insight

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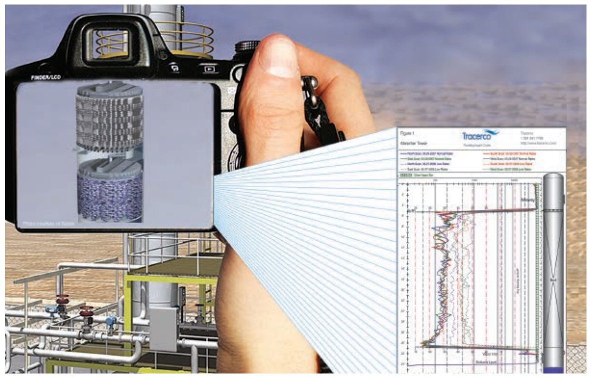
Volume 6 Edition 2

PackView™ – quantitative analysis of packing mal-distribution

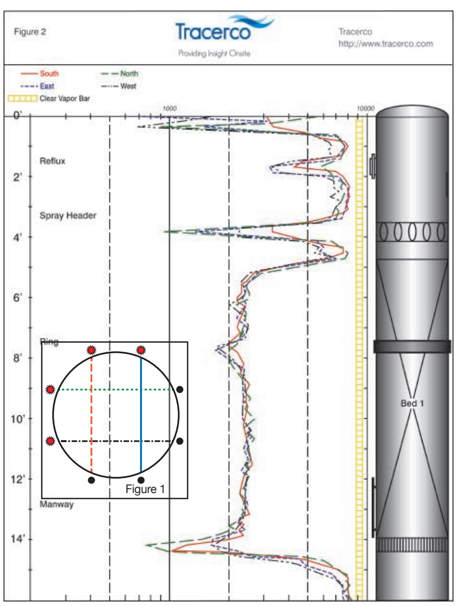


By Lowell Pless, Business Development Mgr – Distillation Applications

The last issue of Tracerco Insight (Vol 6 Ed 1) featured our patent pending FrothView™ technology illustrating how using Tracerco's new measurement detector technology and analysis of gamma scan data provides quantitative information about the useful capacity of trayed towers. In this article you will learn how applying this technology to packed towers can determine the % liquid fraction providing a measure of the maximum useful capacity of the packing.

Enhanced quantitative analysis of Tracerco Diagnostics™ Scan results

Once beyond questions concerning damage to internals and flooding within a packed tower, the next big concern is the state of liquid distribution through the beds. Historically gamma scan analysis has relied upon performing two sets of parallel scanlines (given the tower diameter is sufficiently large) through the packing as shown in Figure 1, commonly referred to as a grid scan.



Figures 1 & 2 – Grid Scan orientation and a typical example of scan results illustrating good liquid distribution.

The reasoning goes that all scan parameters being constant, particularly the length or path of radiation through the column, uniform liquid distribution can be confirmed by all four scans detecting identical radiation. Figure 2 is a typical example of grid scan results showing all four scanlines matching, implying good liquid distribution.

On the other hand, Figure 3 represents a grid scan where the lines do not seem to match very well but is this liquid mal-distribution? If so, what is the quantity of liquid mal-distribution? Up until now the available qualitative analysis of a gamma scan is not able to answer this very well.

Tracerco has developed an enhancement in detection capability and data presentation that is termed a liquid retention scale. Figure 4 shows typical scan results through a bed of packing. Overlaid on the data is a density scale.

The density scale begins at the density of the dry or non-operating packing. To derive this value it is necessary to know the packing type to reference its dry bulk density. The density scale to the left of the dry packing density is the calculated density of the liquid retained in the bed of packing. As with the normal gamma scan analysis, if the four scanlines have matching liquid retention densities then the implication is the liquid distribution is good. However, if there is a difference between the scanlines, the retention density gives a numerical comparison from which to gauge the extent or severity of any liquid mal-distribution.

Back to Figure 3 – how "bad" is this liquid mal-distribution? Figure 5 shows the scan results from Figure 3 with the liquid retention scale in place. The spread in density from the lightest density, 104 kg/m^3, scanline (blue) to the heaviest density, 136 kg/m^3, scanline (black) is 32 kg/m^3. Scans of dry towers (tower is not operating so presumably no liquid mal-distribution!) have shown that we naturally get a variation of radiation readings corresponding to a 16-32 kg/m^3 difference. Based on this guideline a 32 kg/m^3 difference among scanlines would hardly seem to be a significant operational problem.

