



Radioisotope and Chemical Tracer Applications in the Refining and Chemical Industries

By Dave Ferguson



TRACERCO Diagnostics™

Today's Discussion



**Flow
Measurement**

Leak Testing



**Distribution
Studies**



**Residence
Time**

TRACERCO™ Diagnostics

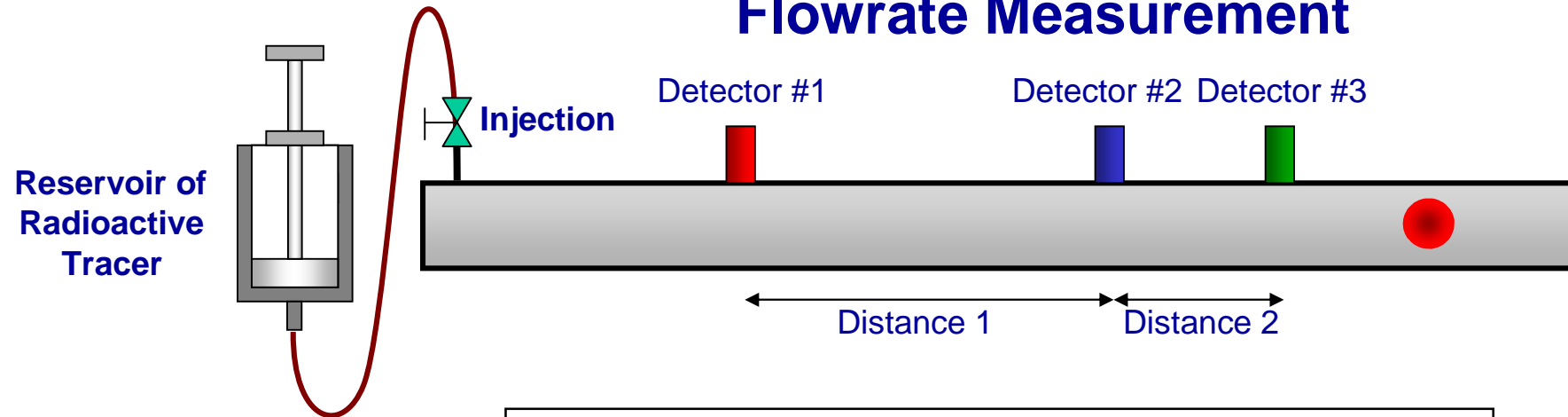
Safety

- Tracerco is Licensed by State and Federal Agencies and inspected once a year by appropriate agencies
- Tracerco is responsible for the Transport, Use, and Disposal of any radioactive material we bring onto your site
- Plant does *NOT* inform *EPA, State, or Federal Agencies* about testing
- Similar to radiographers, Tracerco will barricade an area around the injection point, but only about 15 feet in radius
- There is no danger to plant personnel working around process equipment, as long as they stay out of the barricaded area
- Our radiation sources are about 1000 times smaller than radiography sources.

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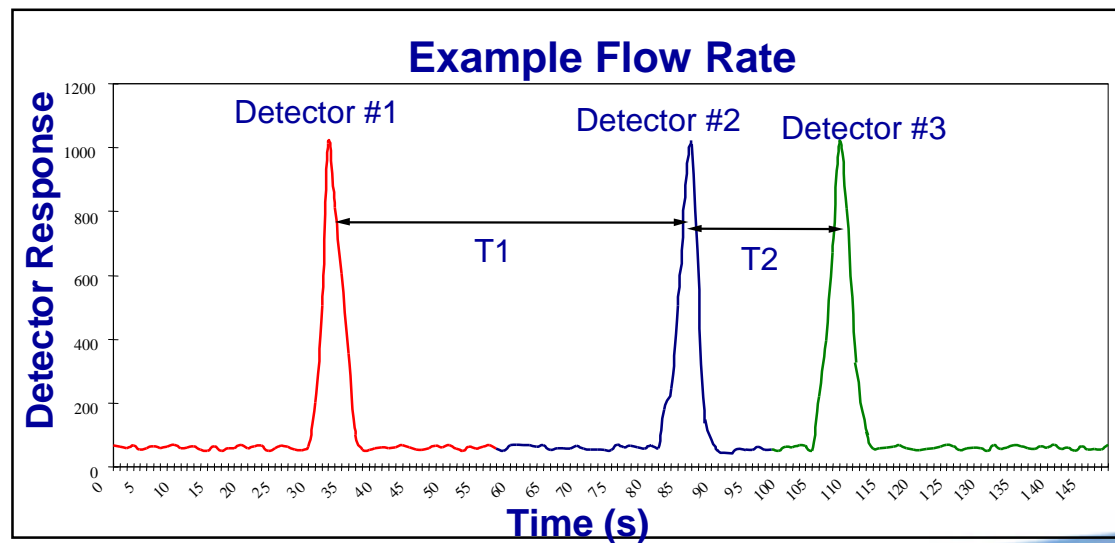
Flow Study

Flowrate Measurement



$$\frac{D1}{T1} = \text{Velocity}$$

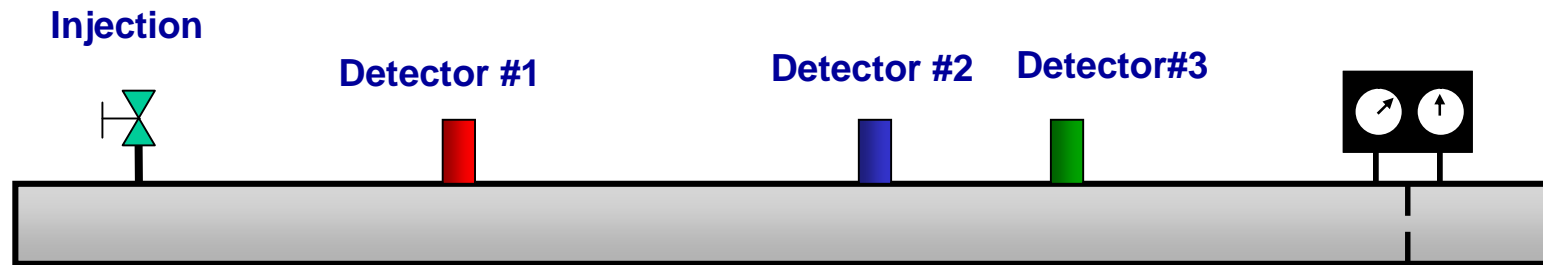
Example Flow Rate



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Flow Study

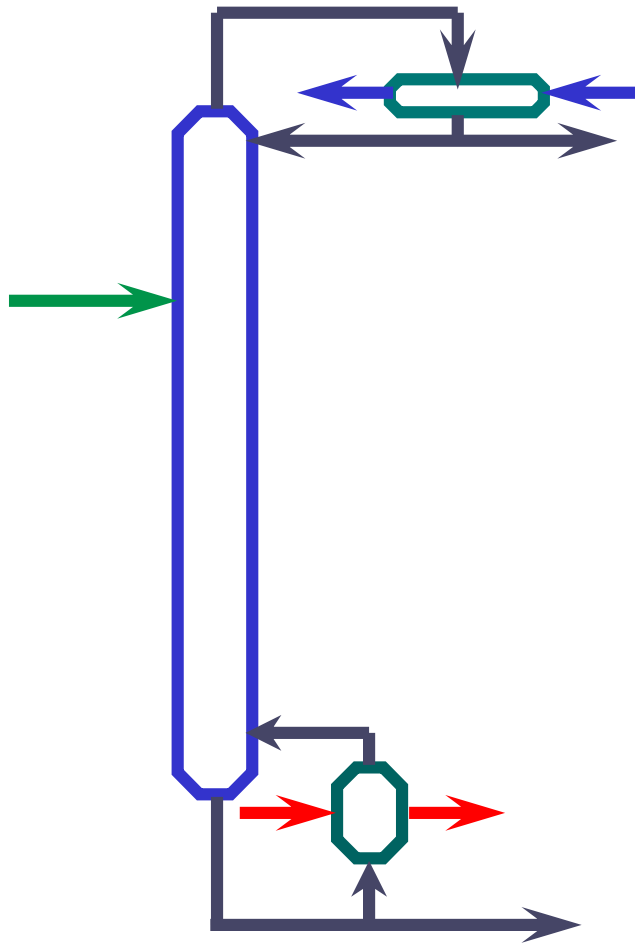
Verify or Calibrate a Flow Meter In-Situ



- Buyer's hydrogen custody transfer meter matched his mass balance calculations, but supplier's meter read a higher flow.
- Tracerco measured velocity of hydrogen in transfer line and found it close to what buyer expected.
- Supplier reviewed his meter setup and discovered pressure used to convert to standard volumetric flow rate was too high.

