A large gulf coast refiner had a history of coke buildup in the Wash Bed of their Vacuum Column during the course of a run cycle. The Wash Bed consisted of several layers of structured packing on top of several layers of grid packing. Historically, the coke would accumulate in the bottom layer of structured packing, right at the interface of the grid packing.

In an effort to try to better track and understand the coking process in the Vacuum Column Wash Bed, Tracerco was asked to perform numerous TRACERCO Diagnostics™ ThruVision Scans at various times during the run cycle.

A TRACERCO Diagnostics™ ThruVision Scan (Computer-Aided Tomography Scan) is a horizontal scan that generates cross-sectional density profiles inside a process vessel. The process vessel can be a packed distillation column or a fluidized catalyst riser or standpipe where flow distribution of the process fluids is vital to performance. In this case, it was desired to measure the cross-sectional

Figure 8 - Initial Baseline TRACERCO Diagnostics™ ThruVision Scan – April 2004

Using TRACERCO Diagnostics™ ThruVision Scans to Monitor Coke Buildup in a Vacuum Column Wash Bed

By William Mixon – Baton Rouge, Louisiana, USA
Exchanger Leak Testing Without Tracers
By Barry Firby and Chris Spenceley – Billingham, Cleveland, UK

A recent call from a customer requested Tracerco to perform a leak test on six intercooler exchangers. One or more were suspected of leaking cracked process gas into the cooling water. When asked to perform a leak test of exchangers, the Tracerco Project Manager almost invariably thought of an unsealed radiotracer technique. In planning the use of a radiotracer, consideration must be given to its acquisition and transportation, its ultimate fate within the industrial process, and obtaining permission from regulatory authorities. This can lead to significant delays, resulting in operational and financial burdens on the customer, particularly if the facility is located in a remote area or a country where Tracerco does not have offices.

Tracerco prides itself in supplying excellence to the customer and therefore any means by which delays in responding can be avoided leads to better service delivery. Although the use of radioactive tracers for carrying out leak tests on heat exchangers is a valuable, well used and successful technique there are times when equally valuable results can be obtained using a sealed source technique. A situation where this applies is when a significant density change occurs because of the leak.

Case Study
The system shown schematically in Figure 12 was one of six intercoolers in a cracked process gas compressor train. The process gas pressure was higher than the closed circuit cooling water. In the cooling water circuit there was a buffer drum at the suction of the recirculation pumps. The drum had a nitrogen blanket and was fitted with a relief valve. The relief valve was found to be opening to atmosphere. Analysis of this vented gas showed it to contain cracked gas. To minimize maintenance effort and shutdown time, the customer needed to know which of the six intercoolers was leaking.

The traditional way to carry out a leakage test on this type of system would be to inject gaseous radiotracer into the high pressure process gas side and to deploy sensitive radiation detectors at strategic positions on the low pressure cooling water side. Since this plant was in a remote area where Tracerco does not have an office nearby, this would have involved the importation of the radiotracer into the country following the slow process of obtaining necessary legislative approval to carry out an unsealed radioactive tracer study. The customer needed to know quickly which of their exchangers was leaking.

The innovative solution was to use the hypothesis that if cracked process gas was leaking into cooling water, then it would have the effect of reducing the density of the water immediately downstream of the leaking intercooler. If the density in the cooling water line from each exchanger could be measured non-intrusively then the leaking exchanger could be identified.

Fortunately, sealed radioactive sources were present in the country within a storage facility set up by the Tracerco representative company. It was therefore possible to quickly mobilize a crew to the plant site. The crew used the TRACERCO Diagnostics™ Pipe study scanning technique to measure the density of the material in the cooling water exit line of each intercooler and determine which one was leaking.

Measurement of radiation intensity passing through the cooling water inlet and exit pipes was measured at the indicated location for each exchanger.