Figure 6 is an example of liquid mal-distribution seemingly becoming a bigger concern. As seen from the liquid retention scale in Figure 6 the spread in density from the lightest density, 24-32 kg/m^3, scanline (blue) to the heaviest density, 120 kg/m^3, scanline (black) is 88-96 kg/m^3. This is a relatively large difference in liquid density so would represent significant liquid mal-distribution.

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PackView™

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Another method by which to put this into perspective is to calculate what is referred to as the liquid holdup fraction or liquid volume fraction. If the liquid retention density is taken and divided by the density of the process liquid at bed conditions (the liquid density at the actual operating temperature and pressure), the result is the liquid holdup or liquid volume fraction. In this case the liquid is an aqueous solution with a density of 961 kg/m^3 at the temperature and pressure conditions through the packing. Thus the liquid mal-distribution, in terms of liquid density, translated to a 10% difference in the volume of liquid holdup between the "lighter" side of the column to the "heavier" side, implying a major liquid distribution problem.

CONCLUSION

It is always easier to understand and discuss technical issues when quantitative information can be used to compare operational parameters with engineering design. Over the past 40 years gamma scanning has become more and more popular as a useful diagnostic tool to understand the hydraulic operation of fractionation equipment. It is our goal that use of FrothView™ and PackView™ analysis will improve the value of gamma scan data and facilitate improvements in the operation of mass transfer equipment.

We would be more than happy to visit your site, provide a lunch-n-learn or other presentation to further explain and show examples of Tracerco's analytical methods. If interested please contact a Tracerco Technical Advisor in your area.

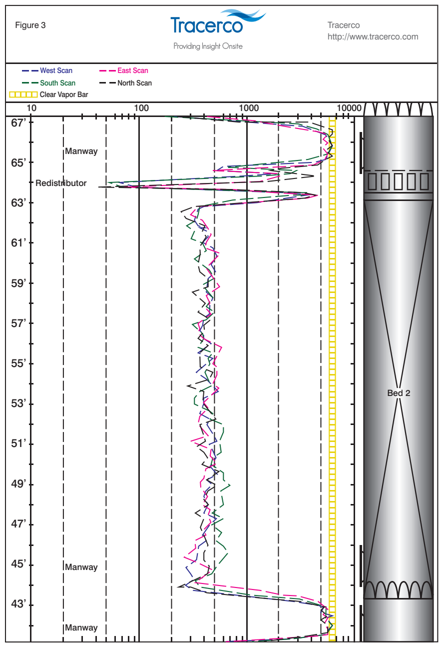

Figure 3 – *Grid scan results implying mal-distribution, but the question is what is the quantity of liquid mal-distribution?*

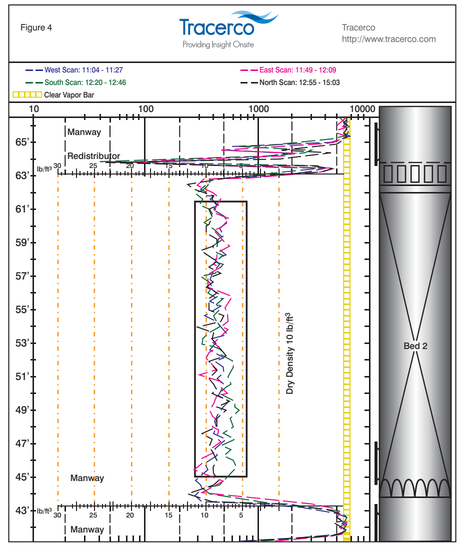

Figure 4 – *Typical grid scan results through a packed bed including the patent pending PackView™ liquid retention scale overlaid on the scan data.*

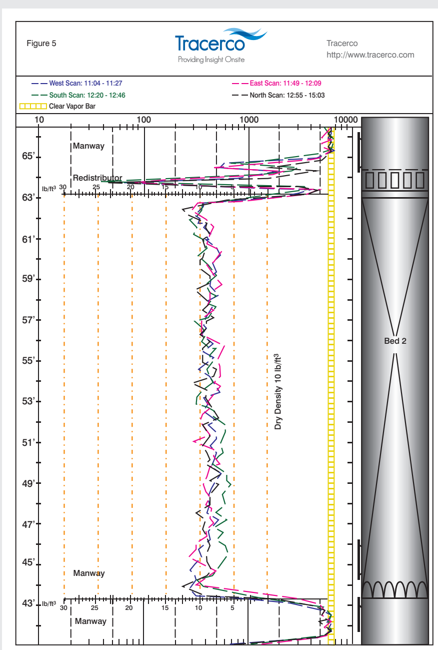

Figure 5 – *Scan results shown from Figure 3 with the liquid retention scale included indicating how "bad" the liquid mal-distribution was at the time of the scan.*

