



# Modernizing a Vintage Cat Cracker

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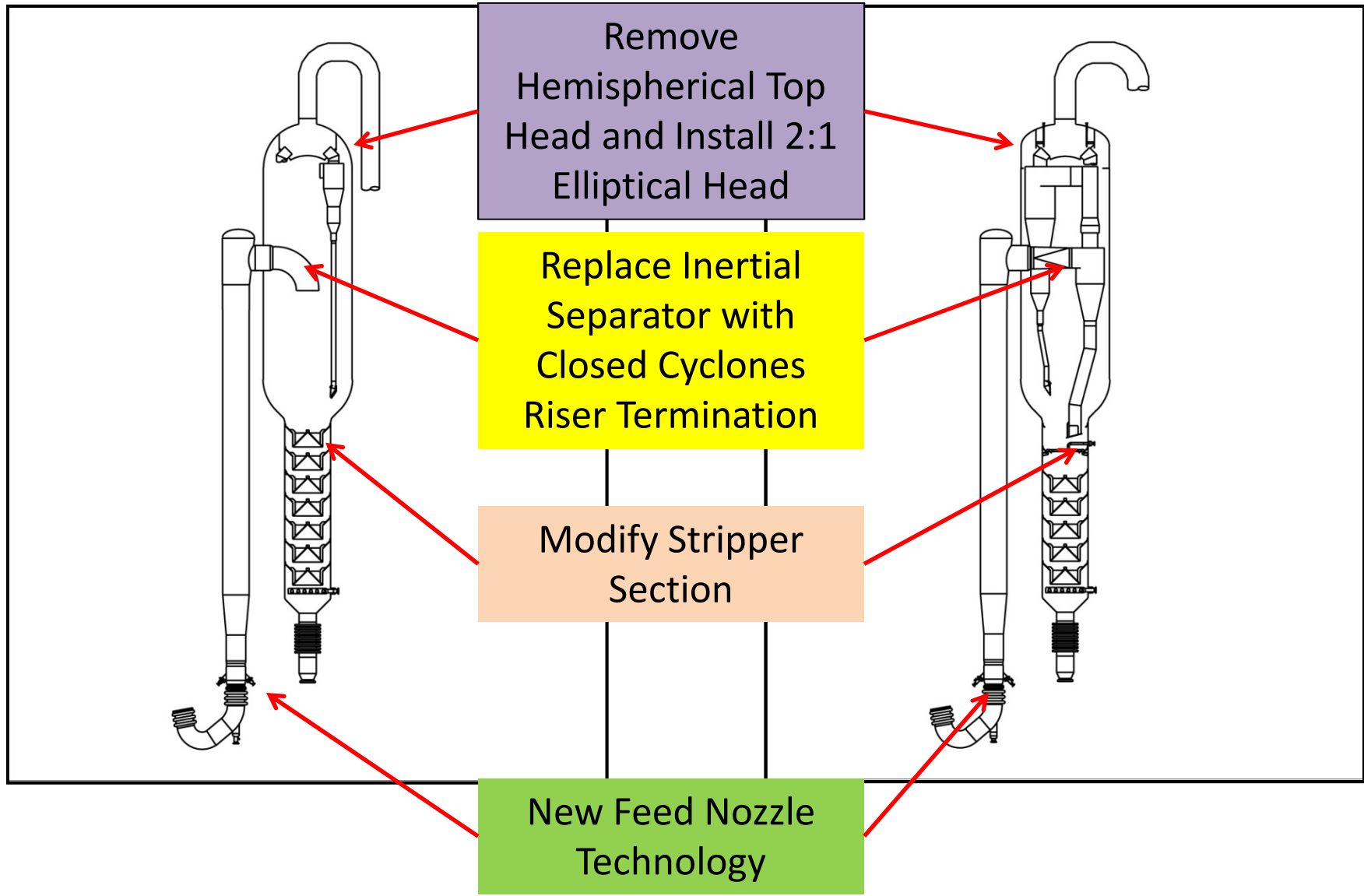
# El Dorado Refinery

