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# Barracuda for Fluidized Bed Hydrodynamics

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Solids Processing – E&PS – Core R&D

The Dow Chemical Company

# How I have used Barracuda

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- Validate cold flow fluidization experiments
- Investigate the effect of gas properties and process conditions on hydrodynamics
- Investigate the effect of reactor design on hydrodynamics
- Chemistry module is used to model the effect of chemistry on hydrodynamics (volume change of gas due to reaction)
- Final thoughts

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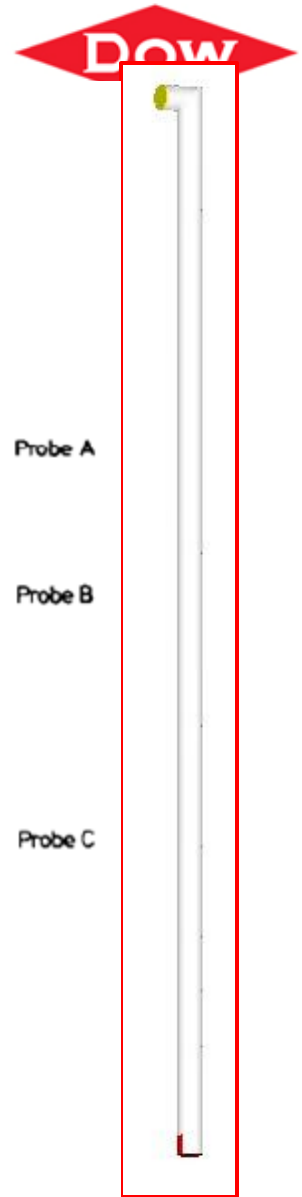
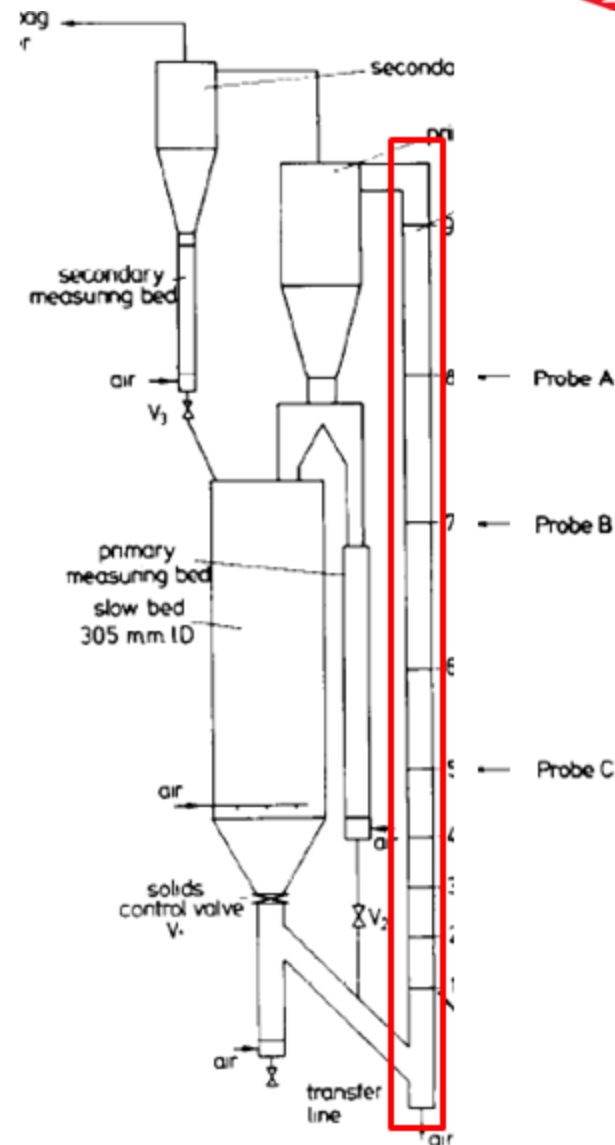


