

Northshore™ CK356N6C

Cuts Iron in Vacuum Sidestreams by 60–70% on TAN 3–5 Crude at Just 12–15 ppm of Low-Phosphorus Inhibitor

Key results

–72%

iron in vacuum sidestream 3 after film formation (2.98 → 0.84 mg/kg)

12–15 ppm

maintenance dose on crude after a 15-day film at 25–30 ppm

91–95%

of days within the agreement's iron limits over 12 weeks

Benefits

- **Fast, durable film** – iron falls within a week of film formation and stays low
- **Low phosphorus ($\leq 3\%$ P)** – respects downstream units' phosphorus limit
- **Works at unchanged acidity** – sidestream TAN held at 3–4.5 while iron dropped
- **No metallurgy change, no new equipment** – three neat injection points

Typical properties

Density (20 °C), g/cm ³	0.90–1.20
Pour point, °C	< –10
Flash point, °C	≥ 62
Phosphorus, wt%	≤ 3

Challenge

After its 2019 turnaround, the 5.1 Mt/a crude unit of a coastal refinery in East China went back on a slate of heavy offshore crudes whose acidity kept climbing. Vacuum sidestreams ran at a TAN of **3–5 mg KOH/g**, and iron in those sidestreams stayed stubbornly high – the tell-tale of active naphthenic-acid corrosion and a threat to the unit's long-run safety. A conventional phosphate-ester inhibitor was not an option: the downstream units set a strict phosphorus limit to protect their hydroprocessing catalysts. The refinery needed sidestream iron brought inside its technical-agreement limits on the existing metallurgy, with phosphorus kept low.

Analysis

Cestoil sampled the unit's streams and reviewed corrosion history, sidestream temperatures and metallurgy with the refinery's technical department. Naphthenic-acid corrosion is a liquid-phase, temperature-window problem – worst near 340 °C where the acids condense, absent below 225 °C. The CK356N series forms a hard, dense inhibitor-iron complex film that blocks acid attack across that window; **CK356N6C** is the low-phosphorus member of the family ($\leq 3\%$ P). Cestoil proposed three injection points on the vacuum tower – the first and second intermediate pumparounds (179 °C and 244 °C) and the wash-oil reflux (325 °C), together carrying ~73% of the crude – with daily TAN and iron on sidestreams 2, 3 and 4 as the corrosion indicator.

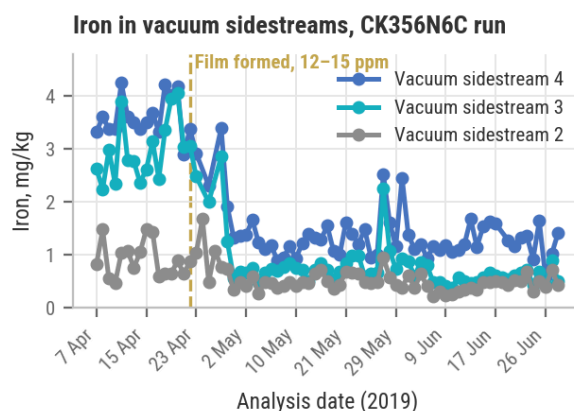


Figure 1: Daily iron in vacuum sidestreams 2, 3 and 4, 7 April – 1 July 2019. CK356N6C was injected from 6 April at 25–30 ppm on crude for 15 days (film-forming period), then at 12–15 ppm. Sidestream TAN stayed at 3–4.5 mg KOH/g throughout. Refinery laboratory data; days without analysis are gaps.

Solution

Injection started on **6 April 2019**. For the first 15 days CK356N6C was dosed at **25–30 ppm on crude** to build the film; from 22 April the dose was cut to a **12–15 ppm** maintenance rate (13–14 ppm from May) and held there while the unit processed its full offshore crude slate. The three vacuum-tower injection points were dosed neat through the existing chemical-injection system. Iron and TAN on vacuum sidestreams 2, 3 and 4 were analysed daily from 7 April to 1 July, and Cestoil reviewed the trends with the refinery through the run.