- Refinery located in El Dorado, Kansas is one of the largest refineries in the Plain States and Rocky Mountains with a crude oil capacity of 150,000 Barrels per Stream Day (BPSD)
- The El Dorado refinery is a high-complexity Coker refinery with the ability to process significant volumes of heavy and sour crudes.
- The fully integrated refinery principal processing units consist of crude and vacuum distillation; hydrodesulphurization of naphtha, kerosene, diesel, and gasoil streams; isomerization; catalytic reforming; fluid catalytic cracking; alkylation; delayed coking; hydrogen production; and sulfur recovery.
- Refining operations began at the site in 1917.

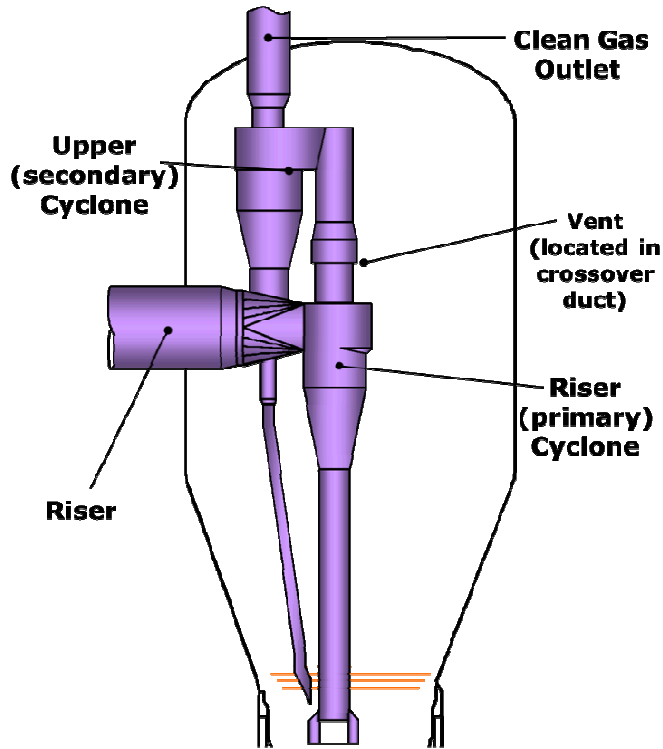
# FCC

- 42,000 BPSD Kellogg Model III design that came on-stream in 1949.
- 60+ years of operation, the unit has undergone several revamps and technology hardware modifications to increase the capacity from the original capacity to 15,400 BPSD to the current capacity.
- Revamp Goals
  - Minimize Dry Gas
  - Increase Liquid Yields
  - Improve Coke Selectivity

# Project Scope

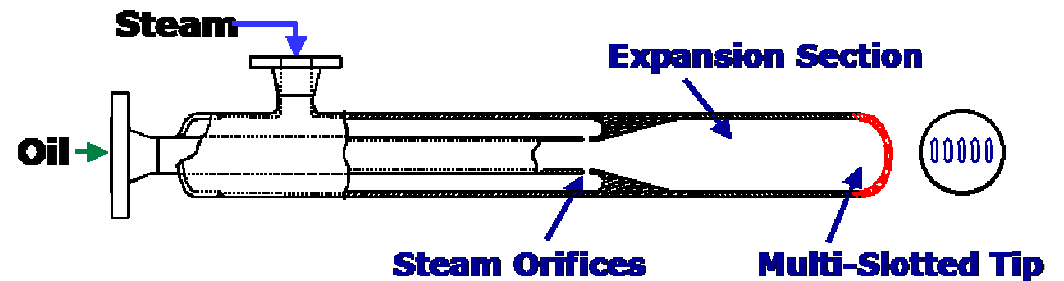


# Technology Description



## KBR Closed Cyclone™ System

- ◆ Minimize Post-Riser Cracking
- ◆ Minimize Dry Gas
- ◆ Increase Gasoline Yield
- ◆ Improve Coke Selectivity