The amount of aeration detected in the cooling water exit lines from the six exchangers is shown below:

<table>
<thead>
<tr>
<th>EXCHANGER</th>
<th>% GAS IN COOLING WATER EXIT LINE</th>
<th>CONCLUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>NOT LEAKING</td>
</tr>
<tr>
<td>B</td>
<td>9.6</td>
<td>LEAKING</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>NOT LEAKING</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>NOT LEAKING</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>NOT LEAKING</td>
</tr>
<tr>
<td>F</td>
<td>4.6</td>
<td>LEAKING</td>
</tr>
</tbody>
</table>

The test showed that exchangers B and F were leaking. This work was carried out in a matter of a few days, instead of the weeks of planning and preparation that would have been required for a traditional radiotracer leak test in this particular country.

Creative thinking allowed Tracerco personnel to respond quickly to identify the leaking intercoolers and significantly reduce the customer’s operational and financial burden.

In this case, the variations within the pipes, such as welds, etc., reduced the sensitivity to a leak rate limit of detection of 2.8% of the gas in liquid.

Conclusion
The test showed that exchangers B and F were leaking. This work was carried out in a matter of a few days, instead of the weeks of planning and preparation that would have been required for a traditional radiotracer leak test in this particular country.

Creative thinking allowed Tracerco personnel to respond quickly to identify the leaking intercoolers and significantly reduce the customer’s operational and financial burden.
Hydrotreating Units
(Continued from page 1)

amount of radiotracer will leak into the effluent side of the exchanger(s). Radiation detectors mounted on the effluent exits of each exchanger will respond to the radiotracers that leak into the effluent stream.

Case Study 1 – Feed Effluent Leak Study

A refinery engineer believed he had a leak in one of the two feed/effluent exchangers in his hydrotreating unit. He wanted to confirm this and determine which one was leaking so he could reduce the maintenance costs and lost production associated with searching for the leak. He asked Tracerco to perform an online TRACERCO Diagnostics™ Leak study.

Figure 2 shows the positioning of the detectors for the leak test. Detectors mounted on the outside of the pipes will detect the radiotracer as it passes through.

If radiotracer leaks into the effluent side, the detectors mounted on the effluent lines will respond to the radiotracer. However, the leak detectors on the effluent line can produce false responses from the radiotracer in the feed side of the exchangers.

To differentiate the responses, a second leak detector is mounted next to the primary leak detector.

A lead brick is positioned between the secondary detector and the effluent pipe. If radiotracer passes through the effluent line, the primary detector will respond, but the response of the secondary detector will be smaller or non-existent, due to the lead brick absorbing the radiation. If both the primary and the secondary leak detectors produce similar responses, the signal is from pickup of the main body of radiotracer in the feed side.

In Figure 3, the passage of the main body of radiotracer through the feed side of the B exchanger is shown by the response of the red and green detectors. The primary leak detector (blue) also showed a response. Yet, the secondary leak detector (black) did not show a response. This indicates that the response of the blue detector was due to radiotracer in the effluent line caused by a leak in the B exchanger. The area under the response of the blue detector was compared to the area under the responses of the red and green detectors. The leak response was determined to be approximately 2.5% of either of the feed responses.

The refinery personnel were pleased to hear that the source of the sulfur was a leaking exchanger and to know which exchanger to repair. They took a short outage to repair the leak. When they restarted the plant, the sulfur levels were back to normal.

TRACERCO Diagnostics™ Distribution study of Reactor

Whenever the efficiency of a hydrotreating unit diminishes, concern builds for problems with the internals or the catalyst in the reactor. Problems with the reactor are expensive to repair. The most common problem with the reactor is poor distribution of the feed to the catalyst bed. Tracerco has designed techniques that will measure this distribution.

A secondary event that occurs, during the leak testing of the feed/effluent exchangers in a hydrotreating unit, is the deposition of the brominated hydrocarbon onto the catalyst bed. It turns out that hydrotreating catalyst has a strong affinity for bromine atoms. Therefore, the radiotracer will not pass through the bed with the liquid. Very important though, the pattern of the absorption of the radiotracer is indicative of the

Figure 1 - A “Simple Hydrotreater Unit” illustrates an injection example used for a TRACERCO Diagnostics™ Distribution study. A sample valve is located upstream of the Reactor and a liquid tracer injection is performed. Detectors can be placed on the effluent stream, downstream of the exchangers where a leak response will be identified.