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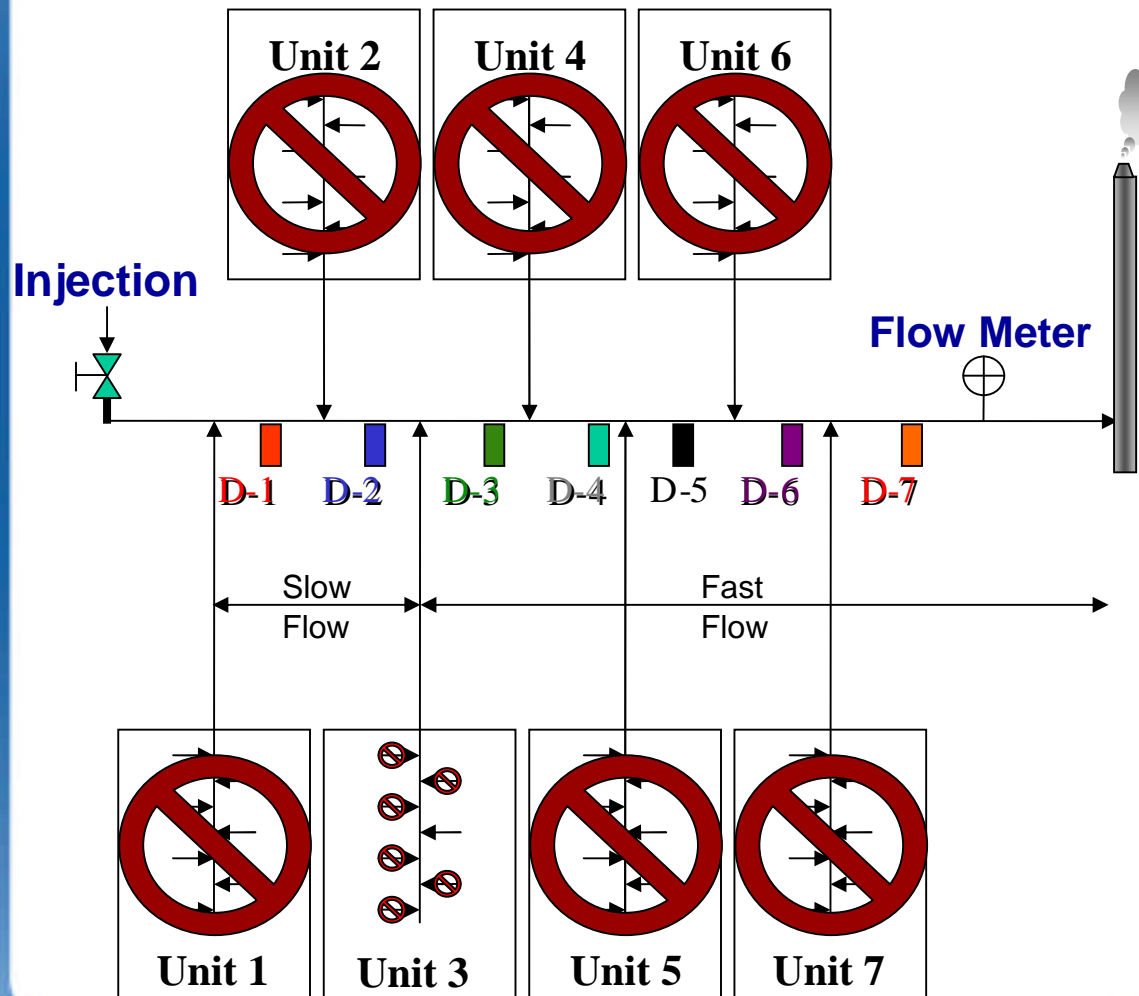
Flow Study



**Determine Flow Rates
Where There Are No
Meters, Facilitating
Mass Balance
Calculations.**

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Flow Study



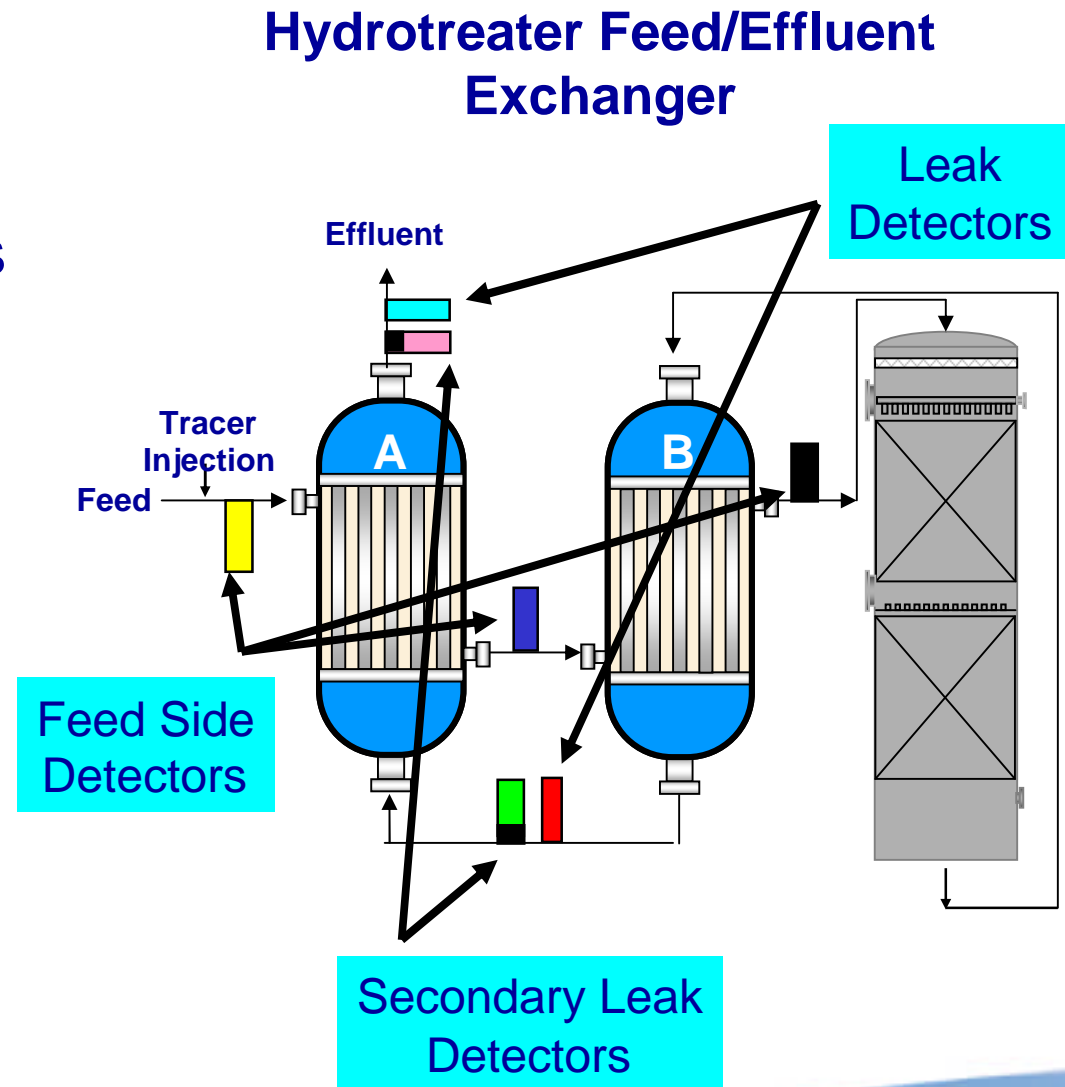
Identify Leak Origination

- Measure where flow rate increases
- Eliminate Units that do not contribute
- Repeat steps in Unit sub-header
- Pinpoint leaking PSV

