Reducing FCC Turnaround Costs
Focus on Speed & Safety

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Agenda

- Brief company introduction
- Preparing FCC for entry; keys to success
  - Pre-T/A planning
  - Available methods
  - Proper testing
- Hydrogen sulfide (H_2S) & Pyrophoric iron sulfide (FeS)
  - Overview
  - Treatment and their effects on cost, safety, and environmental
- FCC Case Study
- Conclusion
- Q&A

Experienced Technical Leaders

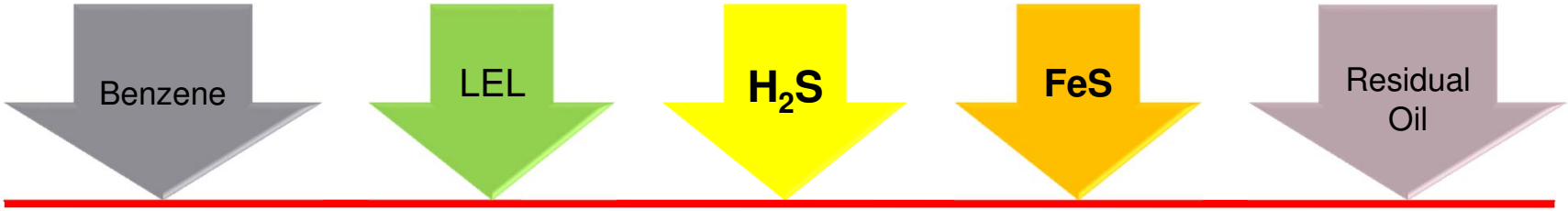
- Decontamination of process units for over 25 years
- Global presence – over 50 countries worldwide
- Zero recordable injuries in the history of the company
- 200+ refinery projects per year

Introduction – State of the Industry

- 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

Key Deliverables – Preparing Vessels

Making process units ready for vessel entry



Benzene	LEL	H_2S	FeS	Residual Oil
0 ppm	0%	0 ppm	Neutralized	Removed

FCC Overview

- 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

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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

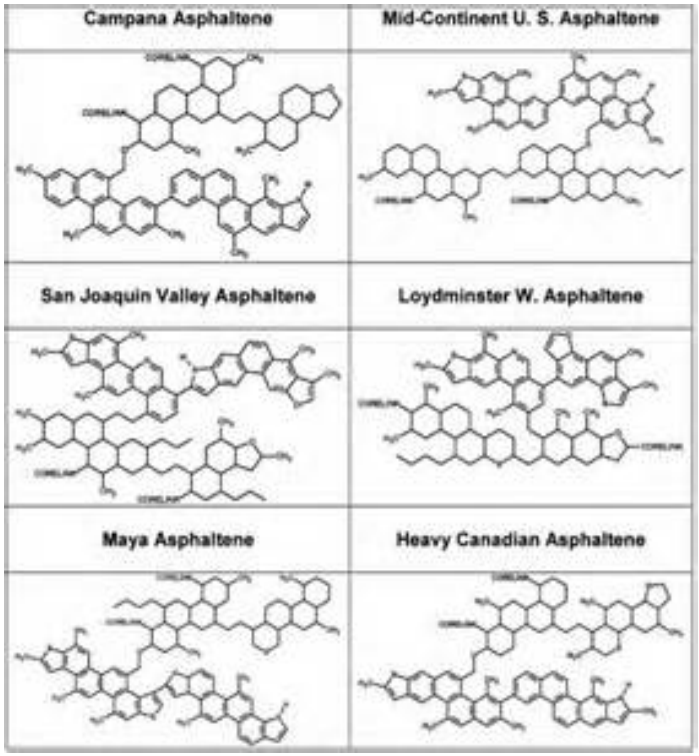
Crude Slate Changes

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 (H_2S)
Pyrophoric Iron Sulfide (FeS)