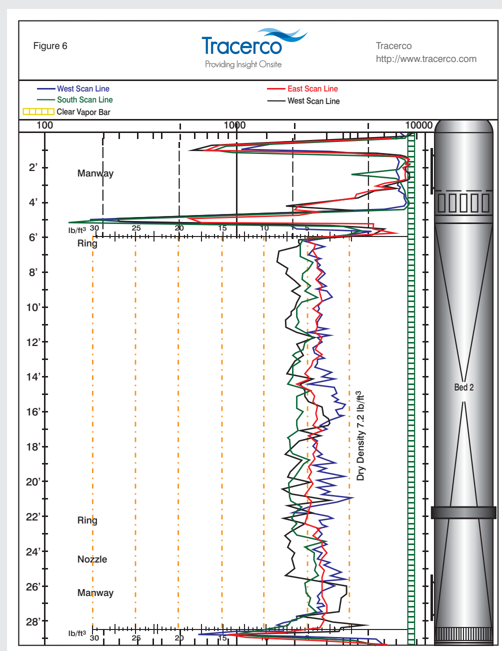

Figure 6 – *An example of liquid mal-distribution where the liquid retention scale indicates a relatively large difference in liquid density representing a significant liquid mal-distribution.*

Tracerco assists a large LNG facility experiencing problems within their slug catcher

By Ben Dumas, Operations Manager, The Netherlands

Liquid/vapour slugging can result in major process upsets and can damage process equipment resulting in production losses as well as major expenditures for damage repair.

In the process industries, liquid/vapour slugging is typically controlled through the use of a Slug Catcher vessel.

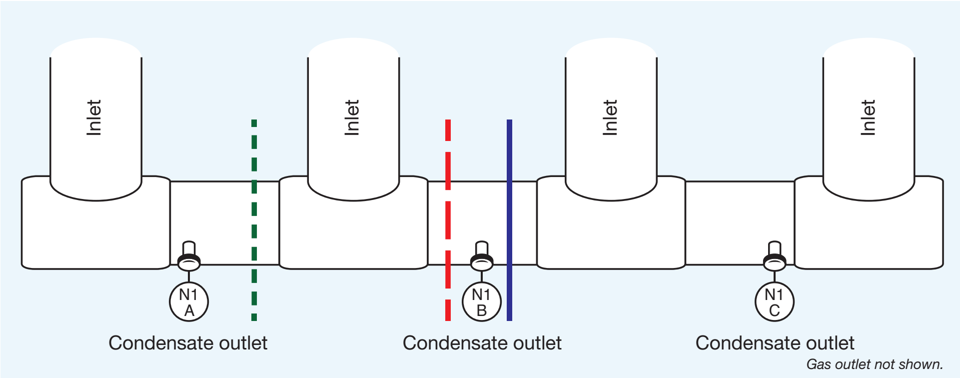

Figure 8 – Pipe scans were performed at 3 locations on the Slug Catcher to determine the cause of level control problems in the pipe.

An on-shore gas liquefaction facility was experiencing problems with their finger-type design Slug Catcher after a pigging operation was performed on an offshore pipeline. The customer was having problems maintaining a stable level in the Slug Catcher, and the condensate appeared to contain high amounts of fouling material.

Tracerco was requested to perform a pipe scan on the Slug Catcher to help determine the cause of the problem in maintaining the liquid level. The design of the Slug Catcher consisted of a horizontal pipe with four fingers connected at the 2 o'clock position. (Figure 7) The condensate is collected through gravity separation and exits through nozzles N1A/B/C as shown in Figure 8. The diameter of the Slug Catcher is 1.17m (3.8 ft.) with 32mm (1.25 in.) wall thickness.