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Leak Study

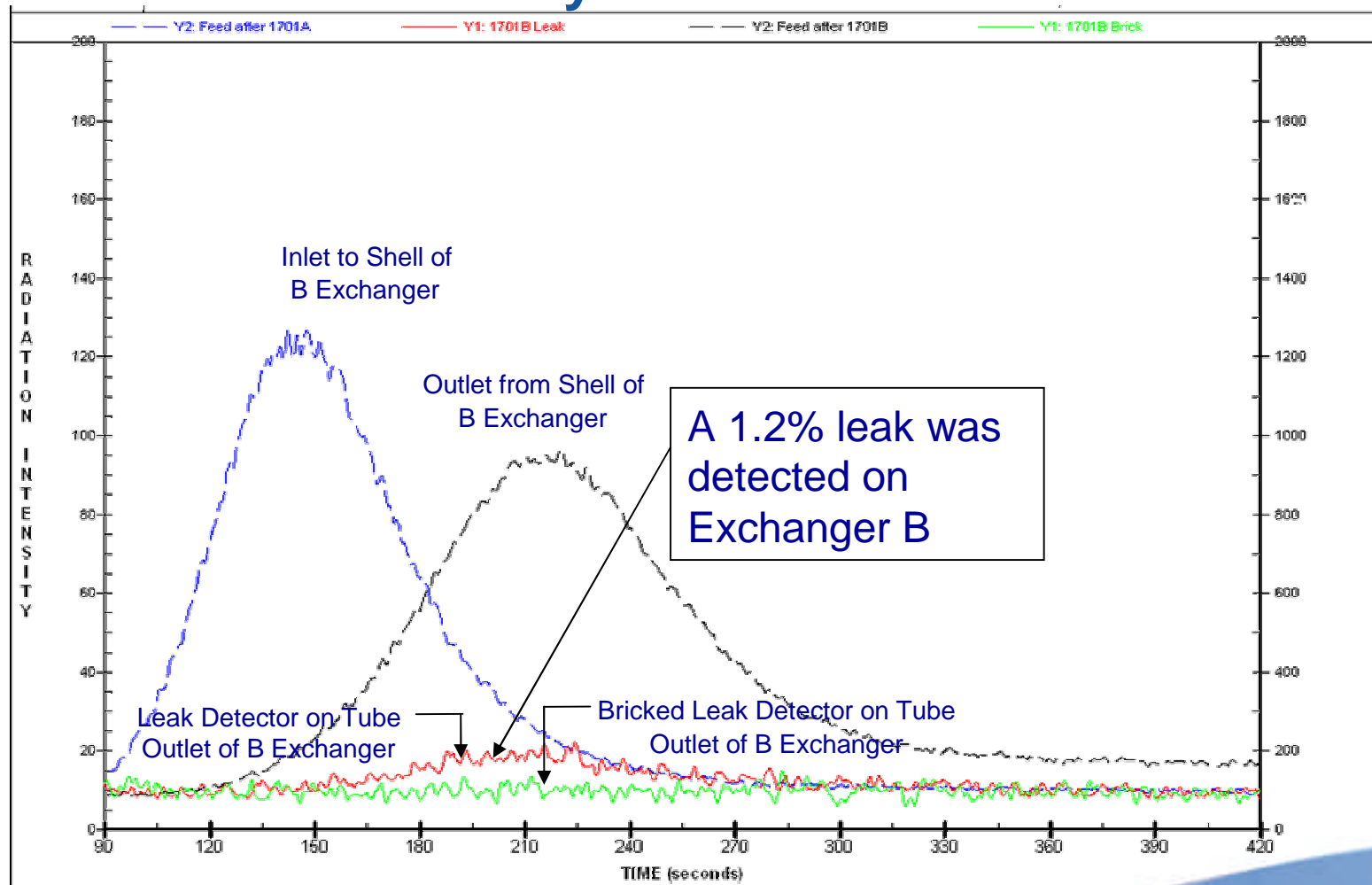
- Some detectors are used to monitor the main body of tracer as it passes through the feed side
- Leak detectors are mounted on the effluent exit lines
- Secondary leak detectors serve to clarify whether a response on the primary leak detector is a leak or pickup of the tracer on the feed side



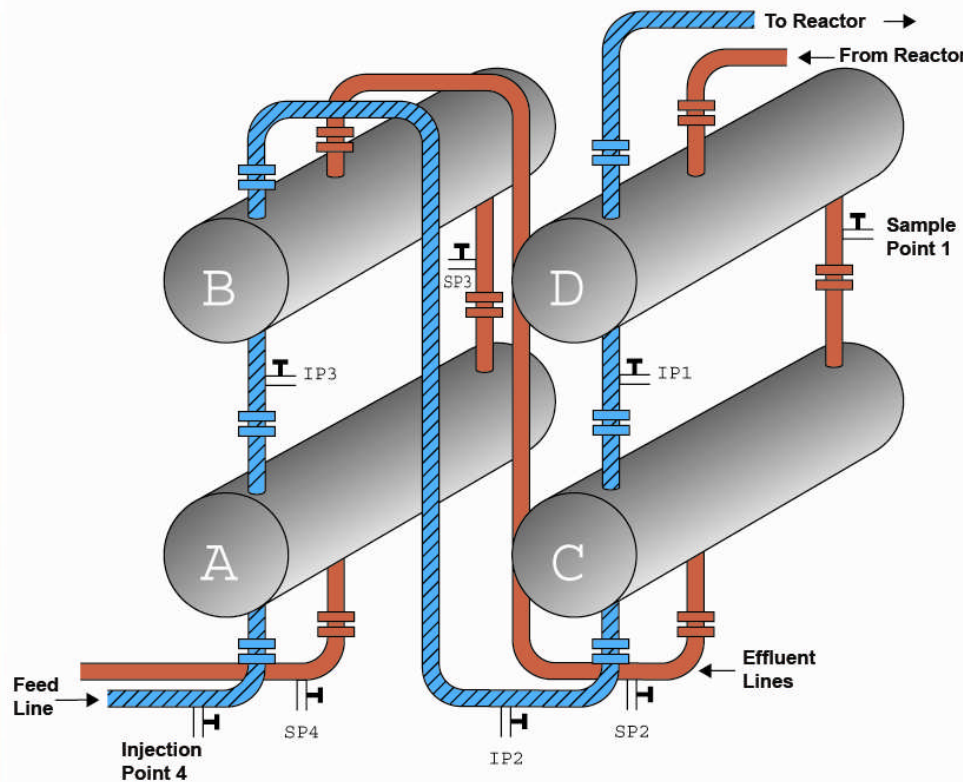
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Leak Study

