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Achieving On-stream Reliability At
TESORO'S Mandan FCC Unit
Presented by
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CatCracking.com
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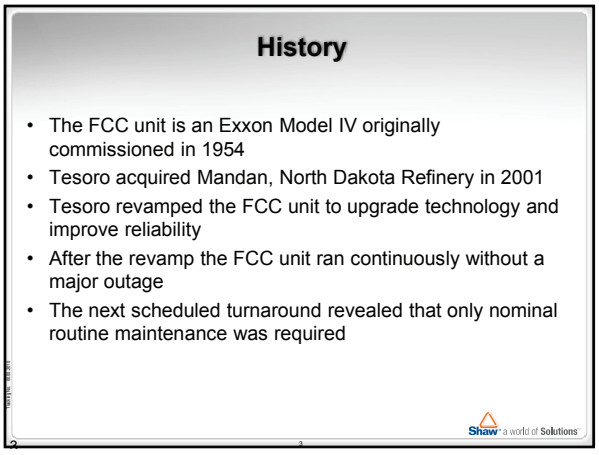
History
• The FCC unit is an Exxon Model IV originally commissioned in 1954
• Tesoro acquired Mandan, North Dakota Refinery in 2001
• Tesoro revamped the FCC unit to upgrade technology and improve reliability
• After the revamp the FCC unit ran continuously without a major outage
• The next scheduled turnaround revealed that only nominal routine maintenance was required
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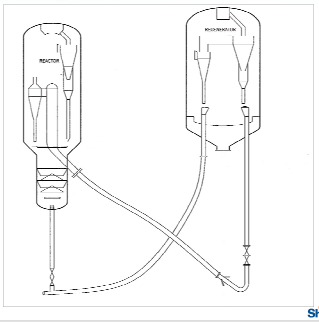
Unit Description (Pre-Revamp)

- Cat feed is reduced crude (no VDU)
- 23-26,000 bpsd feed
- 4 Bete nozzles (feed & HCO)
- Internal rough cut cyclone & quench
- Partial CO burn (5% CO) 1330-1360○ F

Original Design



Operating Issues

- Poor conversion, high dry gas and bottoms
- Slurry circuit fouling issues
- On-line maintenance difficult due to long, harsh winters
- FCC reliability impacts crude unit as both units are heat integrated

Revamp Objectives

- Improve conversion
- Minimize dry gas
- Maximize C3/C4 yields (summer)
- Maximize octane barrels
- Improve reliability to minimize unscheduled shutdowns
- Reduce routine maintenance

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Technology Upgrades

- New external vertical riser with longer residence time
- New Shaw feed injection nozzles
- New rough cut cyclone (external)
- Installed reactor vapor quench
- Longer catalyst stripper (more stages)

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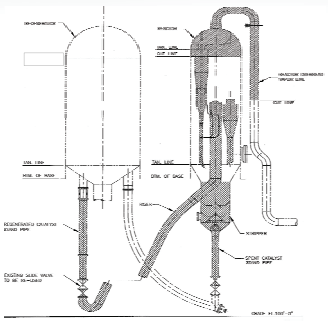
Demolition Plan



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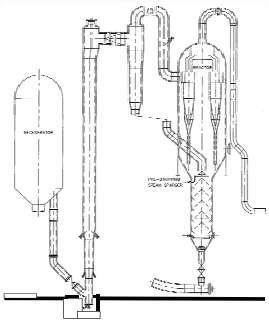
Revamped Unit



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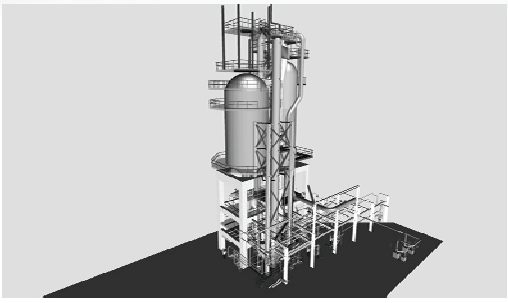
Revamped Unit



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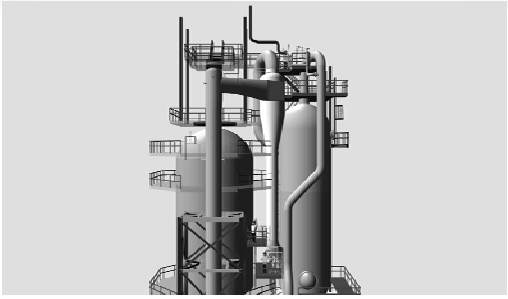
Revamped Unit



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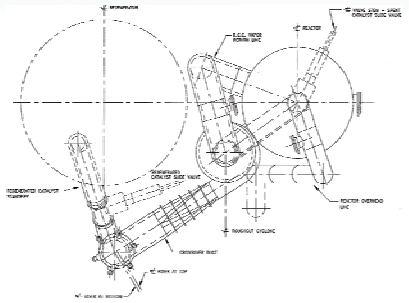
Layout of Revamped Unit



