FCC Catalyst Technical Report- Sample:41007576

Sample Overview

Item	Detail
Unit ID	313
Sample ID	41007576
Sampling Date	2024-10-14 00:00:00
Received Date	2024-10-21 00:00:00
Unit Name	CITGO - CORPUS CHRISTI (NEW), TX, US
Lab Code	C
Anomalous Parameters	Al_2O_3 (wt%), CaO (wt%), Co (ppm), MgO (ppm), Pb (ppm), RE_2O_3 (wt%), Sb/Ni Ratio (nan)

Key Observations

- Elevated Al_2O_3 and RE_2O_3 concentrations significantly exceed their maximum acceptable limits, suggesting a potential shift in fresh catalyst addition rate or catalyst type, impacting overall ECAT composition and economics.
- Critical contamination by CaO is observed, exceeding its maximum limit, indicating a serious issue with feed quality or unit integrity, which will severely impact catalyst activity and product selectivity.
- The Sb/Ni ratio is 0.0, indicating a complete absence of antimony passivator. This leaves nickel unpassivated, leading to a high risk of increased coke and hydrogen production.
- Co concentration is below its minimum acceptable range, potentially reducing hydrogen transfer activity and affecting light olefin selectivity.
- MgO is indicated as outside limits despite its value appearing within a broad range, pointing to a specific, tighter operational target for this contaminant which promotes coke and hydrogen.
- Lead (Pb) concentration is below its minimum limit, an unusual condition that, while seemingly beneficial, flags an unexpected change in feed quality or operational process affecting lead ingress.

Parameter-by-Parameter Interpretation

Parameter	Status	Diagnostic Summary
Al_2O_3 (wt%)	Exceeds Limit	Al_2O_3 concentration is above the maximum acceptable range, indicating a shift in equilibrium catalyst composition. This deviation may be caused by an increased fresh catalyst addition rate or a change to a higher alumina fresh catalyst, affecting catalyst matrix activity and selectivity.
CaO (wt%)	Exceeds Limit	Elevated CaO concentration, above its maximum acceptable limit, is a critical catalyst poison. This will lead to increased coke and hydrogen production, reducing gasoline selectivity and overall catalyst activity by deactivating acidic sites and altering zeolite structure.

Parameter	Status	Diagnostic Summary
Co (ppm)	Exceeds Limit	The Co concentration is below the minimum acceptable range, suggesting reduced catalytic activity for hydrogen transfer reactions. This can impact product distribution, potentially increasing light olefins and affecting the overall balance of FCC reactions.
Cu (ppm)	Within Limit	Copper concentration is within acceptable limits, indicating controlled feed contamination or non-critical levels. Current levels are not expected to significantly impact catalyst performance, coke, or gas make.
Fe (wt%)	Within Limit	Iron concentration is within specified limits, suggesting that its dehydrogenation activity is not severely impacting catalyst performance. The current level is well within acceptable operational bounds.
K_2O (wt%)	Within Limit	Potassium (K_2O) concentration is within the specified limit, indicating that its permanent poisoning effect is not critically impacting unit performance. However, monitoring is warranted as it approaches the upper limit.
MgO (ppm)	Exceeds Limit	MgO concentration is indicated as outside acceptable limits, suggesting it is elevated relative to a specific operational target. Elevated MgO promotes hydrogen and coke formation, potentially reducing gasoline yield and increasing regenerator load.
Mn (ppm)	Within Limit	Manganese concentration is well within the acceptable range and not expected to significantly impact catalyst activity or selectivity. Fluctuations suggest variability in feed or fresh catalyst, but current levels are non-critical.
Mo (ppm)	Within Limit	Molybdenum concentration is within the acceptable operating range, indicating no adverse effects on catalyst performance. Recent values show stable operation regarding Mo.
Ni (ppm)	Within Limit	Nickel concentration is within acceptable limits, indicating that nickel poisoning is not a major concern for catalyst deactivation or product selectivity at present. Its dehydrogenation effects are currently managed.
Ni/V Ratio (nan)	Within Limit	The Ni/V ratio is within acceptable limits, suggesting a managed balance of contaminant metals. This indicates that the combined poisoning effect of nickel and vanadium on catalyst activity and selectivity is currently stable.
P_2O_5 (wt%)	Within Limit	Phosphorus (P_2O_5) concentration is within specified limits, indicating no significant adverse impact on catalyst performance or regeneration. Despite an increasing trend, it remains within operational bounds.
Pb (ppm)	Exceeds Limit	The Pb concentration is below its specified minimum limit. While lower levels of this poison are generally beneficial, this deviation indicates an unusual operational condition or significant change in feed quality that needs investigation.
RE_2O_3 (wt%)	Exceeds Limit	RE_2O_3 concentration is above the maximum acceptable range. Excessively high levels in equilibrium catalyst may indicate over-dosing of fresh catalyst or accumulation under specific operating conditions, potentially leading to suboptimal economics or unexpected performance.
Sb/Ni Ratio (nan)	Exceeds Limit	The Sb/Ni ratio is 0.0, indicating a complete absence of antimony passivator. This leaves nickel unpassivated, which can severely degrade catalyst performance by increasing coke make, regenerator temperature, and decreasing valuable liquid yields.

Parameter	Status	Diagnostic Summary
V (ppm)	Within Limit	Vanadium concentration is within acceptable limits, indicating that contamination is managed. Its deactivating effects on zeolite structure are not critically impacting overall catalyst performance at current levels.
ZnO (ppm)	Within Limit	Zinc oxide concentration is well within acceptable limits, indicating proper management of zinc-related issues. No significant impact on catalyst activity or selectivity is expected from current levels.