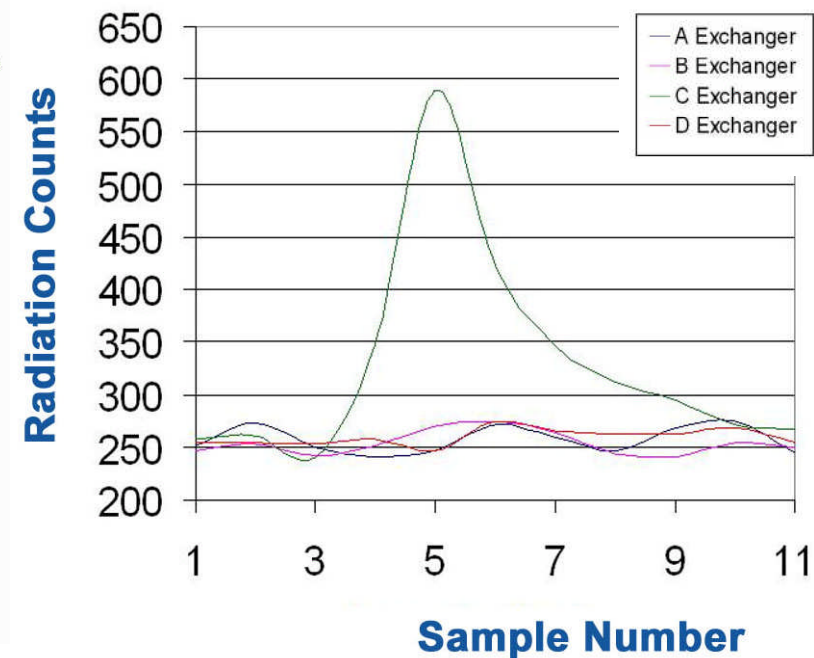
Hydrotreater Feed/Effluent Exchanger



TRACERCO Diagnostics™ Leak Study by Sampling (Radioactive & Chemical)



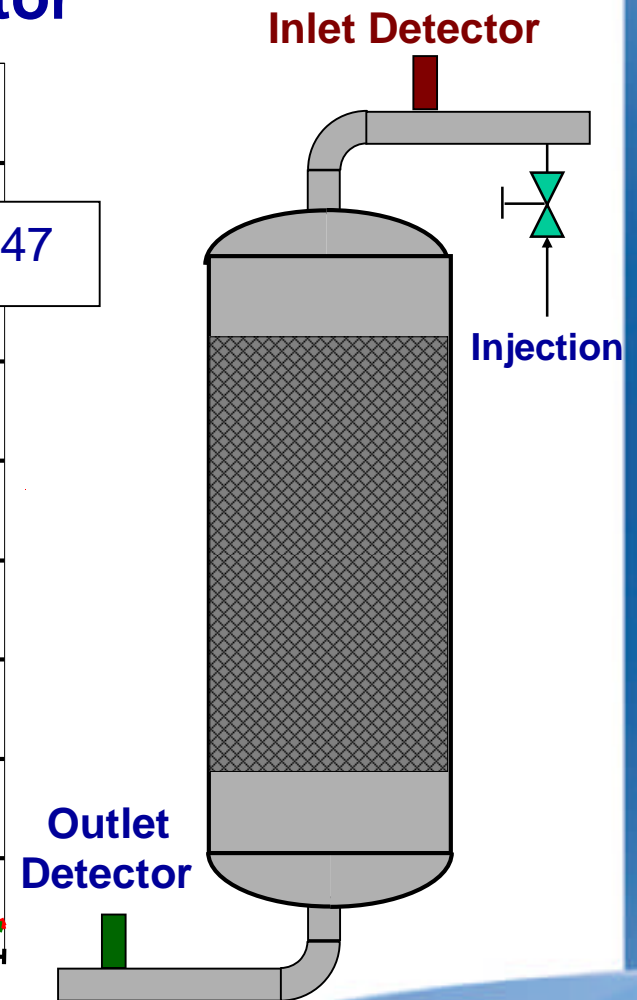
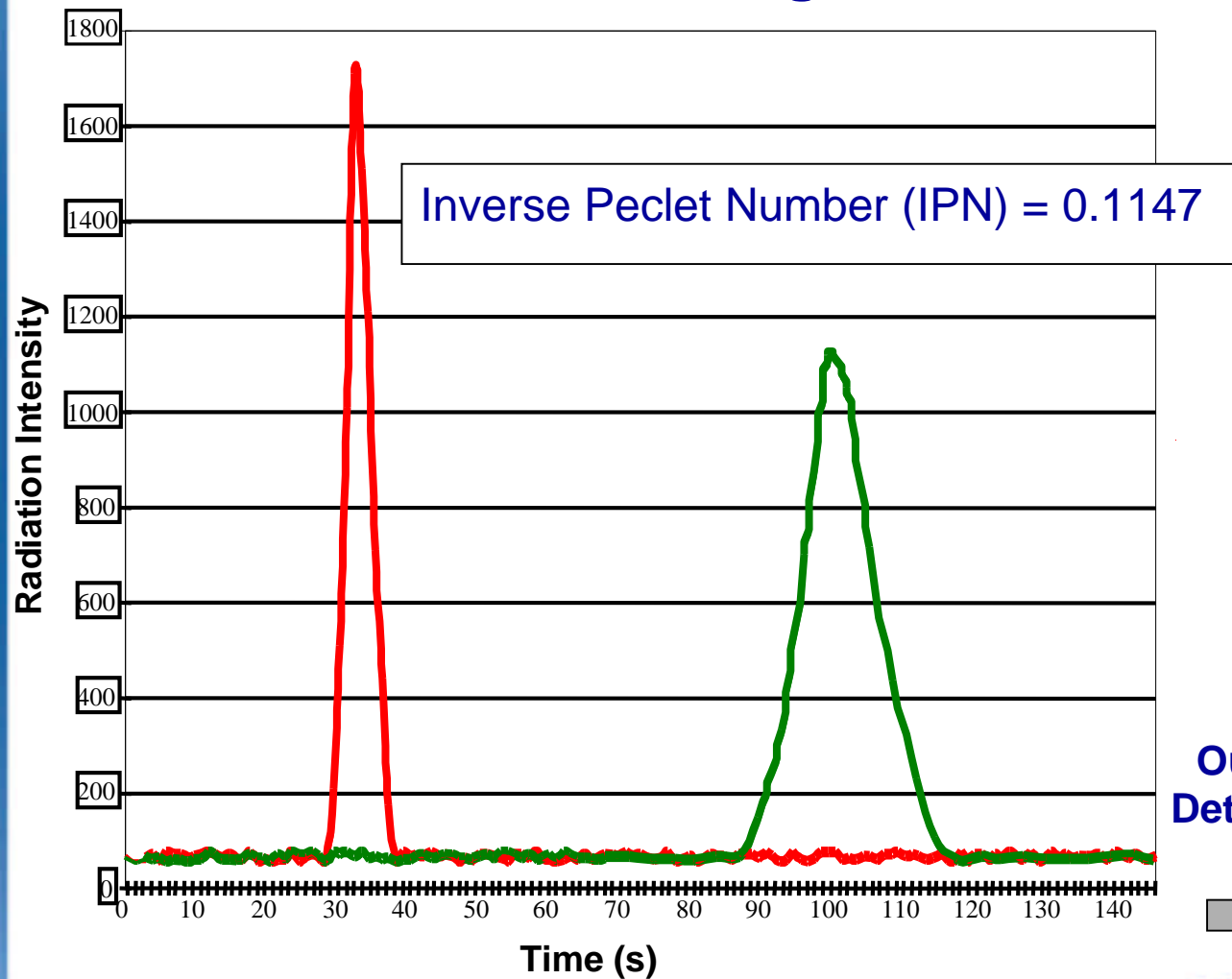
Exchanger Leak Test Results by Sampling



Leaks as small as 100 ppm can be identified with Radioisotope tracers on site. Chemical tracers can isolate exchangers with leaks as small as 1 ppm, but the samples have to be analyzed in our laboratory.