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# Example : Riser Flow

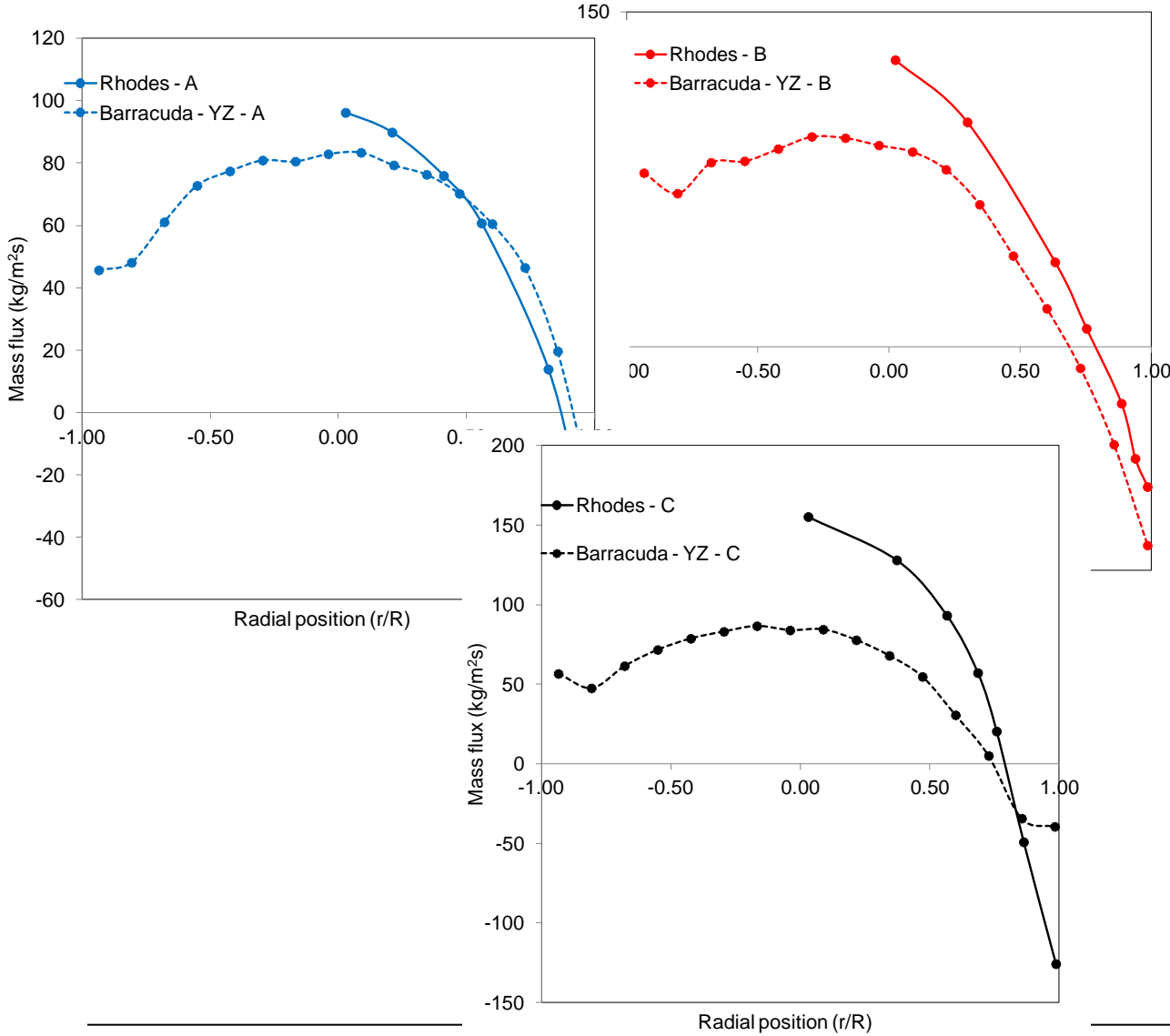
- Process Background
  - Circulating fluidized bed reactor
- Objective
  - Validate riser hydrodynamics using Barracuda software with experimental data (Rhodes, 1990)
  - Alumina particles of mean  $64 \mu\text{m}$  and particle density of  $1800 \text{ kg/m}^3$ .
  - Three probes A, B and C at different levels to measure radial profile of axial mass flux (vertical direction)

Rhodes, M.J., 1990, Modeling the flow structure of upward-flowing gas-solids suspensions, *Powder Technology*, 60, 27-38.

