Reducing FCC Turnaround Costs
Focus on Speed & Safety

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Brief company introduction

Preparing FCC for entry; keys to success
  - Pre-T/A planning
  - Available methods
  - Proper testing

Hydrogen sulfide (H₂S) & Pyrophoric iron sulfide (FeS)
  - Overview
  - Treatment and their effects on cost, safety, and environmental

FCC Case Study

Conclusion

Q&A

Agenda
Experienced Technical Leaders

- Decontamination of process units for over 25 years
- Global presence – over 50 countries worldwide
- Zero recordable injuries in the history of the company
- 200+ refinery projects per year
- Crude price volatility
- More strict environmental and safety regulations
- Fouling, coking, emergency shutdowns
- State of the global refining industry requires more efficient and safe technologies including turnarounds and maintenance
Making process units ready for vessel entry

- Benzene: 0 ppm
- LEL: 0%
- H₂S: 0 ppm
- FeS: Neutralized
- Residual Oil: Removed
- Monitoring and executing a more successful turnaround – key conditions for success, include planning, monitoring, troubleshooting and results.

- There are many stages and variables to an FCC Unit each with unique issues.
  - Reactor section
  - Fractionation section
  - Gas Plant
  - Caustic treating
  - Exchangers
Fast & Safe Vessel Entry - Keys to Success

- Choosing the correct method
  - What’s important; Time? Wastewater? Environment? Others?
  - What resources are available; Adequate steam? Water restrictions? Enough room for equipment?

- Pre-turnaround planning
  - Contractor relationship
  - Critical path identification

- Proper testing/monitoring
  - During treatment
  - Post treatment before opening for entry
Opportunity Crudes - Increase Crack Spread

These crudes can contain high levels of:

- Asphaltenes, Tars and Waxes
- Polymers and Paraffin
- Naphthenic Acids

Increasingly important to augment traditional approach with chemistry
Hydrogen Sulfide ($\text{H}_2\text{S}$)
Pyrophoric Iron Sulfide ($\text{FeS}$)

Overview
Concerns
High Risk Units
Treatment Methods
Hydrogen Sulfide (H$_2$S) Overview

- IDLH - can cause instant death at high levels without warning
- Rotten egg odor detected in low concentrations
- Higher concentrations deaden sense of smell
- Increased presence due to sour crude around the world
- Best Practice: Personal H$_2$S monitor should be used to prevent deadly exposure
- Deposits form during process operations when H₄S reacts with metal surfaces with little or no oxygen.
- High risk of fire during maintenance.
- Deposits can oxidize rapidly when exposed to air producing sufficient heat to ignite hydrocarbon air mixture.
- Hard to predict or detect complete removal.
- Forms SO₂ when exposed to air (white smoke).
Pyrophoric Iron Sulfide (cont.)

- Present in almost all vessels when sour crude is processed
- Extremely dangerous – can ignite quickly after exposed to oxygen
- Undetectable until vessel is opened – no test
- Difficult to reach, especially heavily fouled vessels
- Increased presence due to sour crude around the world
- Almost every process unit has a risk for pyrophoric iron sulfide

- Structured packing and trays have an elevated risk; hard to clean, limited ability to inspect, collects combustible materials

- FCC: typically very large units full of trays or structured packing
Treatment Options

Steam Only
Chemical Cleaning
Zyme-Flow Vapour-Phase
**Treatment Options – Steam Out**

- **Time/Resources**
  - Days to weeks
  - Secondary treatment required for $\text{H}_2\text{S}$ in sludge
  - Secondary treatment required for pyrophorics
  - Additional treatment for hardened scale
  - Large quantity of steam required

- **Safety**
  - Cannot guarantee complete $\text{H}_2\text{S}$ removal
  - Will not treat pyrophorics – become insulated and risk of fire increases

- **Environment**
  - Some harmful components can be released to atmosphere
  - Large energy consumption due to extended time needed
Treatment Options – Chemical Cleaning

Conventional oxidizers, solvents, surfactants, and scavengers

- **Time/Resources**
  - Long mob and de-mob time
  - Multiple treatments needed
  - Large quantity of water needed for circulation

- **Safety**
  - Not all chemicals treat H₂S and/or pyrophorics
  - Can be hazardous or exothermic
  - Exposure concerns

- **Environment**
  - High BOD/COD
  - Disposal concerns
Zyme-Flow UN657: safe oxidizer and surfactant blend

- **Time/Resources**
  - Vapour-Phase®
  - 12 hours or less
  - Minimum equipment footprint
  - No secondary treatment needed

- **Safety**
  - Non exothermic
  - Non reversible oxidation of H₂S and pyrophoric iron sulfide
  - No exposure concerns (MSDS 0,0,0)

- **Environment**
  - Wastewater friendly
  - Water based
Treatment Options – Zyme-Flow

- Effectively oxidizes pyrophoric iron sulfide
- Non hazardous and non exothermic

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<th>Chemical Type</th>
<th>Potassium permanganate</th>
<th>Zyme-Flow</th>
<th>Hydrogen Peroxide</th>
<th>Triazines</th>
<th>Terpenes</th>
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*Note: Always consult SDS sheets before using or handling any chemical.
Case Studies

Large Capacity FCC
**Challenge**
- Perform decon on FCC system processing 190k BPSD during scheduled turnaround
- Open unit as safe and fast as possible to turn over to maintenance

**Concern**
- High concentration of H₂S and pyrophorics
- Short timeframe

**Past Procedure**
- Multiple chemical treatments – concerns for wastewater
- Pyrophorics were also present upon opening – safety risk and extended time to treat

**Engineered Solution**
- Amine Unit – circulated with Zyme-Ox® Plus
- FCC pre-soak using Rezyd-X® and Zyme-Flow UN657
- Perform Vapour-Phase with Zyme-Flow UN657
- Flare drum – boil out with Rezyd-X and Zyme-Flow UN657
Tested clear for entry

- Zero $H_2S$
- Zero Benzene
- Zero LEL

Absolutely no issues with pyrophorics when tower was opened

Expressed that it was a significantly shorter timeframe and Zyme-Flow methodology would be used again

“...first time we opened the vessel without pyrophoric issues.”
Conclusion

- H₂S and pyrophoric iron sulfide neutralization are critical for clearing equipment for personnel entry and hot work
- Correct selection of chemistry and application can not only avoid an incident but also reduce time significantly
- Implications on effluent sent to wastewater should be evaluated carefully
- Planning is critical to ensure treatment success