Emulsion Breaker and Metal Removal Technology Increases FCC Residuum Processing

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GE Water & Process Technologies

Imagination at work
The marketplace

CRUDE UNIT

Fuel Gas

LPG

SR Gasoline

Naphtha

Kerosene

Gas Oil

Residue

SATURATE GAS PLANT

ISOMERIZATION UNIT

NAPHTHA HYDROTREATER

MEROX/ TREATRE OR HYDROTREATER

DISTILLATE HYDROTREATER

GAS OIL HYDROTREATER

DELAYED COKER

CATALYTIC REFORMER

HYDROCRACKER

FLUID CATALYTIC CRACKING

ALKYLATION

Refinery fuel gas

Propane/butane

Gasoline

AVGas

Jet fuel

Diesel

Petroleum coke

industrial fuel/Power boilers etc.
Opportunity crudes

- Bakken
- Utica
- Marcellus
- Niobrara
- Permian
- Eagle Ford
- Haynesville
**LTO variability**

**Sample description**

12888.1  #3  Raw crude  
12888.2  #3  Desalted crude  
12888.3  #4  Raw crude  
12888.4  #4  Desalted crude  

<table>
<thead>
<tr>
<th>Sample number:</th>
<th>12888.1</th>
<th>12888.2</th>
<th>12888.3</th>
<th>12888.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-extractable chloride; ppm</td>
<td>6.7</td>
<td>6.5</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Salt by extraction; ptb</td>
<td>28.5</td>
<td>0.9</td>
<td>3.5</td>
<td>0.7</td>
</tr>
</tbody>
</table>

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**Graph and Image:**

- Graph showing elements like C, O, FeCl, Na, Mg, Al, Si, Cl, and Ca with their respective counts.
- Image of a microscopic view showing crystals or particles with a magnification of 100X.
New desalting challenges

Crude compatibility

- Chloride variability
- Fine filterable solids
- Tramp amines
- Metals

Multiple levers

- Crude stabilizer
- Emulsion breaker
- Split feed
- Wetting agent
- pH modifier

* Trademark of General Electric Company; may be registered in one or more countries.
Potential injection locations

A. Crude stabilizers
B. Demulsifiers
C. Solids wetting agents
D. Metal and amine removal aides
E. Metals removal
F. Liquid/solid separation aides
G. Bioaugmentation aides
H. MACarrier
I. Phosphate removal
Simple as it gets

- Desalted oil out
- Effluent water out
- Raw oil and wash water in
- Fresh water
- Raw crude
- Effluent water out
Desalter goals

- Minimize solids carryover
- Minimize solids build-up
- De-oil the water
- Dehydrate oil for salt and water removal
- Clarify the water
- Reduce solids build-up
Contaminant removal

Remove:
- Salts
- Solids
- Water
- Metals
- Amines

Negative downstream effects:
- Fouling, erosion, off-spec products
- Corrosion, preheat exchanger scaling
- Catalyst poisoning
- Energy costs, unit upsets
Desalter performance factors

**ALL factors needed to optimize performance**

- ✓ Mechanical
- ✓ Operational
- ✓ Chemical

- Desalted oil out
- Effluent water out
- Fresh water
- Raw crude
- Raw oil and wash water in
Solids make-up

Solid structure
High charge density

Typical solids in crude oil

Fe₂O₃
SiO₂
Al₂O₃
C
Fe₂S₃
NaAlSiO₄
CaCO₃
BaSO₄
Solids loading

400x resolution and phase contrast

Native

Crude + demulsifier

Crude + demulsifier + wetting agent

Minimal solids
Filter pad results

Inorganic components

Organic components
Organic metal removal

$$2 \text{RCOOH} + \text{CaNAP} \rightarrow (\text{RCOO})_2\text{Ca} + \text{NAP Acid}$$

Oil soluble Ca $\rightarrow$ Water soluble Ca
FCC catalyst particles
Iron nodule
The challenge

- Gas oil/vac resid feed
- Flue gas to heat recovery
- HCN to storage
- LCO to storage
- De-butanizer
- Slurry to storage
- Waste heat boiler
- Fuel gas
- Cat gasoline

Diagram containing process flows and equipment labels.
Front end learnings
Path forward
Solution

Before

After
<table>
<thead>
<tr>
<th></th>
<th>Competitor</th>
<th>Raw crude ppm (avg)</th>
<th>Desalted crude ppm (avg)</th>
<th>Removal rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Na</td>
<td>Fe</td>
<td>Ca</td>
<td>Na</td>
</tr>
<tr>
<td>GE</td>
<td>35.6</td>
<td>21.6</td>
<td>8.9</td>
<td>7.3</td>
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<tr>
<td>Incumbent</td>
<td>30.1</td>
<td>11.8</td>
<td>12.3</td>
<td>14.2</td>
</tr>
</tbody>
</table>
Brine oil and grease

Figure 1
Oil and grease
On GE program average = 56

Figure 2
Oil and grease
Competitor’s program average = 160
Metal removal

Figure 3
Crude out
Iron (Fe)

![Graph showing iron removal over time with GE solution implemented at a certain point.]

Figure 4
Crude out
Calcium (Ca)

![Graph showing calcium removal over time with GE solution implemented at a certain point.]

Elapsed time (days)

Parts per million

GE solution implemented
Filterable solids removal

Figure 5
Filterable solids removal efficiency
On GE program
KP ≥ 70%
Dollarizing the benefits

MARGIN UPGRADE

+$12MM

ANNUALLY
Summary

Integrated solutions for refining

“GE is uniquely positioned to marry water and process in our technology developments.”

For 200,000 bpd refinery

Estimated savings

25% $5/bbl Δ crude = $85MM/year
5°F lower crude unit top temp = $12MM/year
1 point lost availability = $8MM/year
1% slop = $2MM to $8MM/year

Reduce risk and drive profitability