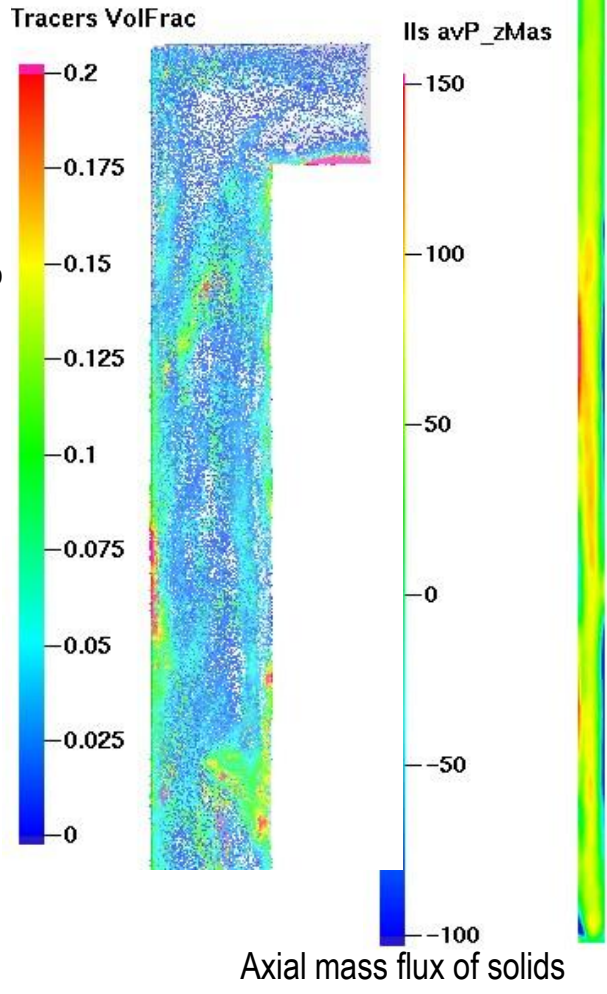




# Barracuda results



7.0000298e+01



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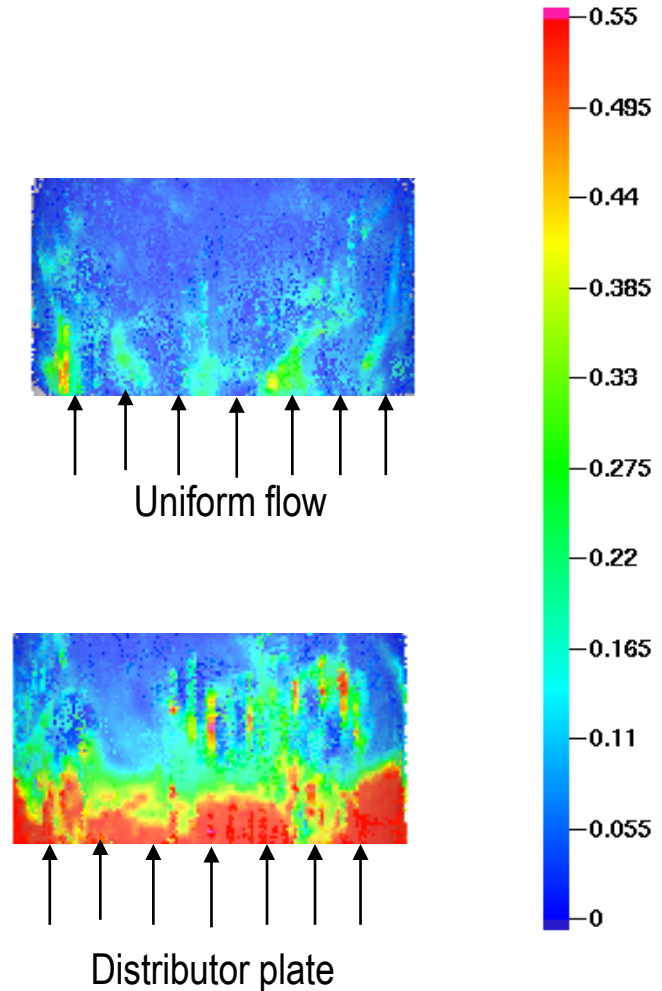
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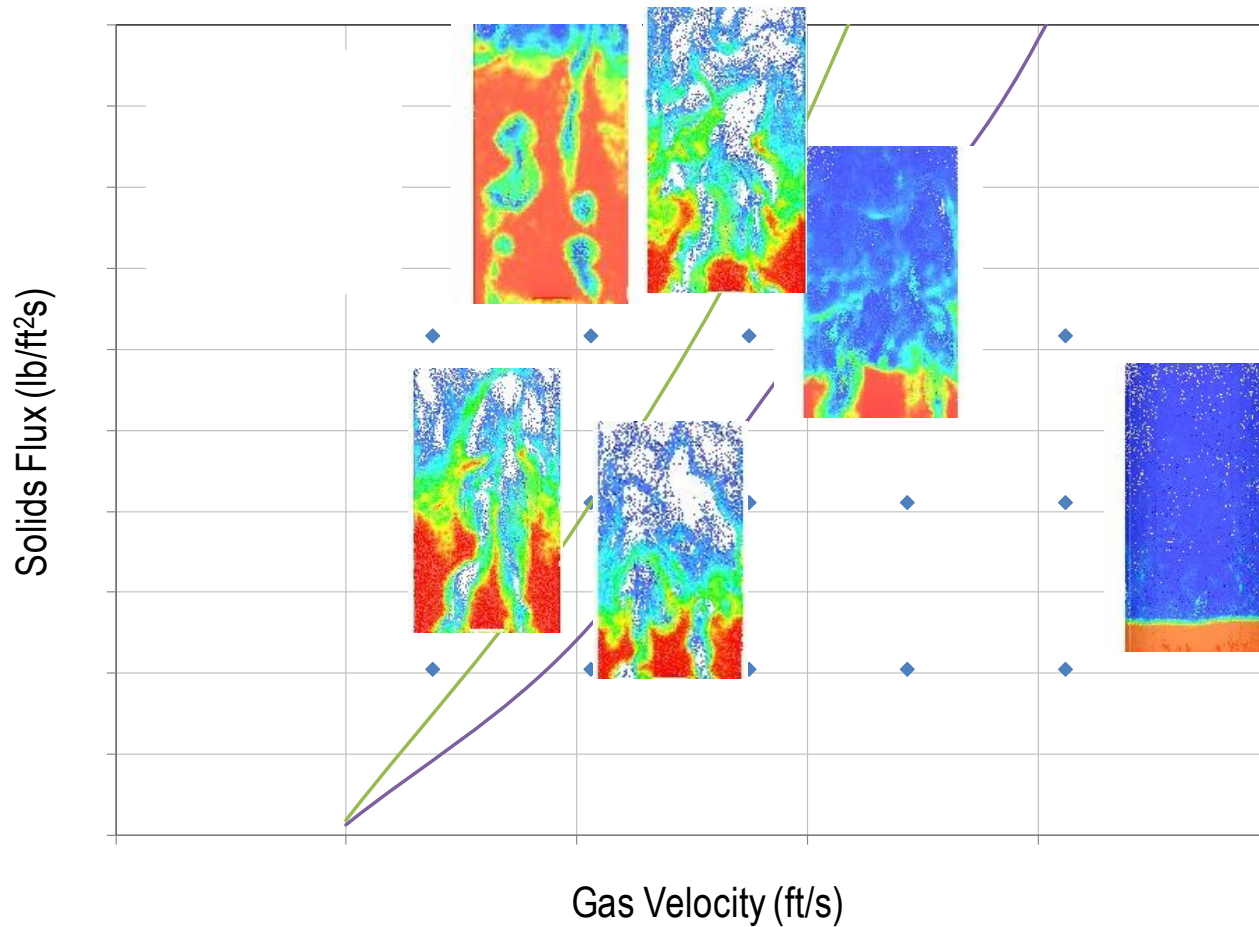
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# Distributor vs Uniform Gas Flow

- Uniform gas flow led to very low density of solids in the reactor
- The gap between the holes in the simulation with grid plate causing the bed to build-up ?