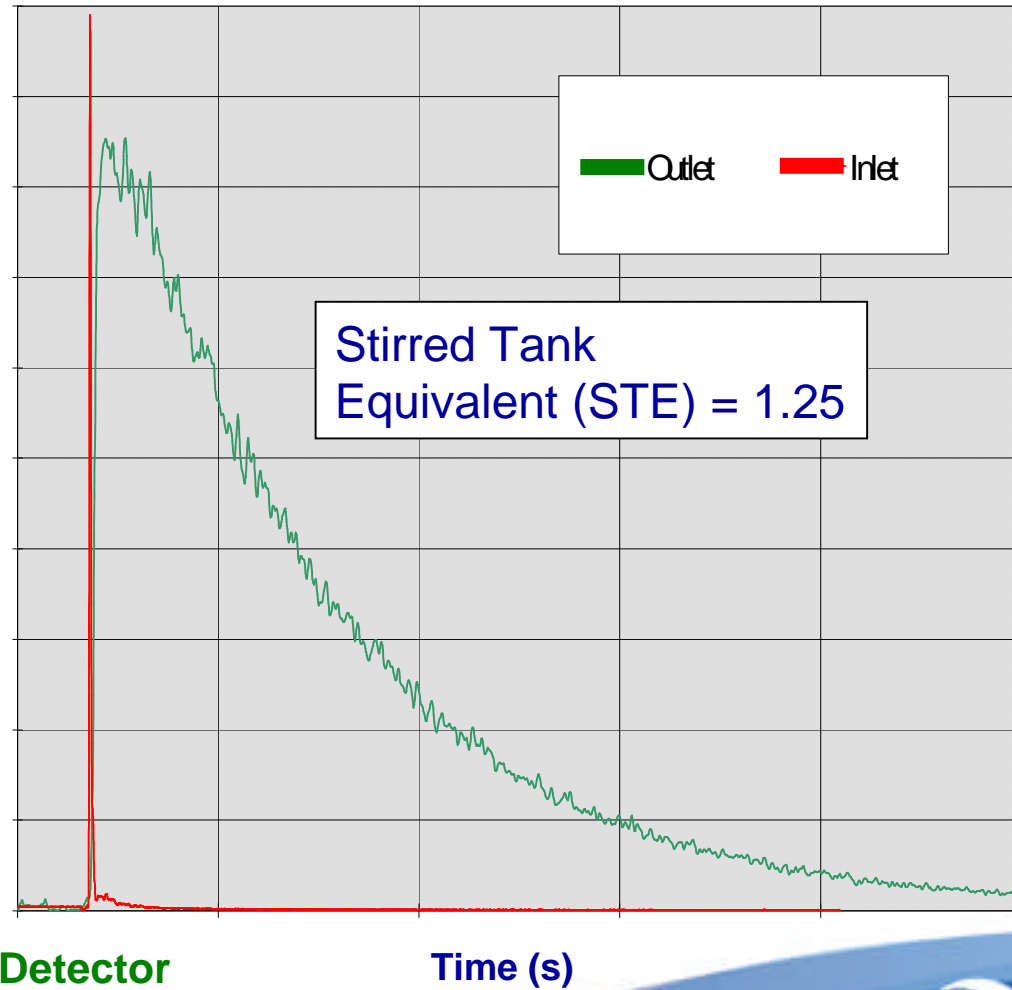
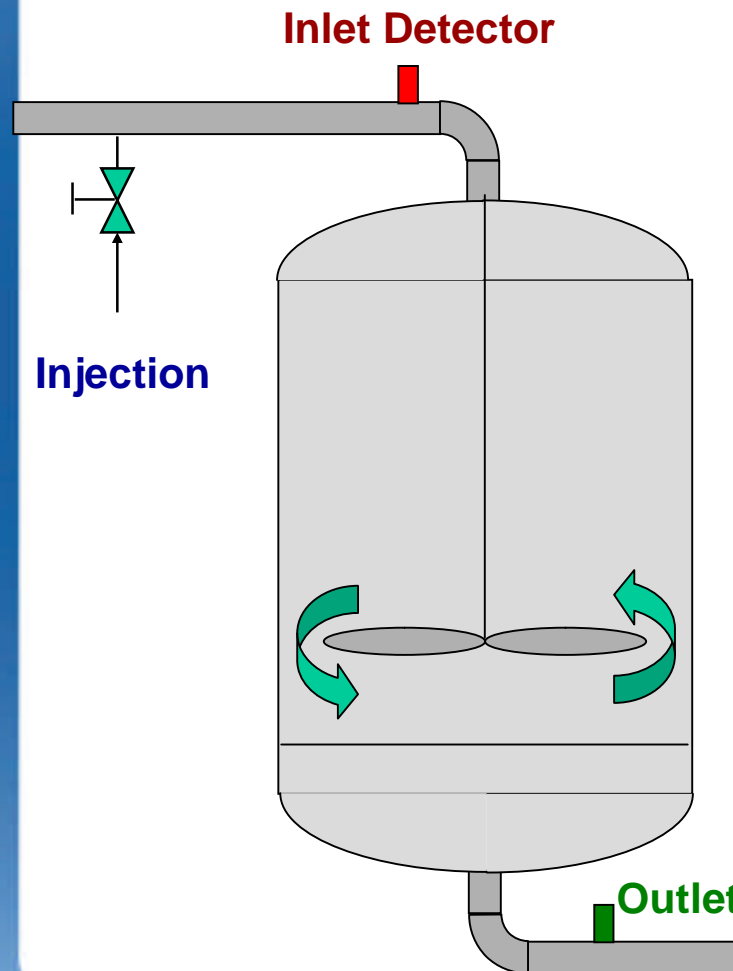
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Residence Time of Plug Flow Reactor



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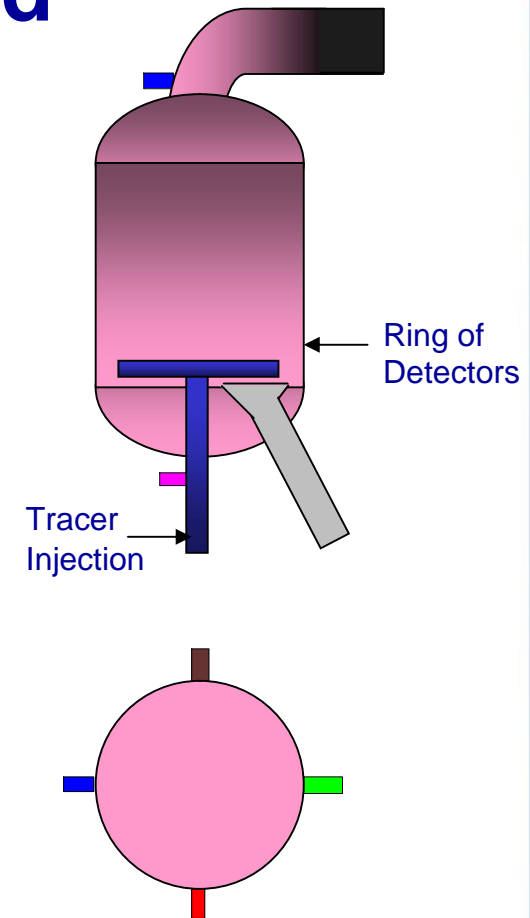
Residence Time of Stirred Tank Reactor



