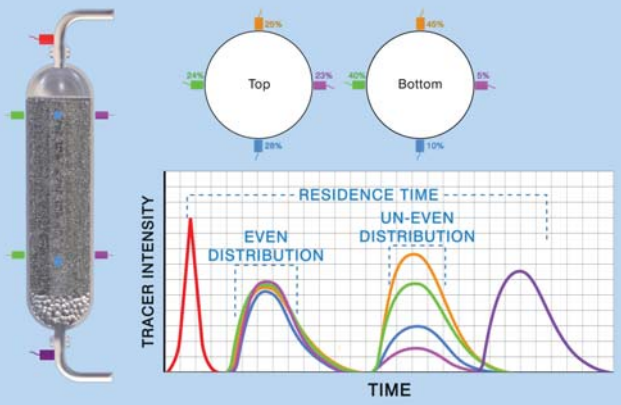
Tracerco

Providing Insight Onsite

Reactor - Residence Time and Distribution

One of the most common questions asked about reactor performance at both the pilot plant and production stages is “What is the residence time and distribution of the components in the reactor?”

With all the instrumentation that is available to monitor the reactor, this question is surprisingly difficult to answer. This question is followed by another, “What techniques are available that can be used to gather information about an online reactor so the design can be improved?” The answer is that tracers can be used to gather this information. An isotope tracer can often be injected and its movement and timing can be determined using external detectors. However, this technique does not work in every situation. In those cases, an isotope or chemical tracer can be injected and samples can be collected from the outlet stream for analysis.



A Tracerco Diagnostics™ Residence and Distribution study can offer a rapid, online, cost effective method of determining the time and distribution of material through mixing, reaction or separation vessels that can be critical to industrial processes.

Project Field Test

One customer who operates a gas phase reactor with two fixed catalyst beds contacted Tracerco to assist with startup issues. Upon startup, maldistribution was suspected to be the cause of lower than expected conversion.

Four rings of six detectors were positioned at the elevations shown in Figure 1. The first set of results (Figure 2) show the responses of the detectors in the top ring of the upper bed. It is obvious that the responses are not all of the same height or width.

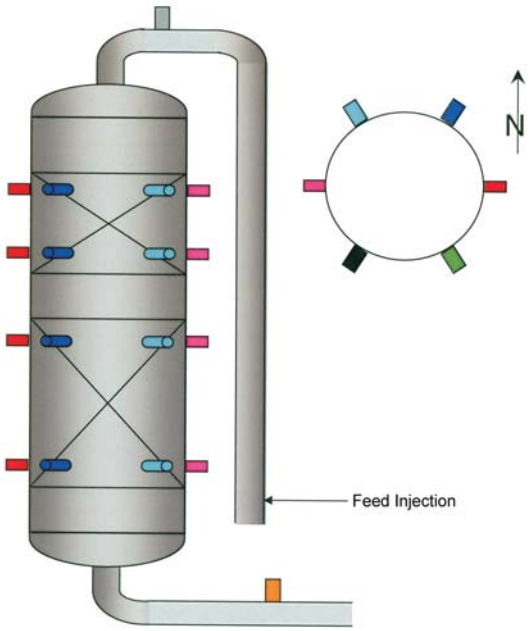


Figure 1 - Four rings of six detectors positioned at elevations shown, produced results illustrated in Figures 2 and 3

Process Diagnostics

Project Analysis

The radar plot in Figure 2 shows that almost 20% of the flow was measured near each of the NE and E detectors, about 17% at the NW and SE detectors, and 11 and 8% at the SW and W detectors respectively. Since each detector should have seen 16.7%, a total of 40% to the NE and E and only 20% to the SW and W, indicated serious maldistribution was present.

The second graph (Figure 3) shows the results of the ring of detectors at the bottom of the lower bed. The detector responses were more similar to each other, but there was still a 58 to 42% flow bias to the east side of the reactor. The Mean Residence Time (MRT) was measured at 36.8 seconds from the upper bed top ring to the lower bed bottom ring and the overall MRT was 53.4 seconds.

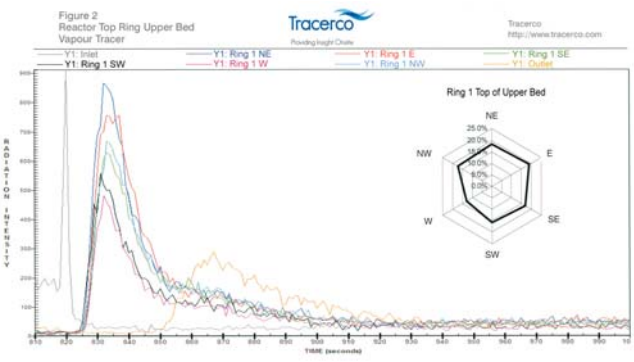


Figure 2 - The first set of results using the Method of Moments analysis indicated serious maldistribution was present.

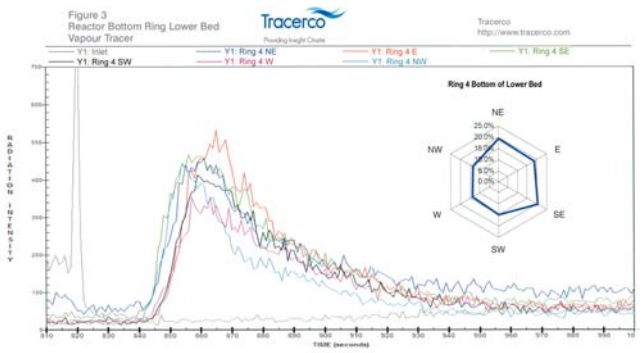


Figure 3 - Results of the ring of detectors at the bottom of the lower bed indicated there was still a 58-42% flow bias to the east side of the reactor.

Customer Conclusion

The engineering staff operating this reactor took the opportunity at the next scheduled shutdown to change the inlet distributor and the redistributor between the beds. When the reactor was restarted, the performance improved.

With the knowledge gained from the reactor distribution study the customer was able to save many times the cost of the investigation just in avoiding lost production. A baseline scan just after a turnaround, while the reactor is operating under normal conditions, will identify the distribution characteristics under ideal conditions. 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.

For further details email: process.diagnostics@tracerco.com or visit: www.tracerco.com/processdiagnostics

For our worldwide offices: www.tracerco.com/processdiagnostics/our-people