Distributor Plate Modeling with CPFD’s Barracuda, Compared to ECVT

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August 7, 2013
Outline

- Experiment
- Electrical Capacitance Volume Tomography
- Computational Models
- Comparison
Experiment: Geometry

Gas Exit to Filter

ECVT Sensor

39.37 cm

1.27 cm

8.89 cm

Distributor

Air Inlet

170 cm

30 cm

3.8 cm

15.2 cm

45°

ϕ.16 cm

ϕ7.62 cm

ϕ5.08 cm

ϕ2.54 cm
Experiment: Particles

- Density: 2.48 g/cm$^3$
- Mean: 185 $\mu$m
- Sphericity: 0.98
- $U_{mf}$: 3.18 cm/s

Static Bed Height: 26.2cm

$U_g/U_{mf}=4$, or specifically 12.68 cm/s
Electrical Capacitance Tomography [ECT]

Relative permittivity
Air ≈ 1
Polyethylene ≈ 2.25
Glass ≈ 4.7
Electrical Capacitance Volume Tomography [ECVT]

Relative permittivity
Air ≈1
Polyethylene ≈ 2.25
Glass ≈ 4.7
Electrical Capacitance Volume Tomography
Computational Models
Computational Models
Results: Velocity Distribution

![Graph showing velocity distribution across radius](image)
Results: Plenum Mass Flow
Results Solid Fraction

Uniform  Discrete  Plenum  Jets  ECVT
Results: Time Average Solid Fraction

Uniform  Discrete  Plenum  Jets  ECVT
Results: Time Average Solid Fraction

Graph showing the variation of solid fraction with radius for different conditions.
Results: Dynamics

Plenum Model

ECVT
Results: Dynamics

- Experiment
- Model

Graphs showing normalized amplitude against frequency for different conditions.

Legend:
- Distributor
- Bed
- Dist Mov Avg
- Bed Mov Avg
Summary

• Four CPFD Barracuda models were compared to ECVT and high speed pressure transducers.
• The plenum model compared best with the experimental data, however the slowest [1s/day].
• The jets model compared reasonably well, and was significantly faster [30s/day].
• The typical uniform distribution did not perform well at all.

Weber, J., Layfield, K., VanEssendelft, D., Mei, J., “Fluid Bed Characterization Using Electrical Capacitance Volume Tomography (ECVT), Compared to Computational Particle Fluid Dynamics’s (CPFD) Barracuda”, Powder Technology. - Submitted
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# Backup Slides

<table>
<thead>
<tr>
<th>Model</th>
<th>Grid</th>
<th>Cells (Fluid)</th>
<th>Particles (Clouds)</th>
<th>Computation Time</th>
<th>Average Time Step</th>
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<tr>
<td>Uniform</td>
<td>20x20x65</td>
<td>26k (22k)</td>
<td>61M (0.5M)</td>
<td>63.5s/day</td>
<td>2.98x10^{-3}s</td>
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<td>Discrete</td>
<td>23x23x65</td>
<td>34k (28k)</td>
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<td>21.7s/day</td>
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<td>Plenum</td>
<td>22x22x107</td>
<td>52k (45k)</td>
<td>62M (0.8M)</td>
<td>0.98s/day</td>
<td>4.01x10^{-5}s</td>
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<td>Jets</td>
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<td>62M (0.6M)</td>
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<td>2.80 x10^{-3}s</td>
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<th>Plenum</th>
<th>Jets</th>
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