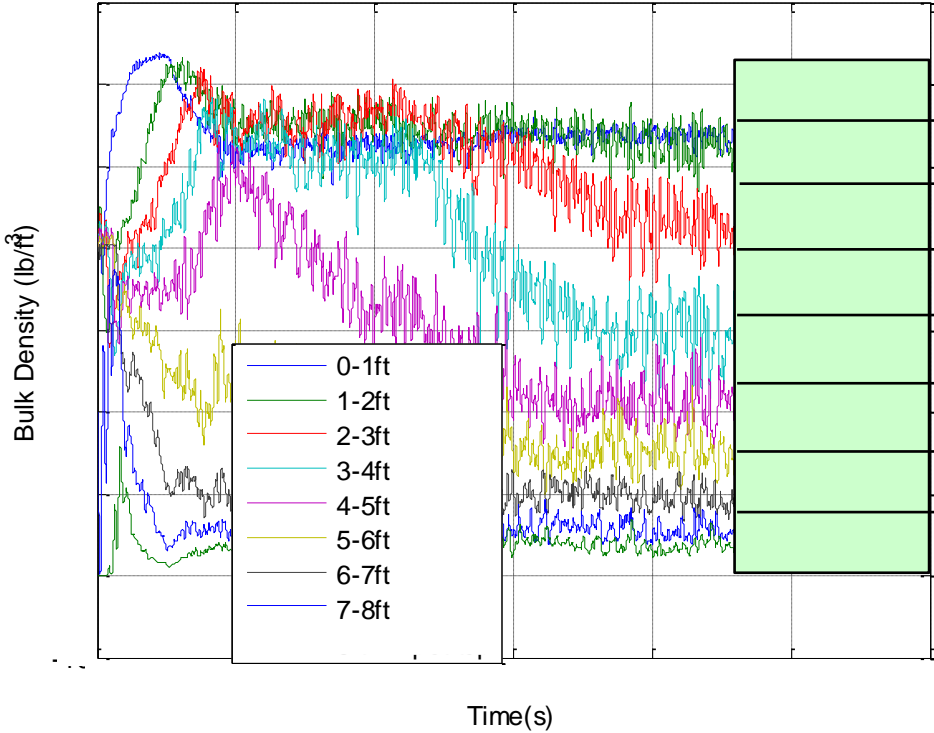
# Effect of Process Conditions on Hydrodynamics