A Tracerco Diagnostics™ Pipe Scan is a well-established technique that can determine both the location and depth of solid deposits. Typically on long sections of horizontal pipe or a small diameter horizontal vessel containing primarily one phase flow, measurement is taken through the pipe from top to bottom as shown in Figure 9. It is accomplished by placing a yoke assembly across the pipe. The yoke is constructed to maintain the scan source and radiation detector in a fixed orientation so the radiation beam passes through the mid-section of the pipe allowing for consistent data readings.

Long portions of piping can be screened very quickly using the Tracerco system. When the radiation measurements indicate a layer of high density material, the position is marked for further testing. Using the same yoke assembly any suspect section will be tested at two or more different orientations that will provide diameter measurements to determine the extent of the deposit layer, as shown in Figure 10.

However, in the particular case of the Slug Catcher, the pipe was filled with two possibly three phases: fouling (solids), liquid and gas (Figure 11). The three different phases would have different densities and, therefore, different radiation absorption rates so a different method of scanning was needed to distinguish these phases and calculate or measure the amount of fouling.

Because of the possible different material segregations the Tracerco Diagnostics™ Pipe Scan was performed by actually scanning vertically through the Slug Catcher at three different locations as shown in Figures 8 and 12. When a "slice" of a pipe is scanned at a specific location the results will ideally resemble one of the graph examples as indicated in Figure 13a and 13b. The graph of a clean, empty pipe should ideally look like a backwards "C" (Figure 13a). When the pipe is full of liquid, the profile on the graph should (ideally) look like a mirror imaged "D" (Figure 13b).

A plot of the three scan locations of the Slug Catcher condensate header are illustrated in Figure 14 which includes the idealistic results of an empty/full pipe and the scan results from the three locations. Results of the Tracerco Diagnostics™ Pipe Scan indicated the condensate header of the Slug Catcher was completely filled with liquid and fouling (solids) as shown in Figure 14. The fouling (solids) had filled approximately 410mm (16.14 in) of the pipe, which would equate to 41% of its cross sectional area therefore covering the condensate outlet nozzles.

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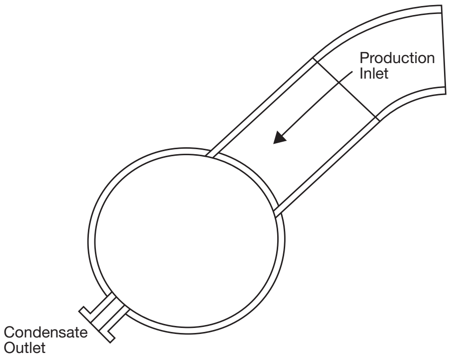

Figure 7 – Illustration of Slug Catcher design.

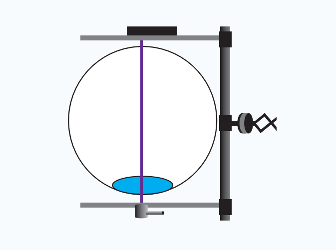

Figure 9 – Illustration of a gamma scan orientation for long sections of horizontal pipe containing primarily a one phase flow.

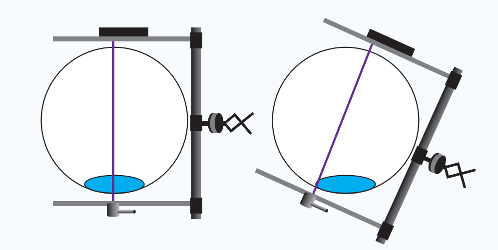

Figure 10 – Suspect sections of pipe will be tested at 2 or more different orientations to provide diameter measurements and determine the deposit layer.

LNG Facility

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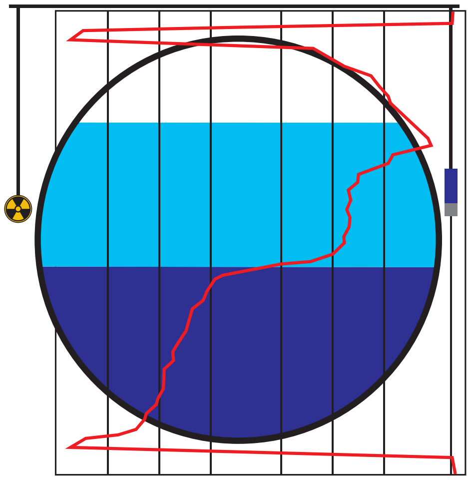

Figure 11 – *In this case the Slug Catcher pipe was filled with two possibly three phases: fouling (solids), liquid and gas.*