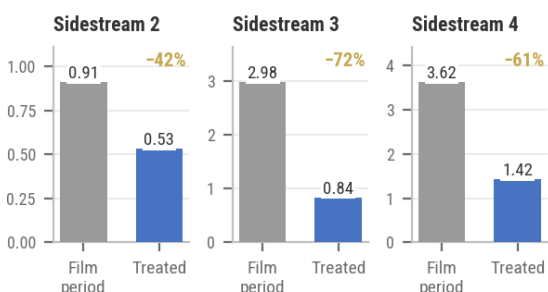


Figure 2: Average iron (mg/kg) in each vacuum sidestream during the 15-day film-forming period (7–21 April) and over the maintenance-dose period (22 April – 1 July 2019). Refinery laboratory data.

Result*

- **Iron down 60–70% once the film had formed.** During the film-forming period sidestream-3 iron ran at 2.2–4.1 mg/kg and sidestream-4 at 2.9–4.3 mg/kg. Within a week of switching to the maintenance dose they had fallen to 0.4–0.9 and 0.9–1.7 mg/kg, and stayed there: averages over 22 April–1 July were **0.84 mg/kg (-72%)** on sidestream 3, **1.42 mg/kg (-61%)** on sidestream 4 and 0.53 mg/kg (-42%) on sidestream 2 (Figures 1 and 2).
- **Inside the limits 91–95% of days.** Against the technical agreement's iron limits, sidestreams 2, 3 and 4 were within specification on 94.9%, 94.7% and 91.1% of analysis days over the 12-week run – the refinery records the agreement as met.
- **Protection at unchanged acidity.** Sidestream TAN averaged 3.0–3.4 mg KOH/g throughout, with peaks above 4 in April and mid-June; iron did not follow. The film, not a milder crude, delivered the result. Two one-day excursions on 27 and 30 May cleared by the next analysis.
- **Refinery verdict.** The technical department's report concludes that CK356N6C "effectively controls high-temperature naphthenic-acid corrosion, greatly reduces the corrosion rate of high-temperature equipment and piping, and supports long-cycle safe operation".

Value delivered

Iron in vacuum sidestreams 3 / 4 (film period → treated)	2.98 → 0.84 mg/kg (-72%) / 3.62 → 1.42 mg/kg (-61%)
Days within technical-agreement iron limits, 12 weeks	94.9% / 94.7% / 91.1% on sidestreams 2 / 3 / 4
Inhibitor dose	25–30 ppm for 15 days, then 12–15 ppm on crude
Phosphorus to downstream units	Product ≤ 3% P – downstream limit respected
Crude and metallurgy	Planned 5.1 Mt/a heavy, high-acid offshore slate run on existing vacuum-section metallurgy



About Northshore™ CK356N6C

Northshore™ CK356N6C is a low-phosphorus high-temperature corrosion inhibitor for crude and vacuum units processing high-acid crudes. It forms a hard, dense inhibitor-iron complex film on furnace tubes, transfer lines, tower internals and side-cut piping in the 225–400 °C naphthenic-acid corrosion window, and keeps phosphorus at ≤ 3% to respect the limits of downstream hydroprocessing units.

Together with the phosphorus-free CK356N8C, it lets refiners broaden their crude slate to high-TAN grades without changing metallurgy. Cestoil designs the injection program – film-forming and maintenance doses, injection points – and monitors sidestream iron and TAN through the run.



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Discuss a similar application

Send us your crude TAN curve, sidestream temperatures and metallurgy, and your iron and phosphorus limits – we will propose injection points, a film-forming plan and a maintenance dose.

About Cestoil Chemical

Cestoil Chemical is a global provider of specialty chemicals – fuel additives, process additives and advanced materials – headquartered in Ontario, Canada, with operations in North America and Asia. For over 20 years we have combined disruptive technology with hands-on technical service to deliver bottom-line results for refiners, petrochemical producers and pipeline operators.