GE Power
Water & Process Technologies

Case Study

CrudePLUS* Shows How to Reduce Fouling Impact by $12MM/Year

Challenge

A North American refinery operating two 240,000 barrel per day crude units was experiencing significant economic penalties due to critical heat transfer equipment fouling in one of the units. Preheat train and atmospheric heater fouling in Unit A was costing approximately $30MM per year.

The refinery processes a variable mix of West Texas Intermediate, West Texas Sour, tight oils, Canadian crudes, four different offshore crudes, and slop oil. Blended oil is sent to the refinery's units from a tank farm segregated by sulfur content; tanks are designated as light, medium, or high sulfur.

As shown in **Figure 1** and **Figure 2**, Unit A processes predominantly light sulfur oils, with the remainder of its diet from the medium sulfur tank. These two feeds are blended to meet specified sulfur and gravity targets of the unit feed. In contrast, Unit B processes mostly medium sulfur crude oil, supplemented with a notable amount of high sulfur crude oil produced from western Canadian oil fields.

Solution

After evaluating the economics of the challenge, the GE team, composed of on-site engineers and remote experts, mapped the system logistics, tested various blends on both crude unit trains, and evaluated the root causes of fouling.

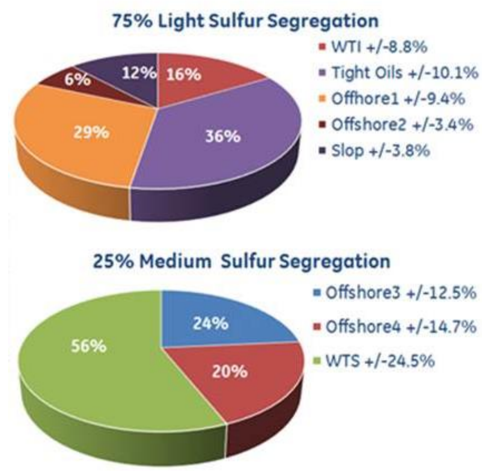

Figure 1: Unit A crude oil diet

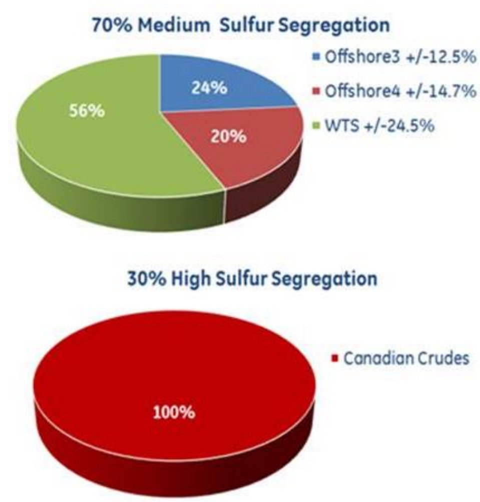

Figure 2: Unit B crude oil diet

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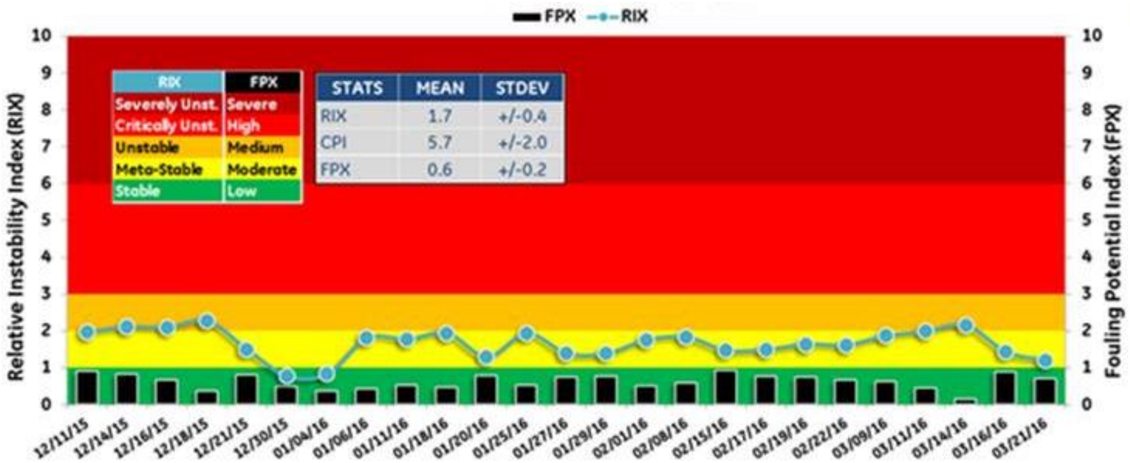

Figure 3: Unit B CrudePLUS analytics output chart

CrudePLUS was used to measure the impact dissimilar crude slates impart on each unit and to determine potential issues of various blends. A component of GE's Integrated Solutions for Refining, CrudePLUS. It is a service that combines a refinery deployable Oil Fingerprinting Device with powerful predictive analytics to provide rapid, on-site analysis of crude oils, oil blends, and other hydrocarbon fluids like slop oil. The Oil Fingerprinter Device and CrudePLUS predictive analytics measure the instability and incompatibility potential of hydrocarbon fluids and provide guidance on potential actions to ensure the crude/blend can be processed without difficulties. Combined with GE's solids loading and classification measurements, CrudePLUS can simultaneously predict the hydrocarbon fluid's fouling potential.