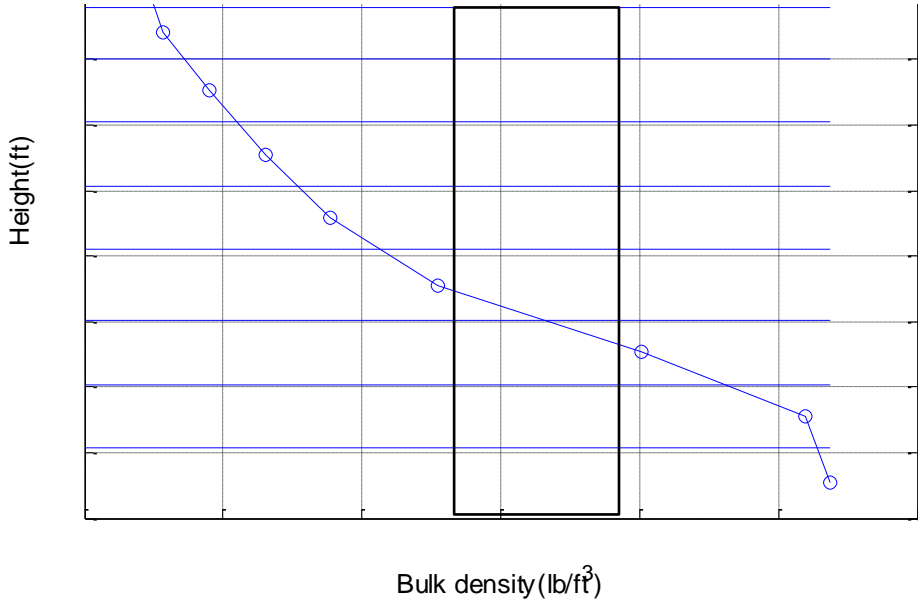




# Bulk Density in the System

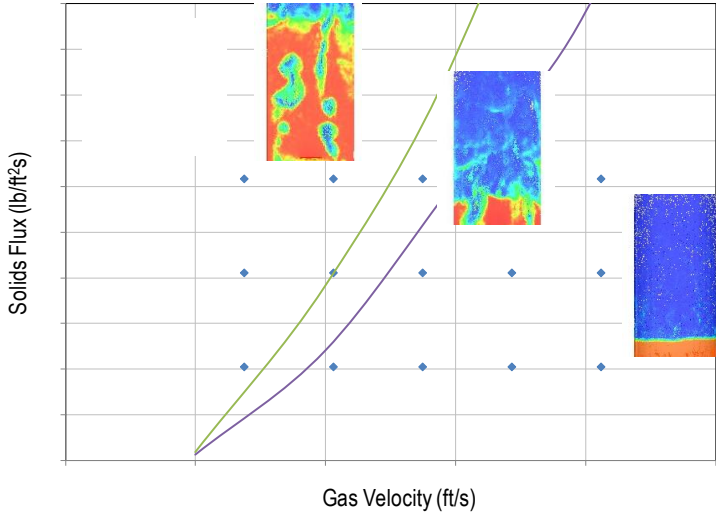
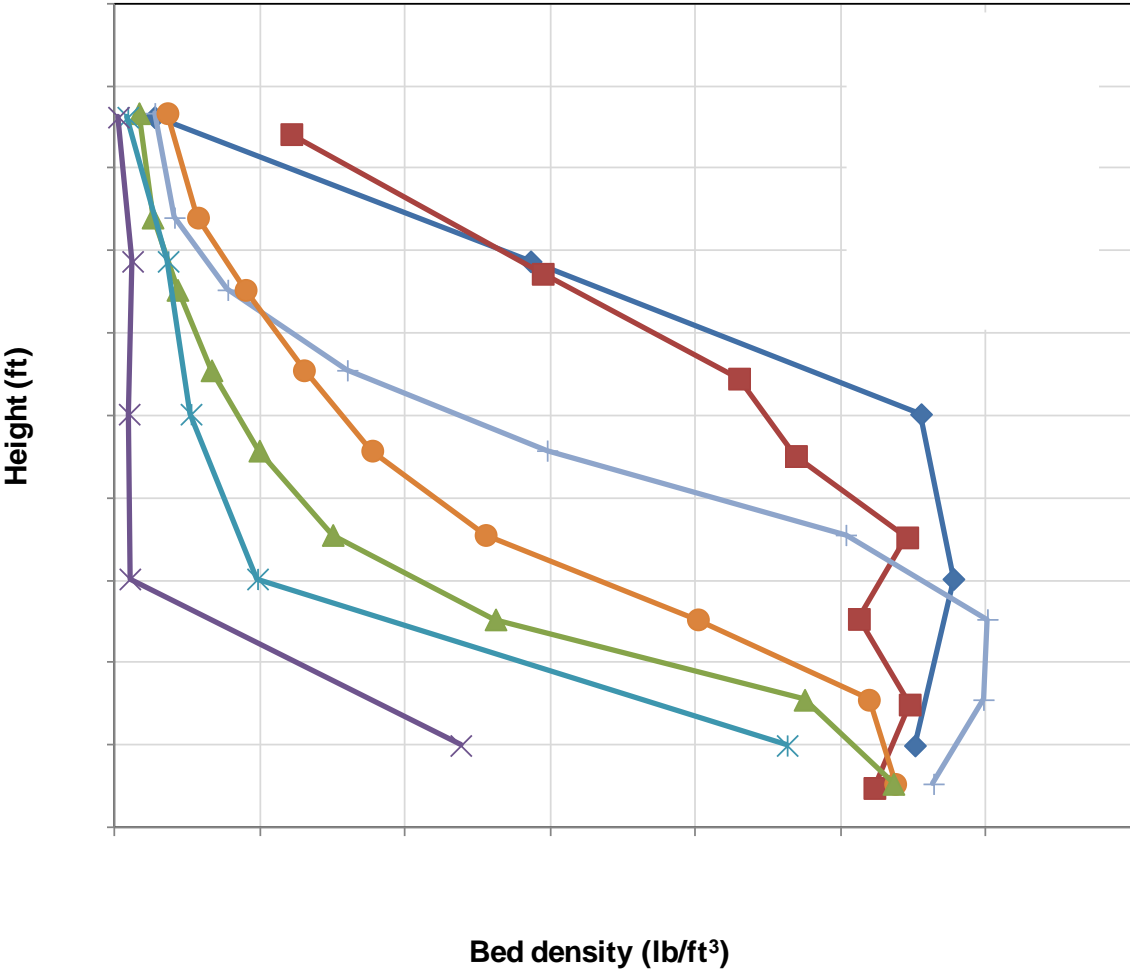


