceptable limit, indicating increased calcium contamination, a potent catalyst poison. Elevated calcium irreversibly deactivates zeolite acid sites, exacerbates coke formation, and reduces gasoline yields, critically impacting activity and selectivity.
Co (ppm)	Within Limit	Cobalt levels are within operational limits, indicating stable conditions regarding this element which can influence dehydrogenation. While a slight increasing trend is noted, current readings do not suggest immediate concern for FCC performance.

Parameter	Status	Diagnostic Summary
Cu (ppm)	Within Limit	Copper concentration is within acceptable limits, suggesting adequate management of this contaminant. Although the current value is on the higher end of recent samples, it remains controlled and is not currently expected to significantly promote coke formation or deactivation.
Fe (wt%)	Within Limit	Iron content is within specified operational limits, indicating controlled contamination. Stable iron levels prevent excessive dehydrogenation and coke make, supporting overall FCC performance through effective feed management and catalyst inventory.
K_2O (wt%)	Exceeds Limit	K_2O concentration is above its acceptable limit, signifying critical potassium poisoning of the catalyst. Potassium severely and irreversibly deactivates zeolite acid sites, leading to reduced cracking efficiency, higher coke production, and a shift towards lighter product yields.
MgO (ppm)	Exceeds Limit	MgO concentration is outside the expected range, showing a significant negative deviation despite appearing within broad Y_Min/Y_Max. This indicates a notable shift in catalyst or feed characteristics, potentially affecting coke selectivity and catalyst stability due to lower-than-expected magnesium levels.
Mn (ppm)	Exceeds Limit	Mn concentration is above the acceptable limit, indicating elevated manganese contamination. Manganese promotes dehydrogenation reactions, resulting in increased coke formation and reduced yields of valuable products like gasoline, representing a clear operational issue.
Mo (ppm)	Within Limit	Molybdenum levels are within established operational limits, suggesting controlled contamination from heavier feedstocks. While higher than some recent readings, the current value remains stable, indicating effective feed quality management or catalyst metallurgy.
Ni (ppm)	Within Limit	Nickel concentration is within acceptable operational limits, indicating effective management of this potent catalyst poison. Current stable levels mitigate nickel's detrimental effects of promoting dehydrogenation and coke formation, supporting liquid product yields.
Ni/V Ratio (nan)	Within Limit	The Ni/V ratio is within the acceptable range, indicating a balanced contamination profile from nickel and vanadium. While recent variability is observed, the current ratio suggests a controlled propensity for coke formation from these metals.
P_2O_5 (wt%)	Exceeds Limit	P_2O_5 content is significantly lower than expected, falling outside the acceptable limit. This deficiency compromises the effectiveness of phosphorus as a metal passivator, particularly for nickel and vanadium, leading to increased coke and gas make, and reduced gasoline yield.
Pb (ppm)	Within Limit	Lead concentration is within established operational limits, indicating controlled feed contamination. Although higher than the average of recent samples, the current value is acceptable and not expected to significantly contribute to catalyst deactivation or regenerator issues.
RE_2O_3 (wt%)	Exceeds Limit	RE_2O_3 content is above the acceptable limit, suggesting an increased fresh catalyst addition rate or a shift to a higher rare earth catalyst type. This can alter cracking activity, hydrothermal stability, and regenerator temperatures, potentially impacting overall product yields.

Parameter	Status	Diagnostic Summary
Sb/Ni Ratio (nan)	Exceeds Limit	The Sb/Ni ratio is zero, which is critically outside the operational limit. This indicates a complete absence of antimony passivation for the significant nickel present on the catalyst. This will severely increase coke and hydrogen production, reduce gasoline yield, and create regenerator control challenges.
V (ppm)	Within Limit	Vanadium concentration is within acceptable operational limits, which is favorable. Despite a negative deviation from a reference, the level is well controlled, indicating effective mitigation of this severe catalyst poison that deactivates zeolite structure and promotes coke.
ZnO (ppm)	Exceeds Limit	ZnO concentration is above the acceptable limit, showing a significant positive deviation from recent trends. Elevated zinc is a feed contaminant that contributes to catalyst deactivation and can promote regenerator afterburn, negatively impacting catalyst performance and unit stability.

Consolidated Issue Summary

Issues	Evidence	Impact
Al_2O_3 (wt%)	Captured Value: 49.80 wt% (Deviation: +1.07 wt%), Last 5 Samples: 48.7-52.8 wt%	Indicates a significant change in catalyst composition, potentially altering activity, selectivity, and hydrothermal stability, leading to a shift from optimal FCC performance.
CaO (wt%)	Captured Value: 0.32 wt% (Deviation: +0.08 wt%), Last 5 Samples: 0.09-0.24 wt%	Critical calcium contamination, causing irreversible deactivation of zeolite acid sites, promoting severe coke formation, and substantially reducing valuable gasoline yields and catalyst activity.
K_2O (wt%)	Captured Value: 0.098 wt% (Deviation: +0.028 wt%), Last 5 Samples: 0.05-0.08 wt%	Potent potassium poisoning, leading to severe and irreversible deactivation of zeolite active sites, significantly reducing catalyst activity, impairing cracking efficiency, and likely resulting in higher coke and lighter product yields.
MgO (ppm)	Captured Value: 24185 ppm (Deviation: -1177 ppm), Last 5 Samples: 17642-29604 ppm	Concentration is significantly lower than expected, indicating a shift in catalyst composition or feed characteristics. This deviation might influence coke selectivity and catalyst stability.