Overview

Concerns

High Risk Units

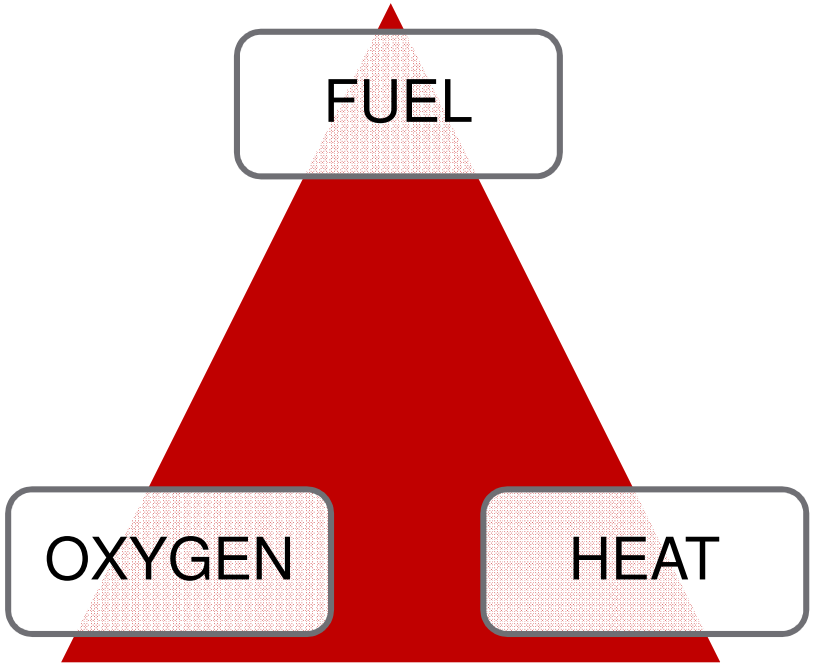
Treatment Methods

Hydrogen Sulfide (H_2S) 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_2S monitor should be used to prevent deadly exposure

Pyrophoric Iron Sulfide (FeS) Overview

- Deposits form during process operations when H_2S 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 SO_2 when exposed to air (white smoke)



Fire Triangle

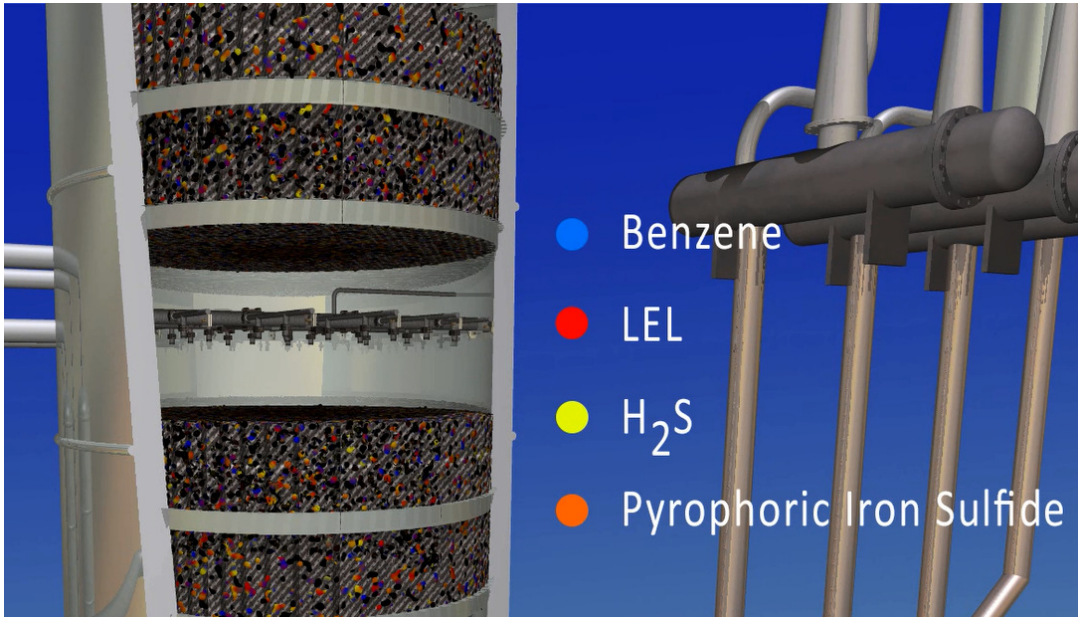
Pyrophoric Iron Sulfide (cont.)

- 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

Vacuum Tower

High Risk Units

- 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 H_2S in sludge
  - Secondary treatment required for pyrophorics
  - Additional treatment for hardened scale
  - Large quantity of steam required
- **Safety**
  - Cannot guarantee complete H_2S 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

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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 H_2S and/or pyrophorics
  - Can be hazardous or exothermic
  - Exposure concerns
- **Environment**
  - High BOD/COD
  - Disposal concerns

Treatment Options – Zyme-Flow

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 H_2S and pyrophoric iron sulfide
  - No exposure concerns (MSDS 0,0,0)
- **Environment**
  - Wastewater friendly
  - Water based

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Treatment Options – Zyme-Flow

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

Chemical	Potassium permanganate	**Zyme-Flow**	Hydrogen Peroxide	Triazines	Terpenes
Chemical Type	oxidizer	oxidizer/ surfactant	oxidizer	scavenger	solvent
Dangerous exotherm possible?	yes	no	yes	WILL NOT TREAT PYROPHORICS	WILL NOT TREAT PYROPHORICS
Dangerous gas emission possible?	yes	no	yes		
Dangerous residue possible?	yes	no	no		
Safe with light hydrocarbons?	no	yes	no		
pH restrictions?	yes	yes	no		
Create additional or hazardous sludge?	yes	no	no		
Penetration ability	Moderate	Excellent	Poor		
Secondary waste-treatment required?	yes	no	no		
Corrosive?	yes	no	yes		
Handling Hazards*	High	Low	High		

*Note: Always consult MSDS sheets before using or handling any chemical.

Case Studies

Large Capacity FCC

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Large Capacity FCC Case Study

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 H_2S 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

Large Capacity FCC Case Study

- 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

- H_2S 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

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Questions?

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