FCC Catalyst Technical Report- Sample:41003698

Sample Overview

Item	Detail
Unit ID	313
Sample ID	41003698
Sampling Date	2024-09-30
Received Date	2024-10-11
Unit Name	CITGO - CORPUS CHRISTI (NEW), TX, US
Lab Code	C
Anomalous Parameters	Al_2O_3, CaO, Co, K_2O, MgO, Mn, P_2O_5, Pb, RE_2O_3, Sb/Ni Ratio, ZnO

Key Observations

- $Al_2O_3$is markedly elevated (49.83 wt %) indicating excessive alumina that may increase catalyst surface area and premature coke deposition.
- Alkaliload (CaO, K_2O, MgO) is far above limits, signaling feed contamination that could poison acid sites and accelerate sintering.
- Metals (Co, Mn, Pb)are below minimums, potentially weakening redox balance and radical scavenging, while$RE_2O_3$and$P_2O_5$are above limits, suggesting rare■earth/ phosphate contamination that promotes coke and structural distortion.
- ZnOis below spec, hinting at degraded particle strength and increased attrition in the fluidized bed.

Parameter■by■Parameter Interpretation

Parameter	Status	Diagnostic Summary
Al_2O_3 (wt%)	Exceeds Limit	High alumina (49.83 wt %) exceeds spec, implying feed contamination or calcination defect. Increases surface area but may accelerate coke deposition, lowering FCC throughput.
CaO (wt%)	Exceeds Limit	Elevated CaO (0.192 wt %) enhances sintering and poisons active sites. Coupled with Fe and Na, it can reduce catalyst activity and raise coke yield.
Co (ppm)	Exceeds Limit	Co is below minimum (25.8 ppm), undermining Ni■site effectiveness. Likely accelerates sintering or coke formation, reducing overall activity.
Cu (ppm)	Within Limit	Copper is within spec and correlates with stable H_2 and Coke yields, supporting maintained metallic activity and minimal deactivation.
Fe (wt%)	Within Limit	Fe is within limits; along with Na and CaO it balances composition, mitigating metal■induced deactivation while sustaining activity.

Parameter	Status	Diagnostic Summary
K_2O (wt%)	Exceeds Limit	Potassium (0.079 wt %) exceeds spec, poisoning acid sites. High Na correlates, leading to reduced acidity, increased coke, and lower product yield.
MgO (ppm)	Exceeds Limit	MgO (17.6 kppm) far exceeds desired range, raising basicity. Coupled with CaO, it accelerates sintering, compromising FCC efficiency.
Mn (ppm)	Exceeds Limit	Mn (21.5 ppm) below minimum; deficient redox capability may reduce resistance to high■temperature deactivation and lower catalyst lifespan.
Mo (ppm)	Within Limit	Molybdenum is within spec, supporting durability and resistance to sintering under FCC conditions.
Ni (ppm)	Within Limit	Nickel (550 ppm) is acceptable; its correlation with H_2 and coke yields indicates preserved active sites and balanced product distribution.
Ni/V Ratio (nan)	Within Limit	Ratio (0.320) is within limits, reflecting balanced metal distribution for optimal activity without excessive aggregation.
P_2O_5 (wt%)	Exceeds Limit	Phosphate (0.467 wt %) above upper limit and correlates with high RE_2O_3. Can poison sites, increase coke, and alter sintering behavior.
Pb (ppm)	Exceeds Limit	Lead (17.6 ppm) below minimum; deficiency may reduce radical scavenging, potentially increasing polymerization and altering product slate.
RE_2O_3 (wt%)	Exceeds Limit	Rare earth oxide (2.846 wt %) exceeds spec, linked to unit■cell expansion and higher coke yield, distorting surface geometry and decreasing activity.
Sb/Ni Ratio (nan)	Exceeds Limit	Ratio = 0.0, below minimum; hint of analytical noise or low Sb load. Although not strongly deleterious, monitoring is needed to confirm catalyst stability.
V (ppm)	Within Limit	Vanadium (1719 ppm) within spec, keeping Ni/V ratio stable and supporting redox balance with minimal deactivation.
ZnO (ppm)	Exceeds Limit	Zinc oxide (172 ppm) below minimum; indicates possible loss in structural integrity. Correlation with APS suggests decreased particle strength and higher attrition in the fluidized bed.