Bulk density with time in different regions



Bulk Density vs Height

# Effect of Gas Velocity and Solids Flux



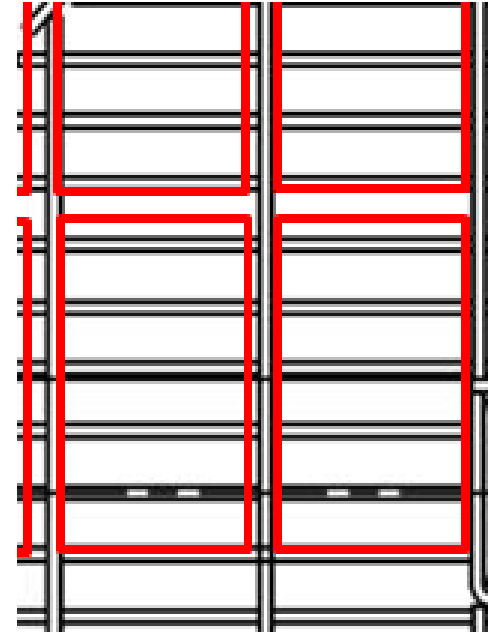
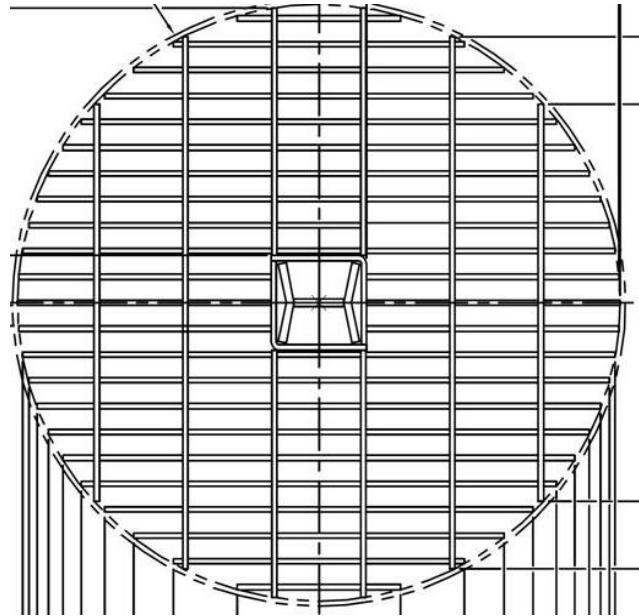
# How I have used Barracuda