Figure 2 - Detector placement used for a leak test performed on feed/effluent exchangers.

Figure 3 - A leak was indicated from the “blue” detector response found in Exchanger B. The main body of radiotracer through the feed side of the B exchanger is shown by the red and green detector response curves. A comparison of areas under the red, green and blue plot results indicated that approximately a 2.5% leak was detected.

Continued on page 4
Hydrotreating Units
(Continued from page 3)

distribution of the liquid. A typical hydrotreater set-up for a TRACERCO Diagnostics™ Distribution study scan is illustrated on page 1.

The performance of a leak test or a TRACERCO Diagnostics™ Distribution study does not damage the catalyst or affect production. First, only about 5 grams of the brominated hydrocarbon is used. Second, the absorption of the bromine onto the catalyst is temporary. In 36 to 72 hours, depending on the height of the bed and the liquid flow, the tracer will migrate through the bed and exit the reactor diluted in the product diesel.

Case Study 2 – TRACERCO Diagnostics™ Distribution Study Scan

A refinery with two hydrotreater trains was experiencing poor performance from one of the trains. The operations engineer hoped he had a leak in one of the exchangers, but he was concerned that there might be a problem with the reactor. He asked that Tracerco perform a leak test of the exchangers, and that a TRACERCO Diagnostics™ Distribution study scan be performed as well. To be sure of the conclusions, he asked that a scan be performed on the better performing reactor as well.

The leak test of the feed/effluent exchangers was negative for any leak greater than 0.2% of the feed flow. This was the limit of detectability for this system using external detectors. Even if a smaller leak existed, it would not have accounted for the poor performance of the unit.

After completing the leak test, the TRACERCO Diagnostics™ Distribution study scan data was collected. The method requires the use of a detector and the electronics used to perform a gamma scan, but not the radiation source. The detector was positioned near the north position (15 degrees). Normally, the first position is 0 degrees, but a manway was positioned there, so all the scans were shifted 15 degrees.

Data was collected from the top tangent line down to a point in the bed where the radiation readings were consistent with background. This reactor’s diameter dictated that a total of 12 scans be performed. Smaller diameter vessels may require only 8 or 10 scans.

The results of the poorly distributed reactor scans are presented two ways in Figures 4 and 5. Figure 4 shows an elevation plot of gamma scan data, with distance from the top tangent line on the X-axis and radiation intensity on the Y-axis. In this type of plot, the gamma scan profiles are compared to see if they are consistent in height, width, and elevation. Figure 4 shows that some of the gamma scan profiles were shorter and narrower than others. This is indicative of poor distribution, since the larger profiles were produced by greater amounts of radiotracer near those scan positions.

The second way of plotting the gamma scan data involves producing polar plots (see Figure 5). A polar plot uses the data point at one elevation from all 12 scans to produce a circular data reference. The readings from the 6-foot elevation for all twelve scans are represented by the light blue line. This line and the other lines on this plot show that more radiotracer was deposited in the southern half of the reactor than in the northern half. It further shows that the southwest section of the reactor had the highest deposition of radiotracer.

The radiotracer was also injected into the reactor of the sister hydrotreating unit for comparison data. The results indicated fairly even gamma scan profiles. See Figure 6. The polar plot (Figure 7, back page) made it easier to see that a slight

Continued on back page
density within the bottom layer of the structured packing in the Wash Bed, which was the area of most concern. If coking was occurring, the TRACERCO Diagnostics™ ThruVision Scans would show areas of increased density within the Wash Bed.

The first TRACERCO Diagnostics™ ThruVision Scan was performed in April 2004 (Figure 8). Just prior to this scan, the Wash Bed had been replaced with new packing. This initial scan would provide a baseline to which all future scans could be compared. For this baseline scan, the average bed density measured by the TRACERCO Diagnostics™ ThruVision Scan was 8.9 lb/ft³.

Over the course of the next several months, TRACERCO Diagnostics™ ThruVision Scans were performed periodically to evaluate the cross-sectional density profile of the Wash Bed. By December 2004 (Figure 9), the average density of the bed had increased to 10.6 lb/ft³. In addition, a localized area of increased density (coking) was observed in the west quadrant of the bed.

