Axens CCR Reforming Technology
Octanizing & Aromizing

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Axens CCR Technology - Contents

- Introduction
- Technology
  - Catalyst Circulation
    - Side-by-Side Reactors Arrangement
  - Catalyst Regeneration
    - RegenC2 Regenerator
- New Generation of Catalysts
- Industrial Feedback
- Axens Technical Support
- Conclusion
What Future for CCR Reformers?

Refining

- Increasing $H_2$ demand for HDT units
- High and continuous $H_2$ production requirement
- Replace Octane loss due to FCC gasoline HDS

Octanizing process

Petrochemicals

- Steady increase in demand for aromatics
- High severity requires CCR

Aromizing process + ParamaX
CCR in the Naphtha Processing Block

SRN
Coker N
HDT N

NHT
LN

ISOM

Gasoline Pool

HCHN

CCR
HN

90+

50+

40+

FCCN, Alkylate, Ethers, …
Reactor Design

Simple and cost-effective concept:
• design optimized for process conditions
• simple internals, low stress
• flexible for increased capacity

High capacity:
• unconstrained reactor design, no compromise on design criteria
• thermal expansion is easily managed

Side by Side reactors arrangement:
the higher the capacity, the greater the advantage
Simple and cost-effective concept:
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Side by Side reactors arrangement:
the higher the capacity, the greater the advantage
Safety by Design: Fully Automated Cat Flow, ESD & Transfer Valves

- Normally Open Gas Tight ESD Valves
- Auto Cycling Gas Tight (2) & Catalyst Tight (2) Valves
- Upper Surge Drum
- “Mild” Service Lock Hopper
- Reactors (R1, R2, R3, R4)
- Elutriator
- Reduction Chamber
- Nitrogen lifts isolate Regen & Rxn HC
- Lower Hopper
- Lift Pot
- Regenerator
Side-by-Side Arrangement

- **Low Structure**
  - 3 or 4 reactors

- **Easy access to reactors**

- **Short, hot transfer lines to heaters**

- **Axens**
  - Regen 150 ft
  - R1/R2/R3

- **Less mechanical stress**

- **Competitor**
  - Red. R1
  - Regen

- **Side-by-Side**

- **Stack**

CC.3- Axens Octanizing CCR, IMF 9/09
Reactors & heaters layout:
- Low, short, hot transfer lines
- Simple layout & construction
- Low thermal stress
Regenerator Section: RegenC-2

Clean Vent Gas

Dry Combustion Gas

Primary Burn

2 controlled burning steps

Primary Burn

Finishing Burn

Optimum catalyst “protection”

Chloriding Agent + water

Optimum Chlorine Management

Dry Burn Loop

Calcination

Dry Burn Loop

Oxychlorination Calcination Gas

Regenerated Catalyst

Air

Air

Oxychlorination Gas
## Catalyst Life & Attrition

<table>
<thead>
<tr>
<th>Location</th>
<th>Application*</th>
<th>Catalyst Life, yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>Gasoline</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>RON 102</td>
<td></td>
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<tr>
<td>Southeast Asia</td>
<td>BTX</td>
<td>7</td>
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<tr>
<td></td>
<td>RON 102-103</td>
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</table>

* *units operating at or above design severity*

**LOW attrition: 1-2% / yr ~ 0.010-0.015% of cat circ.**
New CCR Reforming Catalysts: A Step Out Portfolio

“Yields are head and shoulders above other catalysts” customer comment

**High density catalysts**

- **CR 601**
- **CR 607**
  - Gasoline mode ⇒ Low Pt content
- **AR 701**
- **AR 707**
  - BTX mode ⇒ High Pt content

**Low density catalysts**

- **CR 702/712** *
- **CR 617**
  - Tuned for non-Axens units

Pressure:

- **44** (psig) 88 (bar) 176 (psig)
- **3** 6 12

* Pt-Sn only
• Improved Alumina Carrier
  • Greater hydrothermal stability & strength
  • Lower fines and better chlorine retention
• Improved, Patented Impregnation Method
  • Optimized Pt loading
• New Patented Catalysts: Pt-Sn + Promoters
  • 0.8 - 1.5 w% higher C₅+ Yield
  • 0.1+ w% higher H₂ Yield
• High & Low Density for Axens & Other Units
• Commercially Proven
Axens Catalyst in Competitor’s Unit: Fines Production & Chlorine Retention

The best mechanical resistance and chlorine retention

<table>
<thead>
<tr>
<th>Non Axens catalyst</th>
<th>AXENS catalyst</th>
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<th>AXENS catalyst</th>
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<tbody>
<tr>
<td>Fines: 0.13% CCR</td>
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<td>Fines: 0.07% CCR</td>
</tr>
<tr>
<td>CCR: Base</td>
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</table>

Fines in % CCR

First make-up after 800 days of operation

Chloride Injection, % CCR

Days in operation
Third Party Testing of CR 617 & CR 702 and Competitor’s Catalyst

Duplicate tests to confirm ‘step out’ performance

**New CR617: 1%+ better C5+**

**New CR617: 0.1%+ better H2**

Medium pressure CCR, RON = 100
• Long Term Technical Assistance:
  • Performance analysis on site and from home offices
  • Catalyst follow up and analysis
  • Hot line assistance

• Software Tools
  • Catformax: predictive model for CCR Reformer
  • OTS: Operator Training Simulator
  • POS: Process Optimization Simulator
  • APC: Advance Process Control
  • Performance tracking tools
Axens’ CCR Technology: Conclusion

- Simple design with easy access
- Superior regen for long cat life, low attrition
- Breakthrough new promoted catalysts
- Comprehensive & proactive technical service

- Increasing market share: >50% over last 5 yrs
- 35 awards since January 2005
  - 10 customers already operating other CCR tech.
  - 5 customers already operating each technology
  - 10 Aromatics complexes with Aromizing CCR
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