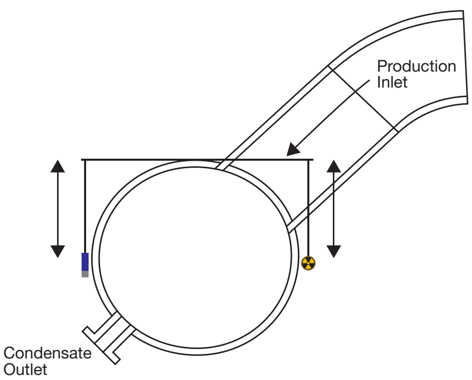

Figure 12 – *Due to the possible different material segregations, the pipe scan was performed as a 'slice' scan (scanning vertically through the Slug Catcher).*

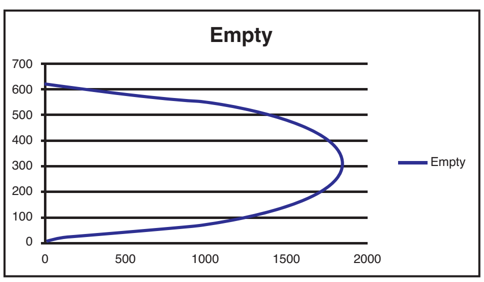

Figure 13a – *Ideal empty pipe*

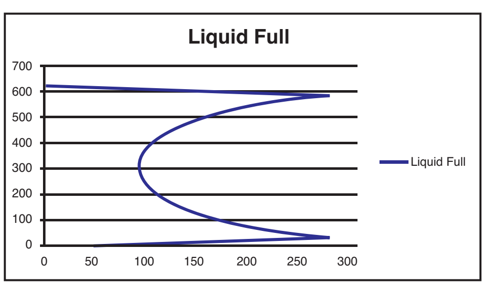

Figure 13b – *Ideal liquid full pipe*

Based upon the scan results the customer now understood the severity of fouling within the Slug Catcher. The photo in Figure 15 shows the degree of fouling found.

Conclusion

Tracerco Diagnostic™ Pipe Scan results of the finger-type Slug Catcher supplied the customer with information on the severity of the fouling. This information provided our customer the confidence they needed to perform a thorough cleaning of the pipe and prevent any possible damage to downstream process equipment.

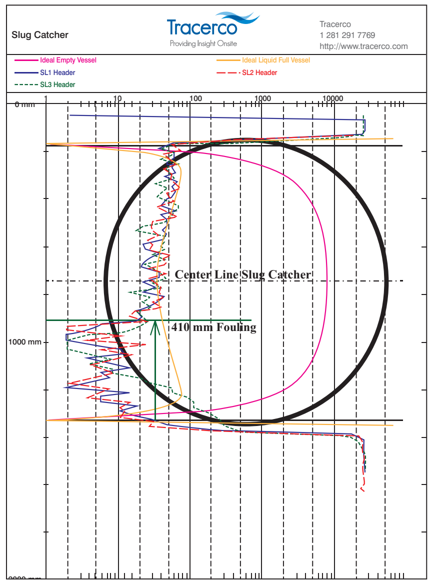

Figure 14 – *Results at the three scan locations of the Slug Catcher including the idealistic results of an empty pipe.*

If you would like to learn more about how Tracerco Diagnostic™ Pipe Scans can identify localised fouling and the depth of solids build-up please contact a Tracerco technical advisor in your region for an onsite presentation.

Figure 15 – *Internal photo showing a view of the extent of fouling within the Slug Catcher.*

Tracerco Diagnostics™ Slug Monitoring system provides key information to avoid process upsets

An additional concern in the industry is the formation of slugs in pipelines causing unsteady process conditions. Tracerco has the ability to detect liquid or gas slugs in pipelines, monitoring their presence, and providing customers with critical slug flow characteristics such as slug size, frequency and velocity. The Tracerco Diagnostics™ Slug Monitoring system is used to determine slugging characteristics by placing two non-intrusive densitometers positioned at a known distance apart on the outside of the pipe. The measurement of density change in the pipe over time at each position and analysis of the shape of the density change allows a slug to be fully characterised providing key information so that process conditions can be changed to reduce the magnitude and detrimental effect on downstream separators.