Consolidated Issue Summary

Issues	Evidence	Impact
Al_2O_3	“High alumina …may lead to premature coke deposition ”	Reduced FCC throughput, higher H_2 selectivity
CaO	“Calcium level…increase sintering and poison active sites”	Activity loss, higher coke yield

Issues	Evidence	Impact
Co	“Copper’s co■presented cobalt concentration is below the minimum…low Co may reduce Ni■based sites”	Accelerated deactivation, lower activity
K_2O	“Elevated potassium…poison acid sites”	Decreased acidity, increased coke, lower product yield
MgO	“MgO concentration is far above the desired range”	Accelerated sintering, reduced efficiency
Mn	“Manganese concentration is below its minimum”	Reduced redox balance, faster deactivation
P_2O_5	“Phosphate concentration is above its upper limit”	Site poisoning, increased coke susceptibility
Pb	“Lead level is below the minimum”	Reduced radical scavenging, potential polymerization
RE_2O_3	“Rare earth oxide exceeds specification…increased unit cell size and higher coke yield”	Structural distortion, reduced surface area
Sb/Ni Ratio	“The Sb/Ni ratio is zero…absence may hint at insufficient metal loading”	Possible instability in Ni activity
ZnO	“Zinc oxide is below minimum, pointing to potential loss of catalyst structural integrity”	Increased attrition, reduced catalyst life

Corrective Actions & Optimization Strategies

Issue	Corrective Action
Al_2O_3	• Verify feed calcination; adjust alumina feedstock.• Implement real■time Al_2O_3 monitoring and throttle calcination temperature to meet spec.
CaO	• Screen raw materials for Ca content.• Introduce Ca■free additives or use ion■exchange resins to reduce calcium load.
Co	• Review catalyst feed composition; ensure adequate Co inclusion.• Conduct analytical audit to rule out measurement bias.
K_2O	• Test alkali■rich feed for K; consider alkali removal steps.• Implement K■sequestering resin or alumina■based adsorbers.
MgO	• Source lower■Mg raw materials and verify batch specifications.• Run Mg■level checks pre■calcination and post■calcination.
Mn	• Adjust catalyst formulation to ensure Mn ≥ minimum; re■balance redox profile.• Check analytical equipment for Mn quantification accuracy.
P_2O_5	• Trace feed for phosphate contamination; replace with phosphate■free alternatives.• Install P_2O_5 monitoring; purge downstream if contamination persists.
Pb	• Audit source materials for inadequate Pb; add controlled Pb if needed.• Monitor Pb to avoid over■scavenging that could affect catalyst stability.
RE_2O_3	• Source feed with low rare■earth content; verify supplier certificates.• Run periodic RE_2O_3 mapping to catch sudden spikes.
Sb/Ni Ratio	• Verify analytical accuracy; perform cross■analysis with ICP■MS.• Maintain stable Ni loading to preserve ratio within spec.
ZnO	• Increase ZnO feed or add zinc■rich binder to improve structural integrity.• Monitor APS; correlate with ZnO to pre■empt attrition.

Final Remarks

- The ECAT performance is compromised bycombined alkali overload(CaO, K_2O, MgO) andphosphate/rare■earth contamination(P_2O_5, RE_2O_3), both driving coke formation, sintering, and acidity loss.
- Low Co, Mn, Pb, ZnOconcentrations further erode the catalyst's redox balance and structural robustness, contributing to rapid deactivation.
- Evidence from issue summaries and trend data confirms that these parameters areoutside specificationand correlate with undesirable operational outcomes such as elevated coke yield and reduced throughput.
- If corrective actions are not implemented, the FCC unit will likely experienceincreasing fresh catalyst addition rates, higher operating costs, and potential product slate drift.