FCC Catalyst Technical Report- Sample:41011461

Sample Overview

Item	Detail
Unit ID	313
Sample ID	41011461
Sampling Date	2024-10-28 00:00:00
Received Date	2024-10-31 00:00:00
Unit Name	CITGO - CORPUS CHRISTI (NEW), TX, US
Lab Code	C
Anomalous Parameters	Al_2O_3 (wt%), CaO (wt%), Co (ppm), K_2O (wt%), MgO (ppm), Pb (ppm), RE_2O_3 (wt%), Sb/Ni Ratio (nan)

Key Observations

- Al_2O_3 and RE_2O_3 levels are significantly below their implied lower operational limits, indicating potential fresh catalyst formulation issues or excessive catalyst deactivation/attrition, which can lead to reduced overall catalyst activity and stability.
- Contaminant levels of CaO, K_2O, and MgO are all above their implied upper operational limits, suggesting increased ingress of feed contaminants, process water issues, or refractory erosion, which are strong poisons for catalyst acidic sites.
- The Sb/Ni Ratio is reported as 0.0 and deemed "Exceeds Limit," signifying a complete lack of nickel passivation, which allows unmitigated nickel dehydrogenation activity, severely impacting selectivity and increasing coke/gas.
- Cobalt (Co) and Lead (Pb) are below their implied lower operational limits, potentially indicating changes in crude slate or analytical anomalies, though the impact of lower levels might be less critical than elevated poisons.

Parameter-by-Parameter Interpretation

Parameter	Status	Diagnostic Summary
Al_2O_3 (wt%)	Exceeds Limit	The Al_2O_3 content is below the implied lower operational limit. This reduction in a critical catalyst matrix component can compromise overall catalyst activity, leading to lower conversion, poor selectivity, and accelerated deactivation, negatively impacting FCC unit performance.
CaO (wt%)	Exceeds Limit	The CaO level is above the implied upper operational limit. Elevated calcium content acts as a catalyst contaminant, neutralizing acidic sites, reducing activity, increasing coke and gas formation, and promoting hydrothermal deactivation.

Parameter	Status	Diagnostic Summary
Co (ppm)	Exceeds Limit	Cobalt concentration is below the implied lower operational limit. While generally less severe than primary poisons, this deviation may indicate a shift in feedstock characteristics towards lower cobalt content, which could be beneficial or benign depending on target ranges.
Cu (ppm)	Within Limit	Copper levels are within acceptable operational limits, indicating that its potential for promoting undesirable dehydrogenation reactions and increasing coke/gas production is currently managed and not adversely impacting catalyst performance.
Fe (wt%)	Within Limit	Iron content is within specified limits. As a common contaminant, iron's dehydrogenation activity is currently controlled, ensuring its impact on hydrogen and coke yields remains within acceptable operational parameters.
K_2O (wt%)	Exceeds Limit	K_2O content is above the implied upper operational limit. This alkali metal is a potent catalyst poison, severely deactivating acidic sites, reducing activity, increasing coke/light gas, and accelerating hydrothermal deactivation.
MgO (ppm)	Exceeds Limit	Magnesium oxide is above the implied operational target. Elevated MgO levels can indicate unexpected contamination from feedstock or refractory erosion, potentially affecting catalyst activity or promoting undesirable side reactions in the unit.
Mn (ppm)	Within Limit	Manganese levels are within the acceptable range. Its impact on FCC catalyst performance is minor compared to primary metal poisons, and its current concentration is not a significant concern for catalyst activity or selectivity.
Mo (ppm)	Within Limit	Molybdenum concentration is within acceptable operating limits. As a trace contaminant, its current level suggests no adverse effect on catalyst performance, and it is not contributing significantly to dehydrogenation activity.
Ni (ppm)	Within Limit	Nickel concentration is within the specified operational limits. As a primary catalyst poison, its impact on severe dehydrogenation, light gas, and coke production is currently managed within acceptable boundaries.
Ni/V Ratio (nan)	Within Limit	The Ni/V ratio is within the acceptable range, indicating a stable relative accumulation of these primary metal contaminants. This suggests effective management of feed metals and their combined impact on catalyst deactivation.
P_2O_5 (wt%)	Within Limit	P_2O_5 levels are within acceptable limits. Phosphorus is a potent catalyst contaminant, but its current concentration is not a significant concern for acidic site poisoning or hydrothermal deactivation.
Pb (ppm)	Exceeds Limit	Lead concentration is below the implied lower operational limit. As a catalyst poison that can cause permanent deactivation, lower levels are generally preferred, but being below a minimum could indicate a significant change in feed composition.
RE_2O_3 (wt%)	Exceeds Limit	Rare Earth Oxides content is below the implied lower operational limit. Lower RE_2O_3 can lead to reduced catalyst activity, lower conversion, and accelerated deactivation, negatively impacting product distribution and unit performance.
Sb/Ni Ratio (nan)	Exceeds Limit	The Sb/Ni ratio is 0.0, indicating a complete absence or extremely low level of antimony relative to nickel. This means nickel's adverse effects (increased coke and light gas production) are unmitigated, severely impacting catalyst performance and selectivity.

Parameter	Status	Diagnostic Summary
V (ppm)	Within Limit	Vanadium concentration is within specified operational limits. As a highly destructive contaminant, its current level indicates effective management to maintain catalyst integrity and performance, preventing severe zeolite destruction.
ZnO (ppm)	Within Limit	Zinc oxide levels are within the acceptable range. As a potential feed contaminant or catalyst component, its current concentration is not showing adverse effects on catalyst activity or selectivity.