## ATOMAX-2™ Feed Injection

- ◆ Smaller Droplets
- ◆ Flat Spray with Optimized Riser Coverage
- ◆ Easy to Install and Easy to remove

# Construction – Pre-turnaround / Turnaround Work

- Schedule
  - Start of Engineering – 26 months in advance of TA
  - Placing Cyclone order (Long lead) – 18 months before
  - Pre-shutdown construction – 6 months before
  - Oil-out / Oil-in – 28 days
- ◆ Determination of Construction Sequence
- ◆ Maximize Pre-shutdown construction work
  - ◆ Installation of Jig-stand for Old Reactor
  - ◆ Installation of new Cyclones on the Jig stand
  - ◆ Crane set-up

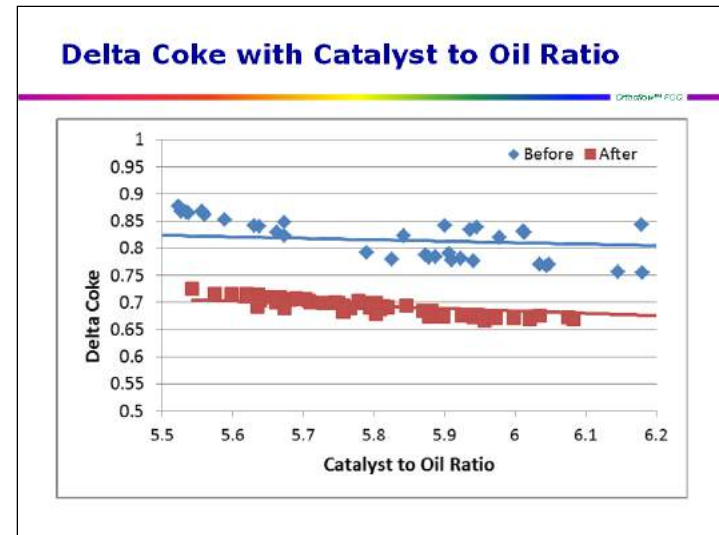
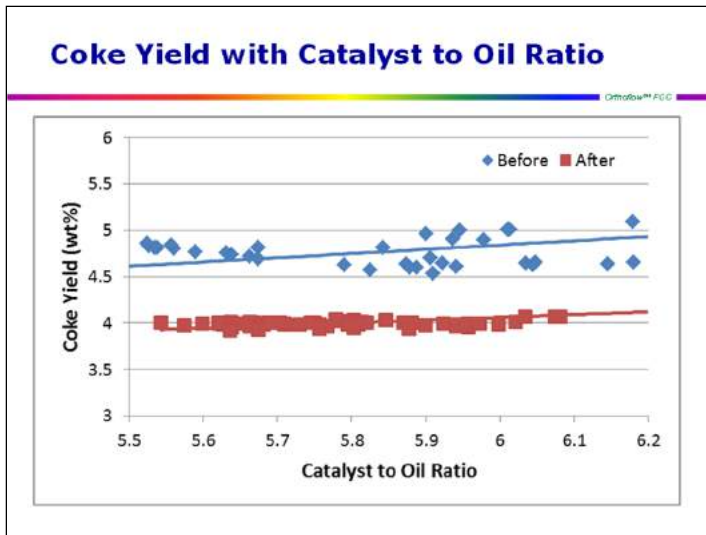
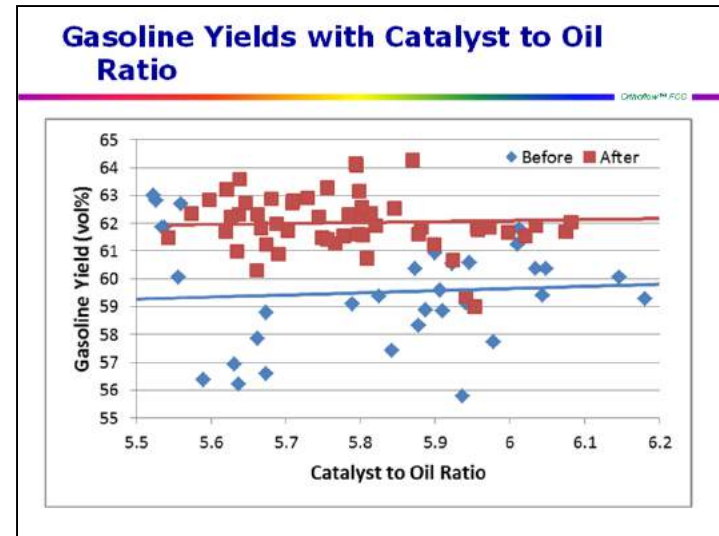
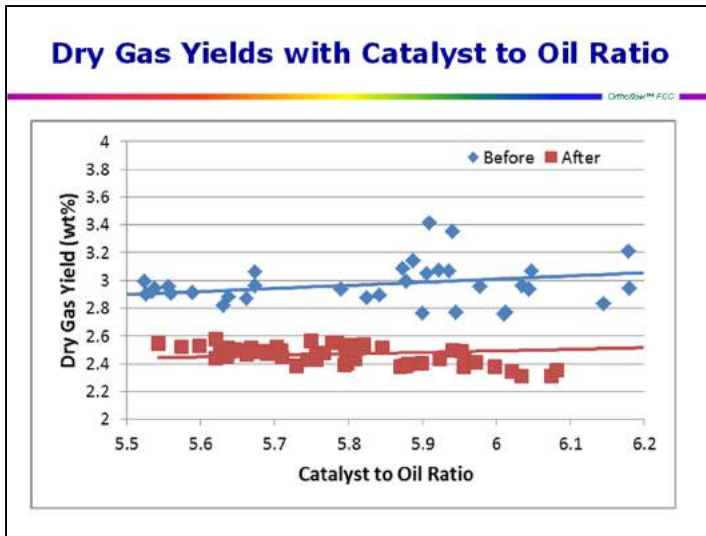