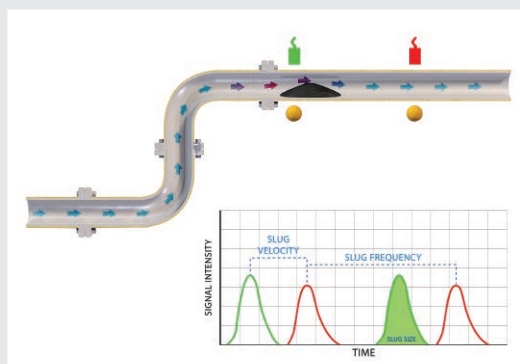

Figure 16 – *Tracerco's slug monitoring system provides slug flow characteristics to allow operations the ability to control and suppress vapor or liquid slugs.*

In addition, the estimated arrival time at a separator can be calculated so remedial action can be taken to avoid damage or upset. An example of this is shown in Figure 16. Look for the next issue of Tracerco Insight that will feature a slug monitoring case study.

Tracerco™ ThruVision scan detects mechanical problems with a mist eliminator pad

By Andy Burleigh, Tracerco Technical Advisor - Baton Rouge, LA

A Tracerco™ ThruVision scan provides a high resolution detailed density analysis of the cross-sectional area through a vessel at one elevation. The equipment used for a ThruVision scan collects many data points around the circumference of the vessel being scanned. Tracerco™ ThruVision scans are often performed on packed columns or FCC risers, but can be used in other applications where a detailed density analysis is required, such as sludge or solids profile in pipework. The following case study illustrates how the results of a Tracerco™ ThruVision scan were used to assist plant personnel in identifying problematic operations, in order that suitable modifications could be planned and applied.

Tracerco™ ThruVision investigates damage in a mist eliminator pad

A U.S. chemical plant suspected damage to the mist eliminator pad in their Knock-Out Drum. Generally, a grid scan is performed to verify the integrity of mist eliminator pads, but because of the larger diameter of this vessel (3.2 metres) and the customer's desire for a more detailed analysis, it was decided to perform a ThruVision Scan.

In this case, a 9 X 9 scanning pattern was used, as shown in Figure 17, to collect scan data at the mid-point elevation of the mist eliminator pad. Each of the 81 scan chords represents data points that were collectively analysed, providing a cross-sectional density of the mist eliminator pad within the Knock-Out Drum. Results are presented in Figure 18 as a tomographic image, with contour colours indicating the relative densities measured.

The ThruVision scan indicated little to no density on the Eastern half of the mist eliminator pad, and a higher than expected density on the Western half. Basically, the Eastern half of the mist eliminator pad appeared to have been displaced. The high density seen on the Western half of the mist eliminator pad could either be attributed to fouling material or crushed packing.

The data collected from the ThruVision scan provided plant personnel with information they needed to make a decision to shut down and replace the damaged equipment. Although Tracerco™ ThruVision scans are generally thought of as a diagnostic tool for packed columns, FCC risers or pipeline blockages, they can also be an effective diagnostic tool for other applications, such as internal mist eliminator pads.

Obtain a complete image of your process

When faced with the need to know more about your vessel internals or packed tower operation, Tracerco recommends you first consider a grid scan to quickly give an assessment of the hydraulic behaviour of the mass transfer hardware. As with all screening techniques, if the grid scan shows a problem, it is a real problem. However, if the grid scan appears to show no major problem but symptoms of a problem persist, then there are advanced techniques, such as ThruVision scans, to assist in determining what problems exist in your vessel or packed tower.

For more information and case studies on how you can increase your units' productivity using Tracerco Diagnostics™ Scan and Tracerco™ ThruVision applications, contact a technical advisor in your area to schedule an onsite presentation or visit www.tracerco.com.

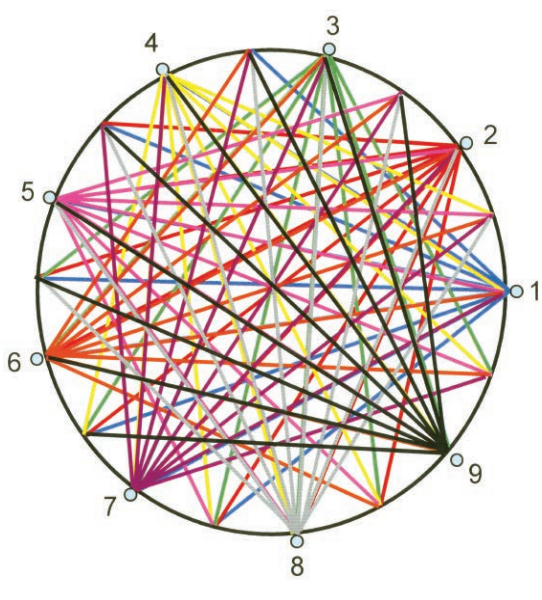

Figure 17 – A Tracerco™ ThruVision scan uses multiple scan chords at the same elevation. In this case study a 9x9 scanning pattern was used.