Consolidated Issue Summary

Issues	Evidence	Impact
Al_2O_3 (wt%)	Captured value (48.73 wt%) is below the implied lower operational limit (deviation: -0.99).	Compromises catalyst activity and structural stability, leading to reduced conversion, poor selectivity, and accelerated deactivation.
CaO (wt%)	Captured value (0.24 wt%) is above the implied upper operational limit (deviation: 0.03).	Neutralizes acidic sites, reduces catalyst activity, increases coke/gas formation, alters product selectivity, and promotes hydrothermal deactivation.
Co (ppm)	Captured value (21.41 ppm) is below the implied lower operational limit (deviation: -1.97).	Indicates a change in feed quality or catalyst aging dynamics; an unusually low value may suggest a shift in feedstock characteristics.
K_2O (wt%)	Captured value (0.07 wt%) is above the implied upper operational limit (deviation: 0.007).	Severely deactivates acidic sites, reduces activity and selectivity, increases coke/light gas yields, and accelerates hydrothermal deactivation.
MgO (ppm)	Captured value (25362.08 ppm) is above the implied operational target (deviation: 7203.98).	Indicates unexpected contamination or operational issues that may affect catalyst activity or promote undesirable side reactions.

Issues	Evidence	Impact
Pb (ppm)	Captured value (17.98 ppm) is below the implied lower operational limit (deviation: -0.41).	Indicates a significant change in feed composition, though lower levels are generally preferred, it might not be a performance concern unless the lower limit represents a target.
RE_2O_3 (wt%)	Captured value (2.75 wt%) is below the implied lower operational limit (deviation: -0.04).	Leads to reduced catalyst activity, lower conversion, and accelerated deactivation due to compromised zeolite stability.
Sb/Ni Ratio (nan)	Captured value is 0.0, indicating absence of antimony (deviation: 0.0).	Nickel's adverse effects (increased coke and light gas production) are unpassivated and uncontrolled, severely impacting catalyst performance and selectivity.

Corrective Actions & Optimization Strategies

Issue	Corrective Action
Al_2O_3 (wt%)	• Review fresh catalyst quality control data for consistent Al_2O_3 content. • Investigate potential preferential attrition of alumina-rich catalyst components. • Evaluate fresh catalyst addition rate to maintain desired matrix integrity while minimizing overall consumption.
CaO (wt%)	• Conduct a thorough analysis of crude feedstock for elevated calcium content. • Inspect process water systems for potential ingress of contaminated water. • Monitor refractory integrity, especially in high-wear areas, for signs of erosion.
Co (ppm)	• Verify crude slate composition for recent changes in cobalt content. • Review analytical instrument calibration and method for Co if consistent low values are unexpected.
K_2O (wt%)	• Implement enhanced monitoring of crude feedstock for alkali metal contaminants. • Evaluate boiler feed water quality and potential carryover into the FCC unit. • Inspect furnace refractories for fluxing agent erosion.
MgO (ppm)	• Analyze crude feedstock for magnesium content. • Inspect unit refractory linings for signs of erosion or degradation. • Verify current make-up catalyst specifications against operational targets for MgO content.
Pb (ppm)	• Review crude slate and feedstock sources for any changes resulting in lower lead content. • Confirm analytical method accuracy for lead at lower concentrations if a minimum target level is required.

Issue	Corrective Action
RE_2O_3 (wt%)	• Investigate fresh catalyst formulation and quality control for consistent RE_2O_3 content. • Conduct particle size distribution analysis to check for preferential loss of rare-earth containing catalyst fines. • Review catalyst steaming severity and duration to ensure optimal zeolite stability.
Sb/Ni Ratio (nan)	• Immediately inspect the antimony additive injection system for blockages, malfunctions, or incorrect dosing. • Confirm antimony inventory and feed rates are at target levels. • If no antimony addition is intended, reassess nickel poisoning mitigation strategy and consider introducing a passivator to manage coke and gas production without increasing fresh catalyst rate.

Final Remarks

- The unit is experiencing a severe imbalance in its ECAT composition, characterized by low critical active components (Al_2O_3, RE_2O_3) and high levels of potent poisons (CaO, K_2O, MgO). The complete absence of antimony passivation (Sb/Ni Ratio of 0.0) indicates a critical failure in managing nickel contamination, which will exacerbate coke and gas make.
- The severity of observed deviations is high, particularly for K_2O and the Sb/Ni ratio. High K_2O is a strong and irreversible poison, while unpassivated nickel will significantly degrade selectivity. The combined effect of depleted active sites and increased contaminant poisoning will severely impact unit profitability and operational stability.
- Corrective actions focusing on feedstock quality, contaminant ingress prevention, and immediate rectification of the antimony injection system are paramount. Evidence from the parameter deviations, such as above-limit CaO and K_2O, point to external contamination sources, while the 0.0 Sb/Ni ratio directly indicates a failure in the passivator system. Addressing the low Al_2O_3 and RE_2O_3 should involve a review of the fresh catalyst quality and attrition.
- If uncorrected, this operational trajectory will inevitably lead to a rapid increase in coke and gas yields, a sharp decline in valuable liquid product conversion, and accelerated deactivation of the ECAT. This would necessitate a significantly higher fresh catalyst addition rate to maintain unit performance, directly contradicting the objective of minimizing fresh catalyst addition, and would ultimately compromise unit profitability and operational reliability.