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Revamp Project Schedule

- Overall schedule – 14 months
- Basic engineering – 10 weeks
- Detail engineering started week 5
- Full project approval by week 15
- All equipment delivered within 12 months
- Turnaround duration 33 days (oil out to oil in)

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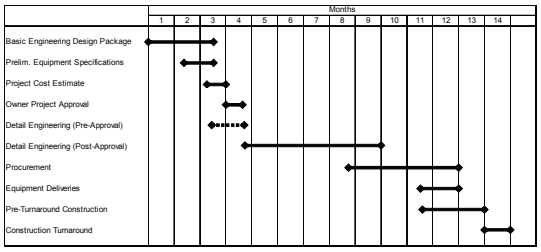
Revamp Project Schedule



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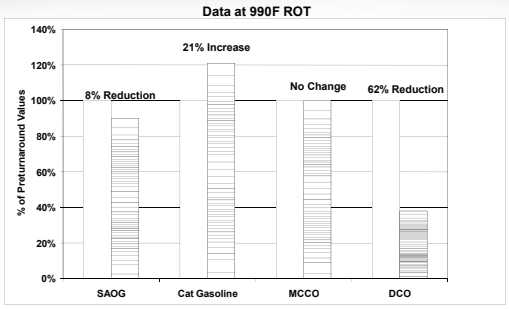
Revamp Construction Issues

- Needed “Fast-Track” to finish by winter
- Pre-turnaround construction
  - External riser
  - Rough cut cyclone
- Turnaround construction
  - Replaced reactor top head and secondary cyclones
  - Replaced stripper including new stages
- Duration 33 days – oil out to oil in

Pre and Post Revamp Data



Vapor Quench

- Required sealing
- 7% reduction in dry gas
- Regenerator temperature dropped 16○ F
- Helped cool reactor overhead line & main column bottoms

Additional Improvements

- Slurry gravity 18 API → 0 API
- Liquid yield up 3.3 vol%
- On-stream maintenance of slurry pumps and exchangers dramatically reduced
- More slide valve Δ P, smoother operation
- Easier startup (hours versus 1½ days)

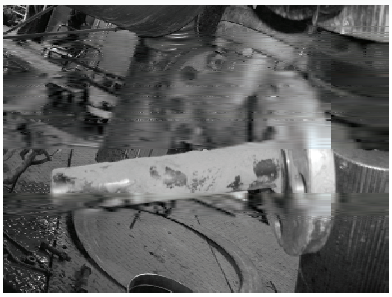
Unscheduled Outages Avoided

- Blockage around spent cat trash guard cleared by a controlled reversal pulse of the spent cat standpipe
- No prolonged outage/thermal cycle occurred until the regularly scheduled maintenance turnaround

Turnaround Repairs Minimal

- Reactor secondary cyclone repair
- Refractory damage in cross-over duct from rough-cut cyclone to reactor
- Typical coke deposits on reactor wall, roof of secondary cyclones and on backside of secondary cyclone gas tube
- Minimal repairs to feed injectors, some injector tips starting to show wear
- Turnaround period and subsequent startup went smoothly

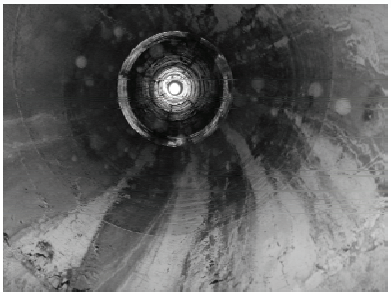
Feed Injector Target Bolt Inspection



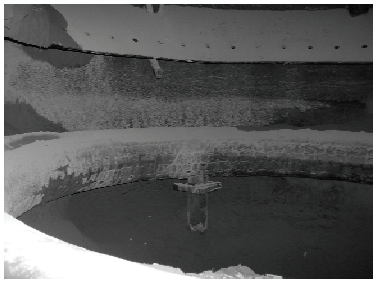
Feed Injector Orifice

Feed Injector Tip Inspection

Riser – Looking Down to Feed Injectors



Stripper - Bottom Baffle and Steam Ring



Rough-Cut Cyclone Dipleg Outlet

Key Factors for On-Stream Reliability

- Proper design and installation of new components for anticipated throughput and operating conditions
- Maintaining throughput and operating conditions within the design parameters
- Proper design/specification, and installation of refractory materials and anchoring systems
- Minimizing thermal cycles by avoiding unnecessary outages
- Proper on-stream maintenance
- Maintaining well-trained, experienced operating personnel

Conclusion

- A Model IV was easily revamped to significantly improve conversion and yield selectivity (21% more gasoline)
- A fast track project (14 months) was achieved utilizing licensor/contractor single point responsibility
- Revamp downtime was reduced by maximizing pre-turnaround activities (33 days oil out to oil in)
- On-stream reliability was successfully achieved by making the proper process, mechanical, and operational improvements
- Minimizing unscheduled outages reduced the need for repairs to only routine maintenance during the next scheduled turnaround

Any Questions?

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