The periodic TRACERCO Diagnostics™ ThruVision Scans were continued over the next several months, with the final TRACERCO Diagnostics™ ThruVision Scan performed in October 2005 (Figure 10) just before a scheduled shut down. For this final TRACERCO Diagnostics™ ThruVision Scan, the average density of the bed had increased to 12.5 lb/ft³. The localized high density (coking) area had expanded from the west quadrant of the bed to the outer edges of the entire bed.

Figure 11 is a graphical representation of the average Wash Bed density vs. time for all TRACERCO Diagnostics™ ThruVision Scans performed from April 2004 through October 2005. This graph illustrates how the amount of coke in the Wash Bed was increasing over time.

With the data from the TRACERCO Diagnostics™ ThruVision Scans, plant operations personnel can gain a much better understanding of the coking process within the Wash Bed of a Vacuum Column. With this knowledge, wash oil rates can be optimized to ensure maximum gas oil yield while at the same time providing adequate wetting of the Wash Bed to minimize coke formation.

Case Study
(Continued from page 1)

The potential for individual or environmental contamination, exists wherever unsealed radioactive materials are being transported or manipulated and might arise in a wide variety of operations relating to the Nuclear Industry, Medicine, Research, Minerals Processing and Oil and Gas Exploration and Production.

The TRACERCO™ Contamination Monitor has been designed to meet the challenge of combining operational reliability under adverse conditions with excellent sensitivity, intrinsic safety, ruggedised construction and a number of additional key features, which simply make life easier for the worker.

The TRACERCO™ Contamination Monitor offers several unique important features:

• Intrinsic safety for use in 1 and 2 hazardous areas – eliminates the need for a specific hot work permit.
• Detects alpha/beta radiation (particularly sensitive for Lead-210 and other NORM nuclides).
• Detachable radiation probe with up to 1.5 metres of extendable cable. Optional extendable probe attachment for surveying contaminated pipework, drains, floors, etc. (probe stepwise rotatable through 90° for internal surface measurements).
• Displays calibration due date
• Backlight facility
• Audible response

To learn about more features of the T201, contact us today or visit our website.
imbalance in flow was to the north side of the reactor. This imbalance was not affecting the performance of the train.

**Conclusion**

On-line investigation of hydrotreating units can identify the causes of poor performance. Once identified, the best course of action can be determined to correct the problem in the least amount of time and with the lowest cost. Such knowledge will save many times the cost of the investigation just in avoided lost production.

With the TRACERCO Diagnostics™ Distribution study you can identify problems before they reach a critical point. A baseline scan just after a turnaround, while the Reactor is operating under normal conditions, will identify the distribution characteristics under ideal conditions. It will also identify normal tracer penetration into properly operating fresh catalyst. This information will provide a “benchmark” for future Reactor scans. It will assist scan interpretations if subtle maldistribution is an inherent design characteristic of the distributor.

Tracerco’s team of experts has performed numerous TRACERCO Diagnostics™ Distribution studies worldwide. If you would like to learn more on our services and specialist measurement instrumentation please contact one of our field office locations for an on-site presentation.

---

**Tracerco Moves Into Azerbaijan**

Staff at Tracerco have recently celebrated the opening of Tracerco operations in Baku, Azerbaijan. The Baku office is Tracerco’s only office in Azerbaijan and will allow Tracerco to provide local support to meet its customer needs in Azerbaijan. The office will also focus on the growing oil and gas market in the remainder of the Caspian region where there is a large customer base working in the areas of upstream oil and gas production. Investment in the region will include the hiring and training of local Azerbaijani staff. Les Winward, the Base Manager in Baku, is working with Vasif Mammadov, Technical Operations Manager, to continue to expand the Baku base. Once expanded, the office will be operated by five or more Azerbaijani staff. The new office details are as follows:

Tracerco
115 Heydar Aliyev Avenue
AZ1029 Baku
Azerbaijan
Tel: +994 12 5141619/5141719
Fax: +994 12 5141519