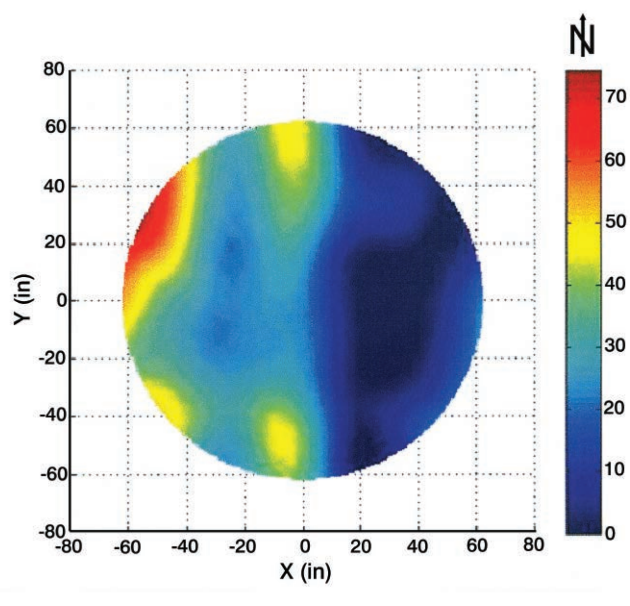

Figure 18 – Scan results showed a higher than expected density on the western half and a lower than expected density on the eastern half of the mist eliminator pad.

Tracerco's analytical lab services are now operational in Edmonton Canada

Tracerco is pleased to announce that it is officially operating its newest analytical laboratory in our Edmonton, Canada base for chemical tracers used to detect the presence of very small leaks in heat exchanger systems and in the detection of tracer in oil and gas reservoir studies.

Accurate, sensitive and reliable analytical data is key to the success of any chemical tracer project. Using some of the most sophisticated analytical instrumentation and methodologies available to the industry, Tracerco can provide this assurance even in the most complex projects.

Our on-going commitment to the development of new tracers and our continual investment in new analytical technologies, ensures that Tracerco remains able to meet the requirements of even the most challenging tracer projects. With strong links to Tracerco operational and R&D teams, our laboratories are involved in the design of tracer projects from an early stage, further assuring the success of your tracer injection study.

Tracerco recognises the importance of local analytical facilities, and we have therefore committed to an expanding network of regional laboratories and sales offices to ensure you will always have a local Tracerco presence in your region. Visit our website www.tracerco.com for additional information.

Tracerco Regional Lab Locations:

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- Rio de Janeiro, Brazil: +55 21 3535-7600
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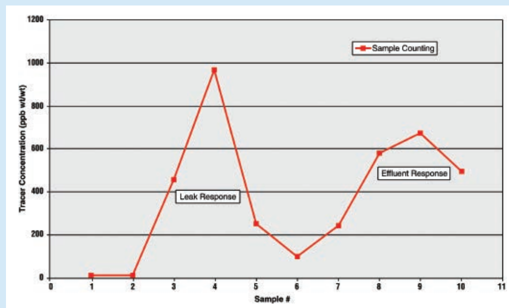
- Oman: +968 92707498

Heat exchanger chemical leak test analysis



A large refinery requested a chemical leak test of four reactor feed/effluent heat exchangers where the customer had been experiencing high sulfur content in their effluent/product stream indicating a potential leak from the high sulfur feed into the low sulfur product. Analysis of the chemical tracer in a local Tracerco laboratory validated the presence of a leak by identifying the presence of the chemical tracer as both a leak and effluent response. The minimum calculated leak based on the laboratory analysis was measured at 0.2%. Analysis of the results narrowed the leak to a specific heat exchanger bank. The application of the chemical tracer technology saved the plant a significant amount of maintenance costs by narrowing the leak to a specific bank, minimising production down time.

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