Online, Non-intrusive Trouble Shooting and Process Characterization of FCCU's using Gamma Ray and Tracer Technology

Presented by:
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Presentation Format

- Introduction to Tracerco Process Diagnostics™
- The Technology
- Applications of the Technology for FCC Diagnostics
- Case Studies
- Conclusion and Questions
Tracerco, who are we?

Tracerco: Part of Johnson Matthey Plc …leaders in environmental catalytic solutions, precious metals and process technology

- Founded in London almost 200 years ago
- Publicly listed FTSE 100 Company
- Turnover excess $10bn
- 10,000 employees in 50 countries
Tracerco – Markets Served

Upstream Oil & Gas - Reservoir to Refinery

- Separator Studies
- Flow Assurance
- Pig Tracking
- Integrity Assessment
- Flow Rate Studies

Downstream Industry – Refineries to Polymers

- Distillation Column Studies
- Reactor system trouble shooting & vessel inspection
- Heat Exchanger Leak Test
- FCC Unit Studies
- Flow Assurance
- Integrity Assessment
- Pipeline Assurance
Tracerco – Global Support

World leading technology specialists in radioisotope technology, chemical tracers, measurement & instrumentation

R&D Centre at HQ plus science institutes worldwide

350+ qualified scientists, engineers and technologists

Winner Queen’s Award for Enterprise: Innovation 2003 and 2009

Winner Queen’s Award for Enterprise: International Trade 2005

ISO 9001:2000 certified

SCC 2006 certified

HQ - Billingham, UK, Aberdeen (Scotland)
Argentina – Buenos Aires
Australia – Perth
Azerbaijan – Baku
Brazil – Rio de Janeiro
Belgium – Brussels
Canada – Sarnia, ON; Edmonton, AB
Germany – Oldenburg
Indonesia – Jakarta
Italy – Vaprio d’Adda (MI)
Malaysia – Kuala Lumpur
Netherlands – Rotterdam
Norway – Bergen
Singapore
Thailand – Bangkok
USA – Pasadena, TX; Corpus Christi, TX; Fresno, CA; West Valley City, UT; Merrillville, IN; Newark, DE; Baton Rouge, LA
Pioneers in radioisotope science…

- Provide diagnostic scanning technology, tracer services, and specialist nucleonic instrumentation to the Oil, Gas and Process Industries to enhance process plant performance.
- Experts at seeing inside process plant to verify real time process conditions and equipment integrity - Online and non-intrusive: *Insight Onsite*
The Technology – Gamma Ray Scan

• **Gamma Scanning** using sources and detectors to non-intrusively scan through vessels and pipelines to obtain accurate density/integrity measurements.

\[ I = I_0 e^{-\mu \rho x} \]
The Technology – Tracer Injection

- **Tracer Injection** using Unsealed Isotopes for tracking the different phases present in a particular process

- Gas, liquid, or solid form (individually measure hydrocarbon, steam and catalyst)
- Follows process material into which it is injected
- Monitored by externally mounted detectors
- Process parameters can be measured

Applications:
- Flow Rate Measurements
- Distribution Studies
- Residence Times
- Leak Detection / Bypassing
- Carryover
- FCCU Efficiency Studies
Improving profitability, increasing yields and reducing downtime are all key parameters for any FCCU. **Tracerco Diagnostic Solutions** are the only techniques available to effectively ‘look inside’ a working FCCU to accurately measure:

- feed and catalyst distribution in the riser feed zone
- catalyst and vapour traffic velocities and slip through the riser
- determination of efficiency of the riser termination device
- flow distribution through the reactor and stripper
- cyclone distribution/operating characteristics
- reactor/stripper residence times
Applications of the Technology – FCCU’s

Technology used in 5 key sections of FCC unit:

- Riser
- Disengagement Chamber
- Stripper
- Regenerator
- Stand-pipe
Applications of the Technology – FCCU’s

• **When is the technology used?**
  • Trouble-shooting exercises
    • Fast response
  • Process optimisation trials
    • Immediate results
  • Pre-shutdown investigations
    • No effect on process
  • Commissioning trials
Benefits

- Minimise shut down time
- Increase production capacity
- Reduce operating costs
  - Minimise raw materials
  - Reduce utilities
  - Identify catalyst losses
Applications – Riser Study

- Catalyst Density Profile
- Coke Deposits
- Velocity - slip ratios
- Residence times
- Distribution of feed, steam & catalyst
Applications – Cyclones and Disengagement Chamber

- Residence times
- Distribution
- Cyclone blockages
- Cyclone efficiency
- Vapour underflow
- Carryover
Applications – Stripper Section

- Residence times
- Velocities
- Distribution
- Steam underflow
- Catalyst Bed Level
- Dip-Leg Catalyst Levels
Applications – Regenerator and Stand Pipe

- Air distribution
- Cyclone efficiency
- Catalyst distribution
- Carryover

- Stratification of catalyst
- Slugging
- Catalyst Flow Patterns
- Catalyst Density Profiles
CFD vs Real time data

Staggered ring

Relocate inner ring to BTL

Relocate middle and inner ring to BTL
• Three different operating levels of the Regenerator

• Gamma Scan at each condition to optimize the bed level and reduce catalyst carryover.
Case Studies – Scan of Internal Cyclones to locate Blocked Cyclone