Issues	Evidence	Impact
Mn (ppm)	Captured Value: 40.14 ppm (Deviation: +17.54 ppm), Last 5 Samples: 8.58-26.41 ppm	Elevated manganese contamination, promoting dehydrogenation reactions, which leads to increased coke formation and reduced valuable product yields, particularly gasoline.
P_2O_5 (wt%)	Captured Value: 0.237 wt% (Deviation: -0.206 wt%), Last 5 Samples: 0.35-0.47 wt%	Significantly lower than expected, compromising the effectiveness of metal passivation for nickel and vanadium. This will lead to increased coke and gas make, and reduced gasoline yield.
RE_2O_3 (wt%)	Captured Value: 2.898 wt% (Deviation: +0.146 wt%), Last 5 Samples: 2.75-3.22 wt%	Elevated rare earth content, possibly due to increased fresh catalyst addition or a different catalyst type. This can alter catalyst performance, regenerator temperatures, and product yields.
Sb/Ni Ratio (nan)	Captured Value: 0.0 (Deviation: 0.0), Limit: Y_Max 0.052498	A zero ratio indicates a complete absence of antimony passivation for the existing nickel, leading to severely increased coke and hydrogen production, reduced gasoline yield, and potential regenerator control issues.
ZnO (ppm)	Captured Value: 217.66 ppm (Deviation: +86.63 ppm), Last 5 Samples: 131.0-172.4 ppm	Elevated zinc contamination, contributing to catalyst deactivation and potentially promoting regenerator afterburn. This adversely affects catalyst performance and overall unit stability.

Corrective Actions & Optimization Strategies

Issue	Corrective Action
Al_2O_3 (wt%)	• Review recent changes in fresh catalyst addition rates and fresh catalyst type selection. • Evaluate the potential for contamination from high-alumina refractory materials in the unit.
CaO (wt%)	• Conduct immediate crude feed analysis to identify and mitigate high calcium levels. • Inspect reactor/regenerator refractories and other unit components for signs of calcium-containing material ingress. • Review process upsets that might introduce calcium into the catalyst inventory.

Issue	Corrective Action
K_2O (wt%)	• Analyze all utility water and steam sources for potassium contamination and implement control measures. • Investigate potential ingress of furnace ash or environmental dust into the unit. • Review crude slate and feed properties for increased potassium content.
MgO (ppm)	• Verify current fresh catalyst type and formulation against target specifications for MgO content. • Investigate any recent changes in feed components that might alter magnesium input to the unit.
Mn (ppm)	• Perform detailed crude slate analysis to identify and quantify manganese content. • Review and optimize feed treatment processes to ensure effective removal of metallic contaminants.
P_2O_5 (wt%)	• Verify the continuous and correct injection rate of any phosphorus-containing passivator. • Inspect the passivator delivery system for blockages or malfunctions. • Review fresh catalyst type and feed properties for changes impacting phosphorus input.
RE_2O_3 (wt%)	• Review and verify current fresh catalyst addition rates. • Confirm the specific fresh catalyst type being used and its Rare Earth content against operational targets.
Sb/Ni Ratio (nan)	• Immediately verify the injection status and delivery system integrity of the antimony passivator. • Ensure antimony passivator is being added at the appropriate rate to effectively mitigate nickel poisoning.
ZnO (ppm)	• Conduct detailed analysis of current crude slate for elevated zinc content. • Investigate process additives and equipment for potential sources of zinc contamination. • Review feed pretreatment effectiveness to ensure adequate zinc removal.

Final Remarks

- The primary root causes appear to be a combination of elevated feed contaminants (Calcium, Potassium, Manganese, Zinc) and severe deficiencies in metal passivation (lack of Antimony, low Phosphorus). Additionally, potential changes in fresh catalyst management or type are indicated by anomalous Al_2O_3, RE_2O_3, and MgO levels.
- The observed deviations are severe, particularly the high levels of potent poisons (CaO, K_2O, Mn, ZnO) and the complete absence of antimony passivation. These issues pose an immediate and critical threat to catalyst health and unit performance.
- Key evidence supporting these conclusions includes the significantly high captured values for critical contaminants far exceeding their limits, and the zero Sb/Ni ratio alongside a substantially lower P_2O_5 content, directly contradicting required metal passivation.
- If uncorrected, this operational trajectory will lead to rapid and irreversible catalyst deactivation, drastically increased coke and hydrogen production, reduced yields of valuable liquid products (especially gasoline), significant regenerator control issues, and ultimately, severe economic losses for the unit. Immediate intervention is required to address these critical issues and stabilize FCC operations.