# Performance Comparison

<b>Reactor Yield Comparison</b>		
	<b>Before Revamp</b>	<b>After Revamp</b>
<b>Feed Rate, BPD</b>	41,900	41,500
<b>Feed API Gravity</b>	24.2	24.1
<b>Feed Conradson Carbon</b>	0.33	0.26
<b>Catalyst Activity</b>	73	77
<b>Zeolite / Matrix Ratio</b>	2.04	1.73
<b>Riser Outlet Temperature, °F (°C)</b>	980 (527)	980 (527)
<b>Regenerator Bed Temperature, °F (°C)</b>	1,310 (710)	1,287 (697)
<b>Catalyst to Oil Ratio</b>	5.8	5.8
<b>Dry Gas, wt%</b>	3.5	2.4
<b>C3+C4 LPG, vol%</b>	26.4	26.7
<b>Gasoline (C5 – 430°F D86), vol%</b>	59.9	61.8
<b>LCO (430°F – 670°F, D86), vol%</b>	20.3	20.6
<b>Slurry, vol%</b>	3.2	3.8
<b>Coke, wt%</b>	5.3	4.1
<b>Conversion, vol%</b>	76.5	75.6
<b>Delta Coke</b>	0.91	0.70



# Performance Comparison (Cont...)



# Project Economics

- Initial Project – Closed Cyclones™ only;  
Estimated 288 BPD increase in Liquid Products
- Feed Nozzle Upgrade - Estimated additional  
222 BPD increase in Liquid Products; no  
increase in turnaround duration
- Initial Payout Estimate – 1 year
- Actual Payout – 3 months

# Conclusion

- Proper planning, scheduling and selection of the right technology are the keys to success in any FCC unit revamp.
- FCC unit at the El Dorado refinery was successfully revamped with KBR Closed Cyclone™ Technology & ATOMAX-2™ Feed Nozzle Technology
- The turnaround and construction were completed on schedule due to proper planning and execution
- Revamped Unit yields exceeded initial estimates resulting in better gasoline and coke selectivity and lower dry gas
- The project was a financial success with a payout of three months