---

**Billingham, UK**
Tel: +44 (0) 1642 375500

**Aberdeen, UK**
Tel: +44 (0) 1224 592527

**Rotterdam, The Netherlands**
Tel: +31 (0) 10 26 46 510

**Oldenburg, Germany**
Tel: +49 441 36 11 09-0

**Milan, Italy**
Tel: +39 02 90989971

**Bergen, Norway**
Tel: +47 55 36 55 40

**Perth, Australia**
Tel: +61 (0) 8 9480 3718

**Kuala Lumpur, Malaysia**
Tel: +603 7957 9821

**Baku, Azerbaijan**
Tel: +994 12 5141619

---

Figure 7 - In the polar plot illustration the process appeared to be flowing into the catalyst bed in a relatively uniform manner.
TRACERCO
PO BOX 1
BELASIS HALL TECHNOLOGY PARK
BILLINGHAM TS23 1LB
UNITED KINGDOM

TRACERCO
PO BOX 1
BELASIS HALL TECHNOLOGY PARK
BILLINGHAM TS23 1LB
UNITED KINGDOM

Please send me additional information on Tracerco's Specialist Measurement Instruments:

Name: ____________________________
Job Title: __________________________
Company Name: ____________________
Address: __________________________
City: ___________________ State: __________ Zip Code: __________
Phone: ___________________ Email: ___________________

The TRACERCO™ Profiler
The TRACERCO™ SmartGauge
The TRACERCO™ Radiation Monitor
The TRACERCO™ Interface Gauge
The TRACERCO™ Level Gauge
The TRACERCO™ Density Gauge
The TRACERCO™ Interface Scan
The TRACERCO™ Radium Scan
The TRACERCO™ Distribution Scan
The TRACERCO™ FCCU Scan
The TRACERCO™ Leak Scan
The TRACERCO™ Flow Scan

Tracerco would like to update our database for 2007. Please complete the information below to register for copies of the Tracerco News.

I would like to schedule an on-site presentation on the following:

[ ] TRACERCO Diagnostics
  [ ] Rapid Scan
  [ ] Towerscan
  [ ] Separator Study
[ ] TRACERCO Diagnostics
  [ ] FCCU Study
[ ] TRACERCO Diagnostics
  [ ] Radium Scan
[ ] TRACERCO Diagnostics
  [ ] Interface Scan
[ ] TRACERCO Diagnostics
  [ ] Distribution Scan
[ ] TRACERCO Diagnostics
  [ ] FCCU Scan
[ ] TRACERCO Diagnostics
  [ ] Leak Scan
[ ] TRACERCO Diagnostics
  [ ] Flow Scan

[ ] I am interested in additional information on the following:
[ ] TRACERCO Diagnostics
  [ ] Rapid Scan
[ ] TRACERCO Diagnostics
  [ ] Towerscan
[ ] TRACERCO Diagnostics
  [ ] Separator Study
[ ] TRACERCO Diagnostics
  [ ] FCCU Study
[ ] TRACERCO Diagnostics
  [ ] Radium Scan
[ ] TRACERCO Diagnostics
  [ ] Interface Scan
[ ] TRACERCO Diagnostics
  [ ] Distribution Scan
[ ] TRACERCO Diagnostics
  [ ] FCCU Scan
[ ] TRACERCO Diagnostics
  [ ] Leak Scan
[ ] TRACERCO Diagnostics
  [ ] Flow Scan

Please send me additional information on Tracerco's Specialists:

Name: ____________________________
Job Title: __________________________
Company Name: ____________________
Address: __________________________
City: ___________________ State: __________ Zip Code: __________
Phone: ___________________ Email: ___________________

I would like to continue receiving future issues of Tracerco News.

[ ] Yes [ ] No

I would like to continue receiving future issues of Tracerco News.

[ ] Yes [ ] No

I would like to continue receiving future issues of Tracerco News.

[ ] Yes [ ] No

I would like to continue receiving future issues of Tracerco News.

[ ] Yes [ ] No

I would like to continue receiving future issues of Tracerco News.

[ ] Yes [ ] No

I would like to continue receiving future issues of Tracerco News.

[ ] Yes [ ] No