TRACERCO Diagnostics™ FCCU Study

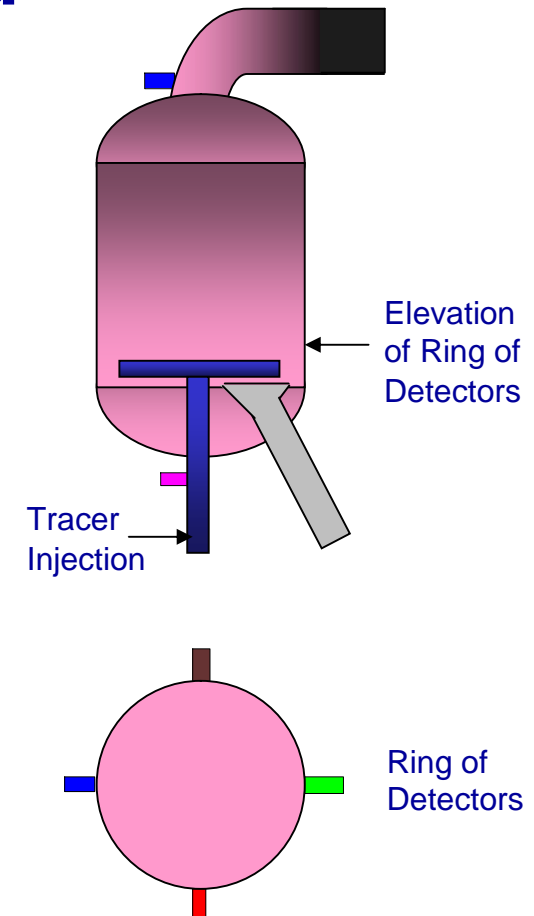
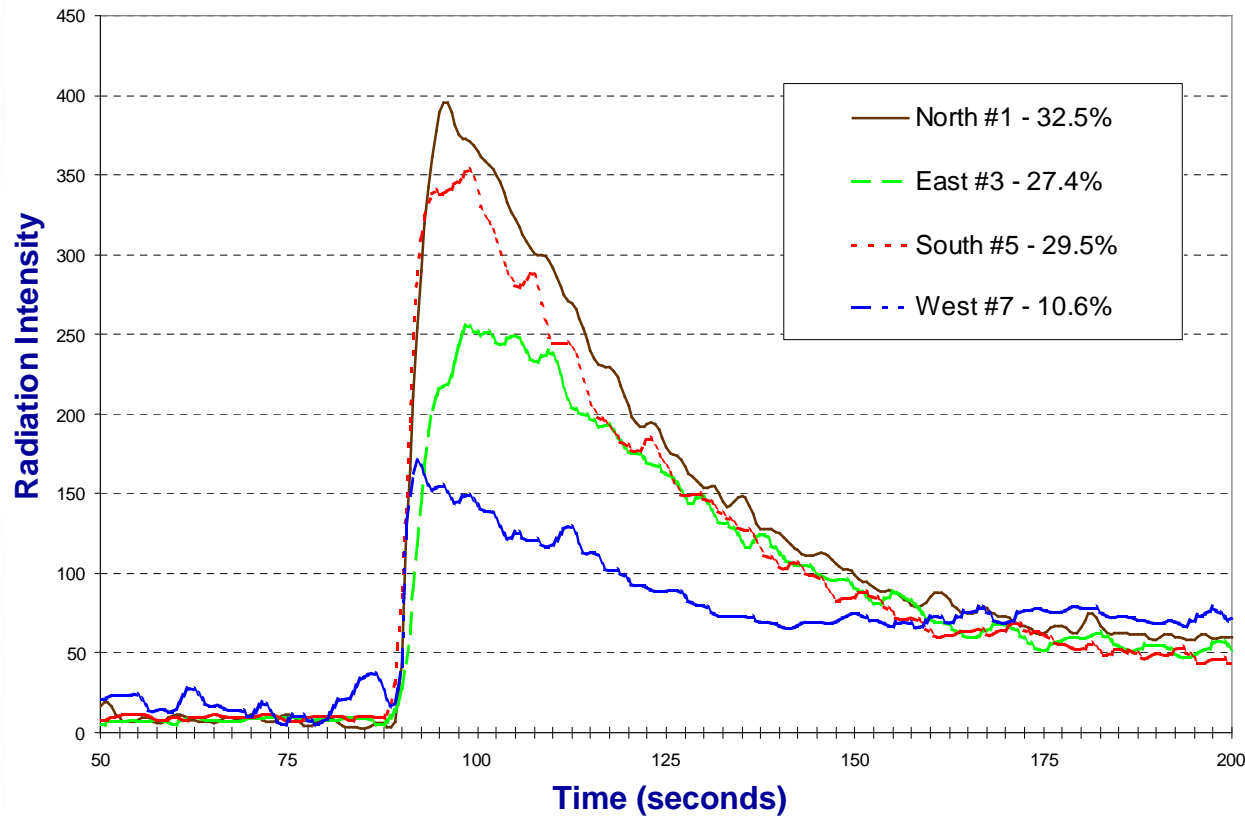
Air Distribution in Catalyst Bed

- Fluidized Catalytic Cracking Unit Studies can involve every part of the unit and as many as 80 detectors deployed to gather information about vapor and catalyst flows.
- One FCC Unit found “salt & pepper” Regenerated Catalyst, indicating incomplete combustion. Suspicion of poor air distribution from the Air Grid. Needed confirmation.
- A ring of detectors were mounted above the Air Grid to measure the air distribution.



TRACERCO Diagnostics™ FCCU Study

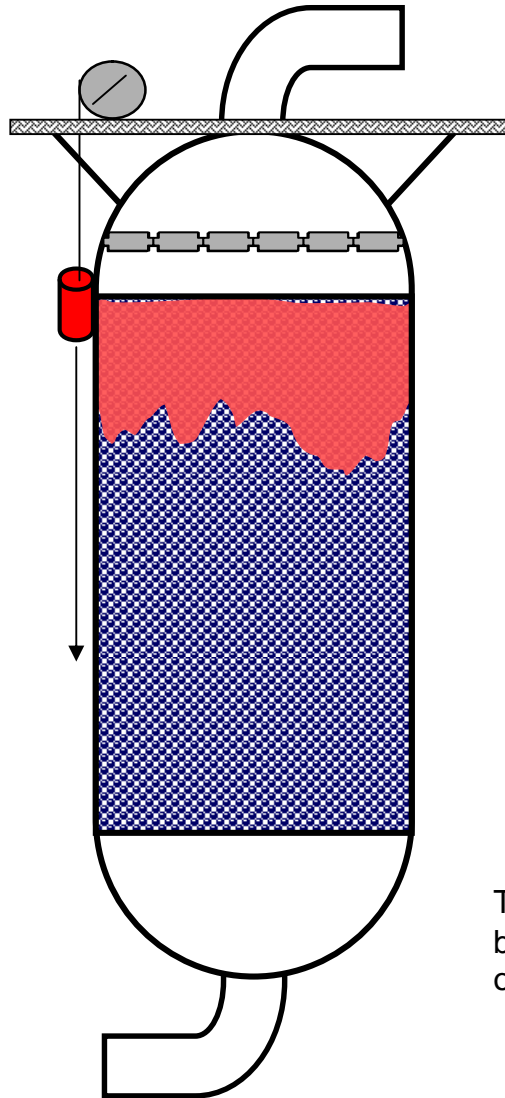
Air Distribution Catalyst Bed



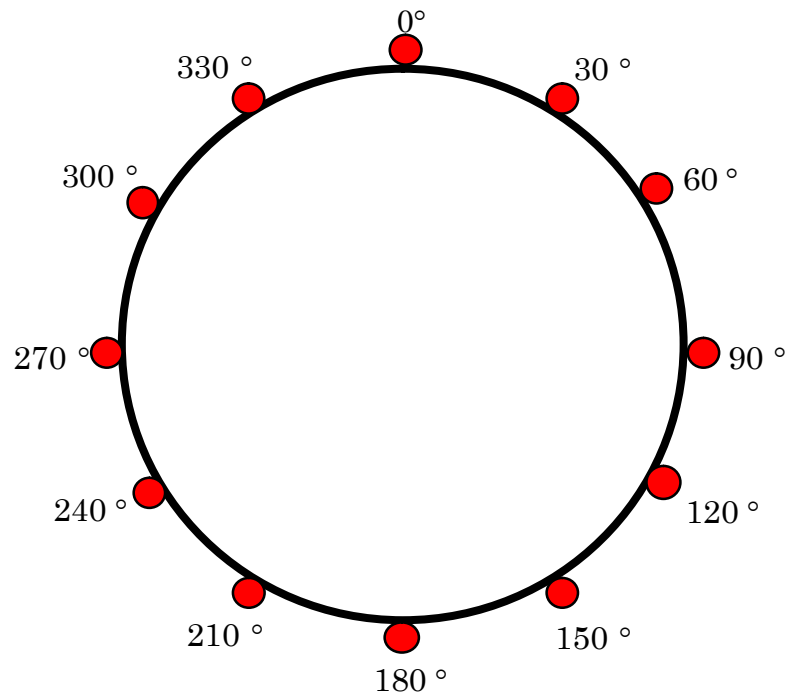
Comparing the areas under the curves, the flow near the West detector was only a third of the flow near the other detectors.