- Plugged Cyclone Dipleg
- Bracing
- Manway
- Flapper Valve
- Catalyst

External Lining
Case Studies – Scan of Internal Cyclones to locate Blocked Cyclone – example 2

- Cyclone A was blocked.
- The blockage commenced at elevation 500mm, in the narrow part of the cyclone, but the catalyst had backed up to elevation 6300mm.
- Above elevation 6300mm, the blockage cleared and the scan profile from that point upwards is identical to that of Cyclone B.
Case Studies – Catalyst Distribution in Riser
Case Studies (Tracer) - RTD Maldistribution

TRACERCO Diagnostics FCCU Study
RTD Vapour Inlet Distribution

Radiation Intensity

Time (seconds)

Pick-up from Overheads Line
Case Studies (Tracer) – Vapour Underflow

TRACERCO Diagnostics FCCU Study
RTD Dip-leg Vapour Distribution

- Pick-up from Overheads Line
- Vapour Returning up Disengagement Chamber with Stripping Steam
- Vapour Underflow Response

Radiation Intensity vs. Time (seconds)

RTD1 Dipleg Top
RTD2 Dipleg Top
RTD3 Dipleg Top
Overheads 2 (2nd Y-axis)
Case Studies (Tracer) – Cyclone Blockage

Results from distribution study
Case Studies (Tracer) – Stripper Maldistribution

Gross maldistribution

East/West maldistribution

East side maldistribution
Case Studies – Stripper Upgrade

BP Baffles

Structured Packing
TRACERCO Diagnostics FCCU Study
Stripping Steam Distribution

Before

Time (seconds)

Radiation Intensity

0 200 400 600 800 1000 1200

30 32 34 36 38 40 42 44 46 48 50

Stripper Top N
Stripper Top E
Stripper Top S
Stripper Top W
TRACERCO Diagnostics FCCU Study
Stripper Steam Distribution - Top

After

Radiation Intensity

Time (seconds)

Stripper Top N  Stripper Top E  Stripper Top S  Stripper Top W  Strip Steam In
Case Studies – Effectiveness of Equipment Upgrades (e.g. RTD’s)
Case Studies (Tracer) – Vapour Maldistribution in Dip Legs

Vapour Distribution in RTD Dip-Legs

<table>
<thead>
<tr>
<th>Detector</th>
<th>Distribution</th>
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<tbody>
<tr>
<td>Dip-Leg Bottom North</td>
<td>40%</td>
</tr>
<tr>
<td>Dip Leg Bottom South</td>
<td>60%</td>
</tr>
</tbody>
</table>
Case Studies (Tracer) – Vapour Distribution Above Air Grids

FCC Regenerator Air Grid Distribution

<table>
<thead>
<tr>
<th>Position</th>
<th>Percent Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air 1</td>
<td>14.4%</td>
</tr>
<tr>
<td>Air 2</td>
<td>13.4%</td>
</tr>
<tr>
<td>Air 3</td>
<td>4.0%</td>
</tr>
<tr>
<td>Air 4</td>
<td>6.0%</td>
</tr>
<tr>
<td>Air 5</td>
<td>10.5%</td>
</tr>
<tr>
<td>Air 6</td>
<td>5.3%</td>
</tr>
<tr>
<td>Air 7</td>
<td>7.4%</td>
</tr>
<tr>
<td>Air 8</td>
<td>10.6%</td>
</tr>
<tr>
<td>Air 9</td>
<td>5.3%</td>
</tr>
<tr>
<td>Air 10</td>
<td>10.0%</td>
</tr>
<tr>
<td>Air 11</td>
<td>5.8%</td>
</tr>
<tr>
<td>Air 12</td>
<td>7.3%</td>
</tr>
</tbody>
</table>
Case Studies (Tracer) – Vapour Distribution Cyclone Inlets

FCC Regenerator Cyclone Distribution
Lower Air Grid Injection

<table>
<thead>
<tr>
<th>Position</th>
<th>Percent Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Cyclone</td>
<td>12.3%</td>
</tr>
<tr>
<td>NE Cyclone</td>
<td>14.9%</td>
</tr>
<tr>
<td>E Cyclone</td>
<td>12.7%</td>
</tr>
<tr>
<td>SE Cyclone</td>
<td>10.9%</td>
</tr>
<tr>
<td>S Cyclone</td>
<td>12.5%</td>
</tr>
<tr>
<td>SW Cyclone</td>
<td>13.2%</td>
</tr>
<tr>
<td>W Cyclone</td>
<td>10.7%</td>
</tr>
<tr>
<td>NW Cyclone</td>
<td>12.7%</td>
</tr>
</tbody>
</table>

Example of Tracer Results - (Link to animation)
Conclusion

• Scanning and Tracer injection/detection are the only techniques that allow you to effectively ‘look inside’ your FCCU whilst in normal operating conditions.

• The perfect technology to:
  • Troubleshoot operating problems
  • Carry out a Process Optimisation Study
  • Plan a Turnaround more efficiently
  • Carry out a ‘baseline’ study of the unit during Commissioning or after a Turnaround
  • Measure Efficiency gains after a Retrofit

• CFD modelling has limitations. Tracerco measurement data can be used to complement/enhance CFD modelling for more accurate analysis.

Thank you and any Questions?

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