Consolidated Issue Summary

Issues	Evidence	Impact
Elevated Al_2O_3 (wt%)	Captured value 49.72656 wt% is above the maximum acceptable range (Y_Max: 44.50726 wt%).	Indicates a shift in equilibrium catalyst composition, affecting the catalyst's matrix activity and selectivity. Potentially suboptimal fresh catalyst utilization.
Elevated CaO (wt%)	Captured value 0.21312 wt% is above the maximum acceptable range (Y_Max: 0.17 wt%).	Significant catalyst poisoning leading to increased coke and hydrogen production. Reduces gasoline selectivity and overall catalyst activity by deactivating acidic sites and altering zeolite structure.
Low Co (ppm)	Captured value 23.38431 ppm is below the minimum accep table range (Y_Min: 27.761 59 ppm).	Reduced catalytic activity for hydrogen transfer reactions, potentially impacting product distribution and increasing light olefins.
Elevated MgO (ppm)	Captured value 18158.1 ppm with a positive deviation of 515.63, indicate d as "Is Within Limit: False".	Promotes hydrogen and coke formation, particularly at high temperatures, which can reduce gasoline yield and increase regenerator load.
Low Pb (ppm)	Captured value 18.38986 ppm is below the specified Y_Min (19.0791 6 ppm).	While a lower level of poison is often beneficial, this deviation indicates an unusual operational condition or significant change in feed quality, signaling a potential shift from optimum operating range.

Issues	Evidence	Impact
Elevated RE_2O_3 (wt%)	Captured value 2.79003 wt% is above the maximum acceptable range (Y_Max: 2.329 wt%).	Excessively high levels may indicate over-dosing of fresh catalyst or accumulation, potentially leading to suboptimal economics and unexpected catalyst performance.
Zero Sb/Ni Ratio	Captured value 0.0 for Sb/Ni ratio, indicated as "Is Within Limit: False".	Complete absence of antimony passivator, leaving nickel unpassivated. Severely degrades catalyst performance by increasing coke make, regenerator temperature, and decreasing valuable liquid yields.

Corrective Actions & Optimization Strategies

Issue	Corrective Action
Elevated Al_2O_3 (wt%)	• Evaluate current fresh catalyst addition rate and optimize to reduce Al_2O_3 without compromising overall activity, thus minimizing fresh catalyst consumption. • Review fresh catalyst specifications and consider adjusting to a formulation with a lower Al_2O_3 content if recent changes occurred.
Elevated CaO (wt%)	• Conduct immediate checks on desalter operation and crude slate for potential calcium ingress. • Inspect refractory materials in the FCC unit for erosion or spalling contributing to calcium contamination. • Implement enhanced feed quality monitoring for calcium content.
Low Co (ppm)	• Review fresh catalyst formulation for cobalt content; consider adjusting fresh catalyst selection to one with higher cobalt to meet operational targets if indicated. • Monitor fresh catalyst addition rates to ensure proper cobalt contribution to the equilibrium catalyst.
Elevated MgO (ppm)	• Investigate potential sources of magnesium in the feed, such as desalter carryover or specific crude sources. • Examine refractory materials for erosion or spalling of magnesium-containing components. • Re-evaluate the specific operational limit for MgO given the discrepancy in broad range vs. indicated status.
Low Pb (ppm)	• Investigate changes in crude slate or upstream processing that might have reduced lead content. • Review operational targets for trace contaminants to ensure alignment with current feed characteristics and desired ECAT behavior.
Elevated RE_2O_3 (wt%)	• Reduce fresh catalyst addition rate to bring RE_2O_3 concentration within acceptable limits, optimizing catalyst economics and minimizing fresh catalyst consumption. • Verify the fresh catalyst type and ensure it is appropriate for the desired RE_2O_3 equilibrium level.

Issue	Corrective Action
Zero Sb/Ni Ratio	• Immediately re-establish or optimize the injection rate of antimony-based passivator to mitigate nickel poisoning. • Verify the functionality of antimony injection systems and ensure adequate inventory. • Review fresh catalyst selection to ensure it contributes appropriate Sb if it's designed to be part of the fresh catalyst.

Final Remarks

- The core issue appears to be a systemic disruption to equilibrium catalyst composition and contaminant management, highlighted by significantly elevated Al_2O_3 and RE_2O_3, indicating either an increased fresh catalyst addition rate or a change in catalyst type. Simultaneously, critical contaminant levels (CaO, MgO) are elevated, while the vital Sb passivator is completely absent, pointing to severe operational and feed quality control issues.
- The severity of observed deviations is high, particularly for CaO poisoning and the zero Sb/Ni ratio. Elevated CaO will directly reduce gasoline yield and increase coke, while unpassivated nickel (due to absent Sb) will exacerbate coke and hydrogen production, leading to regenerator temperature excursions and further yield loss. The high Al_2O_3 and RE_2O_3 indicate economic inefficiency in catalyst management.
- Key evidence supporting these conclusions includes the Al_2O_3 value (49.72656 wt% vs Y_Max 44.50726), CaO (0.21312 wt% vs Y_Max 0.17 wt%), RE_2O_3 (2.79003 wt% vs Y_Max 2.329 wt%), and especially the Sb/Ni Ratio of 0.0. The "Is Within Limit: False" for MgO despite its absolute value underscores the need for tight control.
- If uncorrected, the observed deviations will lead to a rapid decline in FCC unit performance, characterized by significantly increased coke make and hydrogen production, reduced gasoline and desired product yields, higher regenerator temperatures, and potentially higher fresh catalyst consumption to compensate for the compromised ECAT activity.