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Distribution Study



Orientation Set-up

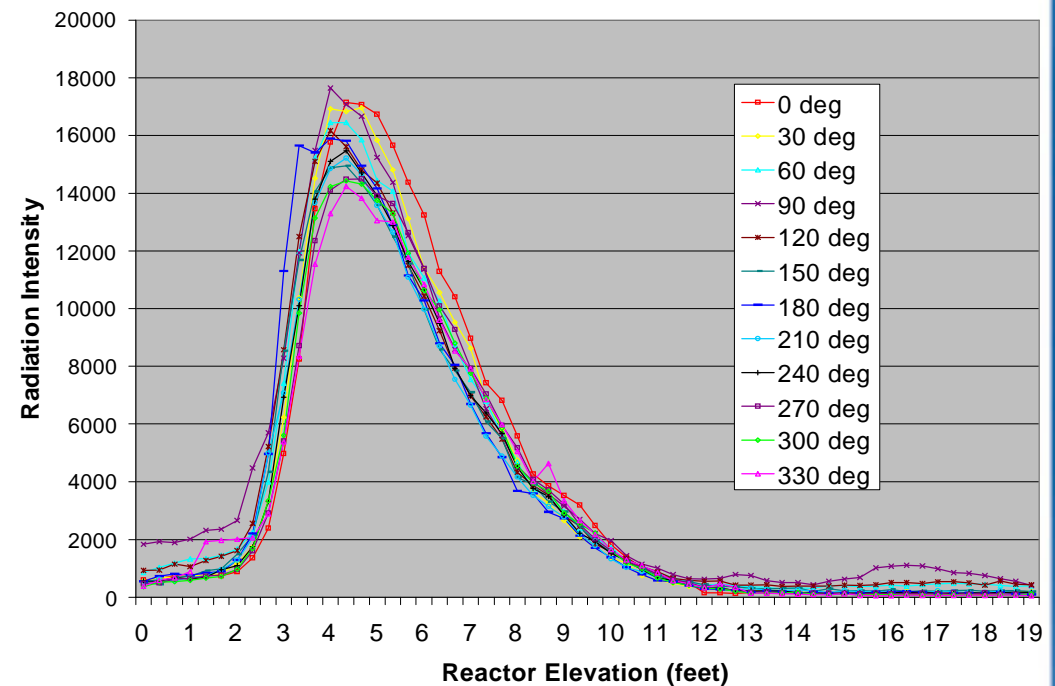
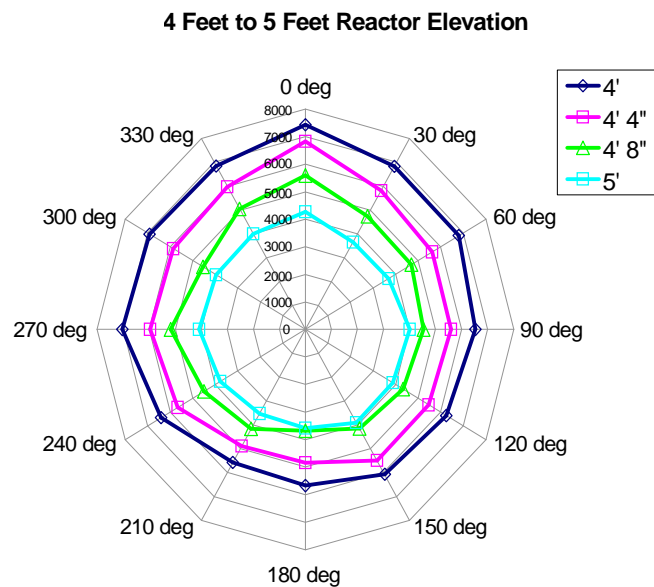


Tracer sticks to bed temporarily, so data can be collected at 8 or 12 orientations, depending on the diameter of the vessel.

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Distribution Study

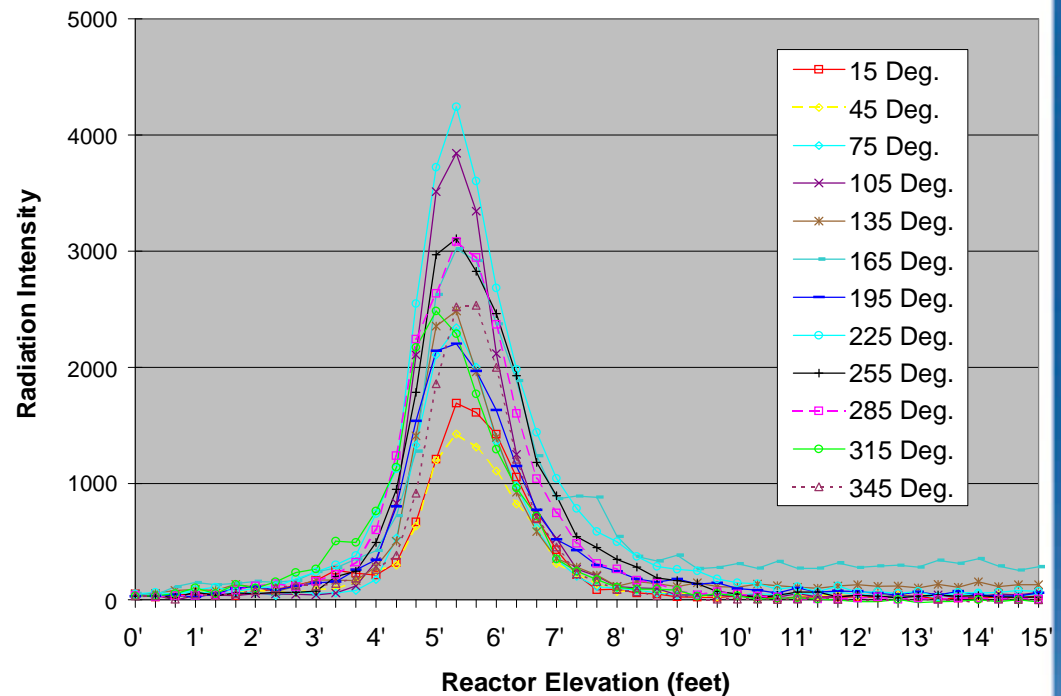
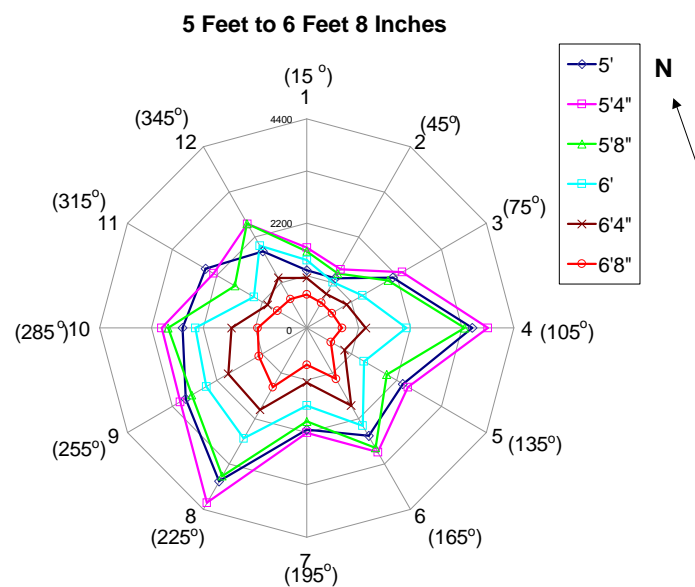
(Even Distribution)



If the distribution is even, the overlay of the plots shows consistency.

TRACERCO Diagnostics™ Distribution Study

(Maldistribution)



If the distribution is uneven, the overlay of the plots shows inconsistency.