Three measurements generated with the CrudePLUS technology are used to evaluate the streams:

- **RIX** – Relative Instability Index (0-10 scale – lower is more stable). This index measures the capacity of the fluid to self-destabilize or to destabilize other fluids in a blend, relative to a stable & proprietary benchmark.
- **CPI** – Crude Precipitant Index (the higher the index the higher mass). A measure of potential precipitant amount upon actual destabilization of a fluid or blend.
- **FPX** – Fouling Potential Index (0-10 scale – lower is better). This index measures the capacity of the fluid to foul crude preheat & heaters at typical conditions.

The GE team tested the segregation tanks and blending points using CrudePLUS over a 6-month period, measuring instability/incompatibility (RIX, CPI) and fouling potential (FPX). The two crude units showed very different profiles for stability and fouling potential.

Figure 3 charts the RIX, CPI, and FPX for Unit B, showing that there was significant variation in the concentrations of the various crude oils blended into the medium sulfur segregation tanks that make up 70% of this unit's diet. The CrudePLUS analysis, however, shows that all indices remain stable and in the low impact regions. This is consistent with the low fouling and good heat transfer performance observed in this unit.

Unit A data paints a very different picture, as shown in **Figure 4**. This unit also had high variability in its crude oil diet, with the compositions of both the light and medium sulfur segregations showing large changes in crude sources. The RIX values for this unit indicate a consistently high potential for asphaltene instability (blue markers on the chart). The FPX values (black bars) show a high degree of variability in the fouling potential of the blends processed. Some data is in the meta-stable region, but most lie in the unstable, severely unstable, or critically unstable regions. These results are consistent with the observations in actual operations – significant periods of high fouling and loss of heat transfer in the Unit A preheat heat exchanger train.

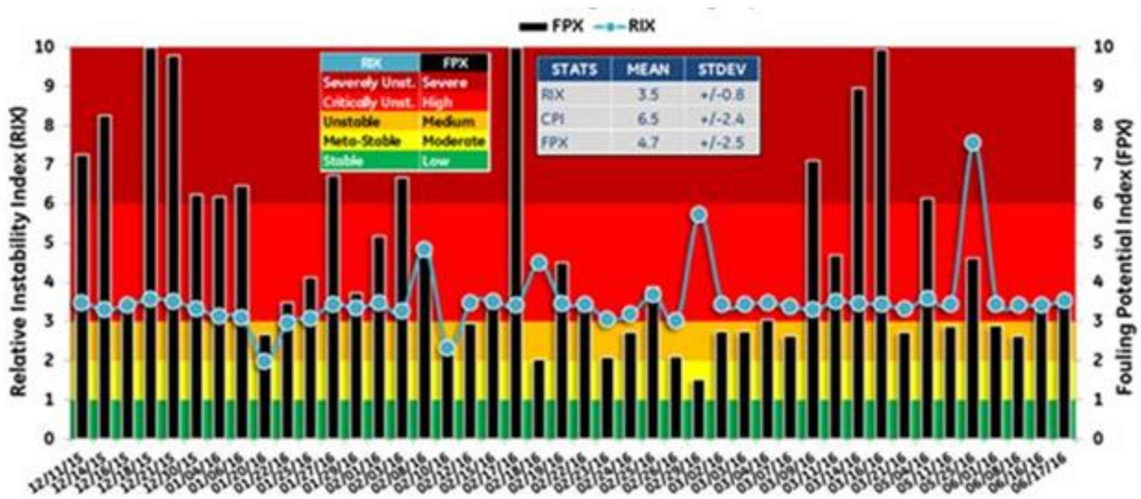

Figure 4: Unit A CrudePLUS analytics output chart

Results

As a result of this analysis, GE's recommendation for Unit B was to make no changes, but continue routine testing and evaluation with CrudePLUS. This would help the refinery track and respond to any increase in fouling or stability indices.

For Unit A, changes to blend order and crude purchases were discussed, but logistics and contractual limitations prevented any significant flexibility in these areas. Since the situation could not be improved by crude purchase selections or operational changes, chemical treatment programs were developed. The main program goals were to reduce the effects of instability and fouling potential when conditions indicate these to be problematic. Treatment injections and dose rates are adjusted based on continued CrudePLUS testing. The following tactical mitigation strategy was proposed:

- On-going use of CrudePLUS constrained optimization analysis to determine blending plans that minimize RIX and FPX.
- Targeted injection of crude stabilizer and antifoulant chemistries at the right time, into the right streams, and in the right amount to reduce instability and minimize fouling through the hot exchanger preheat train.
- Development of a customized antifoulant program to manage high severity fouling in the atmospheric Crude Unit A charge furnace.

The potential economic benefit for implementing the recommended strategies is estimated at $12MM per year, a 40% reduction in the cost of processing.