Process Equipment Imaging by Tomographic Gamma Scan

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Background: gamma scanning

Knowledge, skills and talent ...

... besides new developments

1D density profile
1D?

- Mean density values
- Carries no information about horizontal distribution

Same counts
Gammascanning challenges

- Liquid Distribution
- MD trays
- “Dry” internals (demister chicanes,…)
- Unusual shaped equipments and internals

-15°F, Perm, Russia
Master of Science Project
2010-2013

2D density vertical profile
Packed column

- Only vapor
- Top of column
- Top of packing
- Dense pockets
- Void
- Packing support
- Only vapor at bottom

2 in detector / 2 in steps / 1286 pos
Goal: apply the new technique on real field conditions

Started with a lot of challenges and ideas:

- Positioning hardware
- Automation
- Radiation detection system
- Data acquisition software
Research industrial tomography

High accuracy and complexity

Norway project, 2013

Brazil project, 2009

Korea project, 2012
Field equipment requirements

Transition to field is not straightforward

- Simple
- Versatile
- Light
- Easy usage and maintenance
- Robust
- Autonomous
- Few on-site requirements
Is it possible to use a standard gamma scan equipment to collect the data needed for a tomographic gamma scan?

Answer: Yes!

- Review of gamma scan principles
  - New working procedures
  - Adapt equipment and software
  - Very low investment spent
- Patent Pending
Case 1 – Ripple tray column
Scanned region

- Internal Diam.: 5 spaces @ 600 = 3000
- Center to center: 1488
- Radiation detector
- Radiation Source
- Liquid distributor
- Trays
- Scanned Region

6.8 mCi Co-60
Results

- Manway Interference
- Only vapor
- Symmetric distributor
- Odd "lighter" trays
- Even "denser" trays

908 pos / 2 h scan time

<table>
<thead>
<tr>
<th>Material</th>
<th>Density (g/cm³)</th>
<th>Linear attenuation coefficient (µ = 1/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>7.8</td>
<td>0.419908</td>
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<tr>
<td>Water</td>
<td>1.0</td>
<td>0.063162</td>
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<tr>
<td>Air</td>
<td>0.001205</td>
<td>0.000068</td>
</tr>
</tbody>
</table>
A priori image improvement

Proposed solution

Resulted image

Linear attenuation coeff.

0.060000
0.056471
0.052706
0.048941
0.045176
0.041412
0.037647
0.033882
0.031118
0.026353
0.022588
0.018824
0.015059
0.011294
0.007529
0.003765
0.000000
1/cm
Project status

More investigations

- Obtain image at different planes
- Images at different operational conditions
- Conventional tomography at different trays
Case 2 – Deaerator

9,5 mCi Co-60
Results

1371 pos / 3.5 h scan
A priori result
Effect of scan increment

- All Data D10S10 1371 pts
- D20 S20 353 pts
- D30 S30 157 pts
- D40 S40 89 pts

- 3.5 h (estimated)
- 54 min (estimated)
- 24 min (estimated)
- 14 min (estimated)
Multi-detector systems

All Data
1371 pts

D50 S10
281 pts

With 10 detectors
@ 50 cm spacing
52 positions
8 min (estim.)

3.5 h
43 min (estimated)
Project status

- Customer decides to live with the problem until next turnaround
- More tests being scheduled
Summary

• Successful transition to field
  • Similar sources
    • Bigger sources – depending on diameter, wall thick and internals
  • Good scan time
    • Bigger acquisition times – depending on diameter, wall thick and internals
  • Same gamma scanning equipment
  • Low investment cost
Summary

• Revealing more features and new information
  ❑ Better understand existing problems
  ❑ Open possibilities for other situations
Coming next…

- Multi-detector scans
- Multi slice scans
- 3D images

Thank You!