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Helium Leak Study

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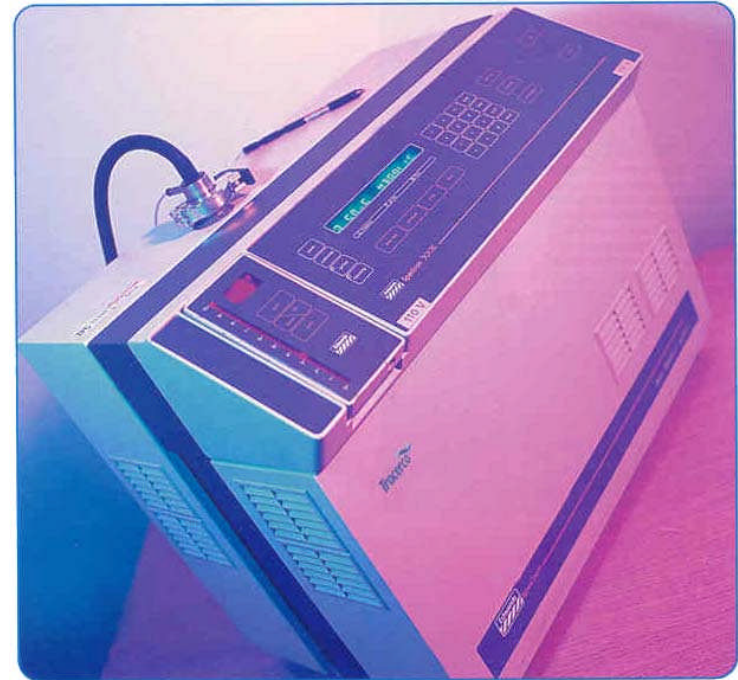
Leak Study

Helium Technology: Off-Line

- Heat Exchangers
- Storage Tanks
- Vacuum Polymerisers
- Refrigeration Units

On-Line

- Vacuum Systems



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Leak study

- Case study 1 - Shell & Tube Exchanger
- **Problem**
 - Offline heat exchanger
 - Known to leak
 - Need to repair leak
 - Total of 250 tubes
- **Options**
 - Replace exchanger
 - Identify leaking tubes with **TRACERCO Diagnostics™** Leak study (Helium)

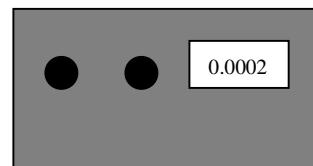
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Leak study

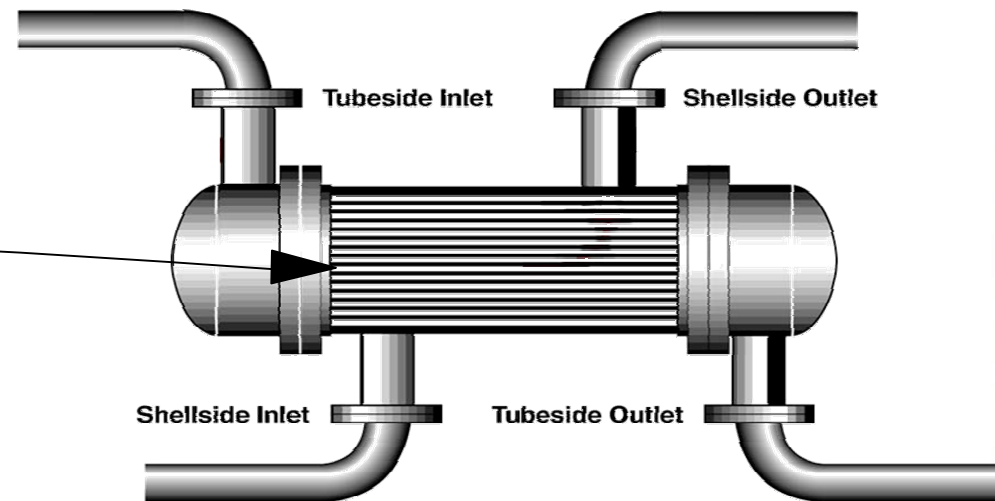
- Case Study 1 – Shell & Tube Exchanger

- **Study**

- Mixture of He & N injected on shell side
- Each individual tube tested



Mass Spec



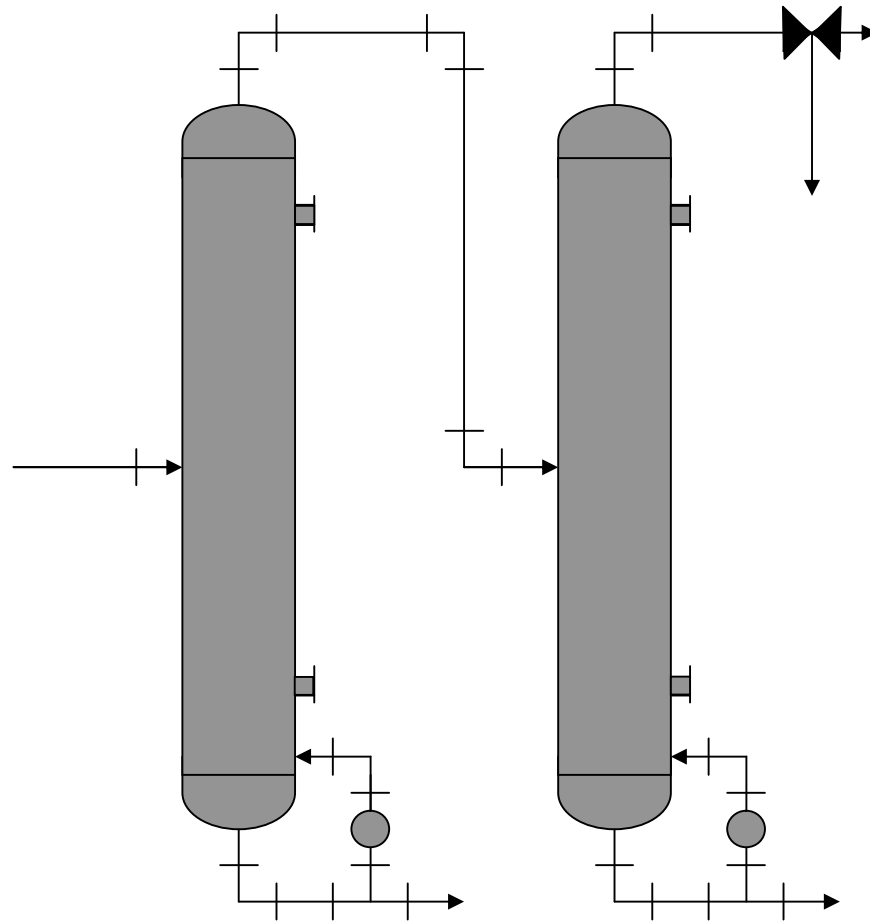
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Leak study

- Case study 1 - Shell & Tube Exchanger
- **Outcome**
 - 12 tubes confirmed as leaking
 - Tubes blocked off
 - Heat exchanger back on-line with 24 hours
 - Process operating satisfactorily
 - Eliminated cost of repairing or replacing whole heat exchanger

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On-line Helium Leak Test of Vacuum System



**Steam Ejector
Discharge**

Mass spectrometer monitors the discharge from the ejector. while helium is squirted around valve stems, sight glasses, flanges, nozzles, manways, etc.

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Leak Tests



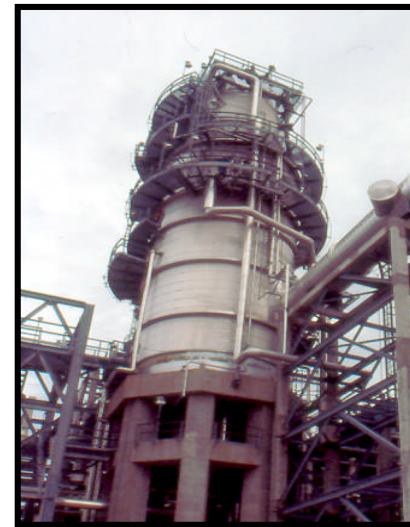
Flow Measurement



Distribution Studies



Residence Time



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TRACERCO Diagnostics™
Providing Insight Onsite

Thank You for Your Attention!
If you have additional questions
please call 800-288-8970.