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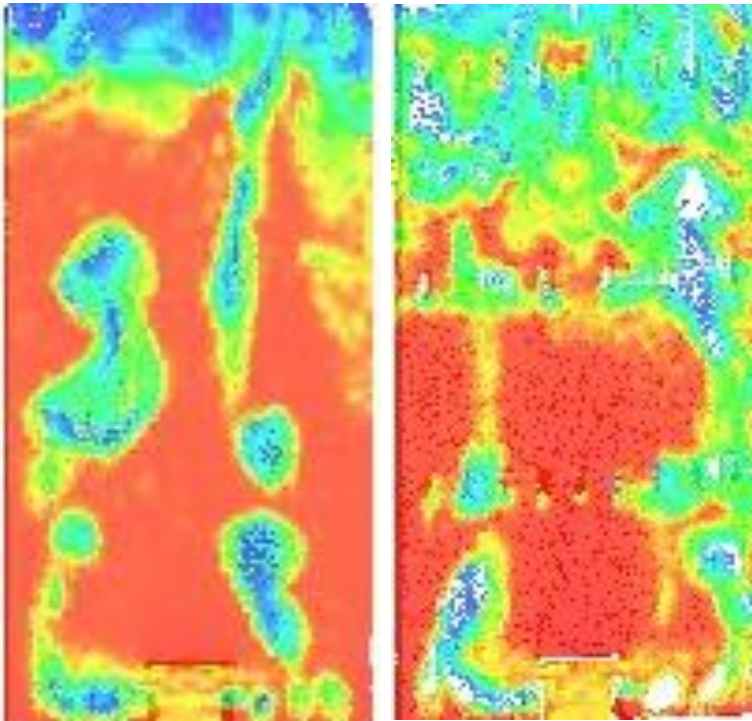
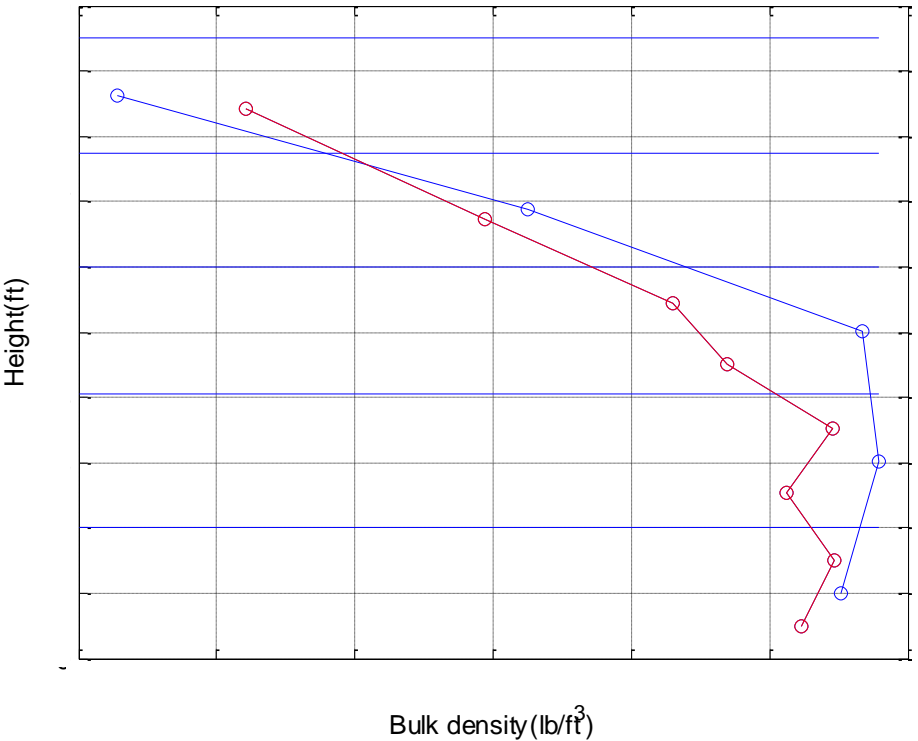
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# Simulating Baffles

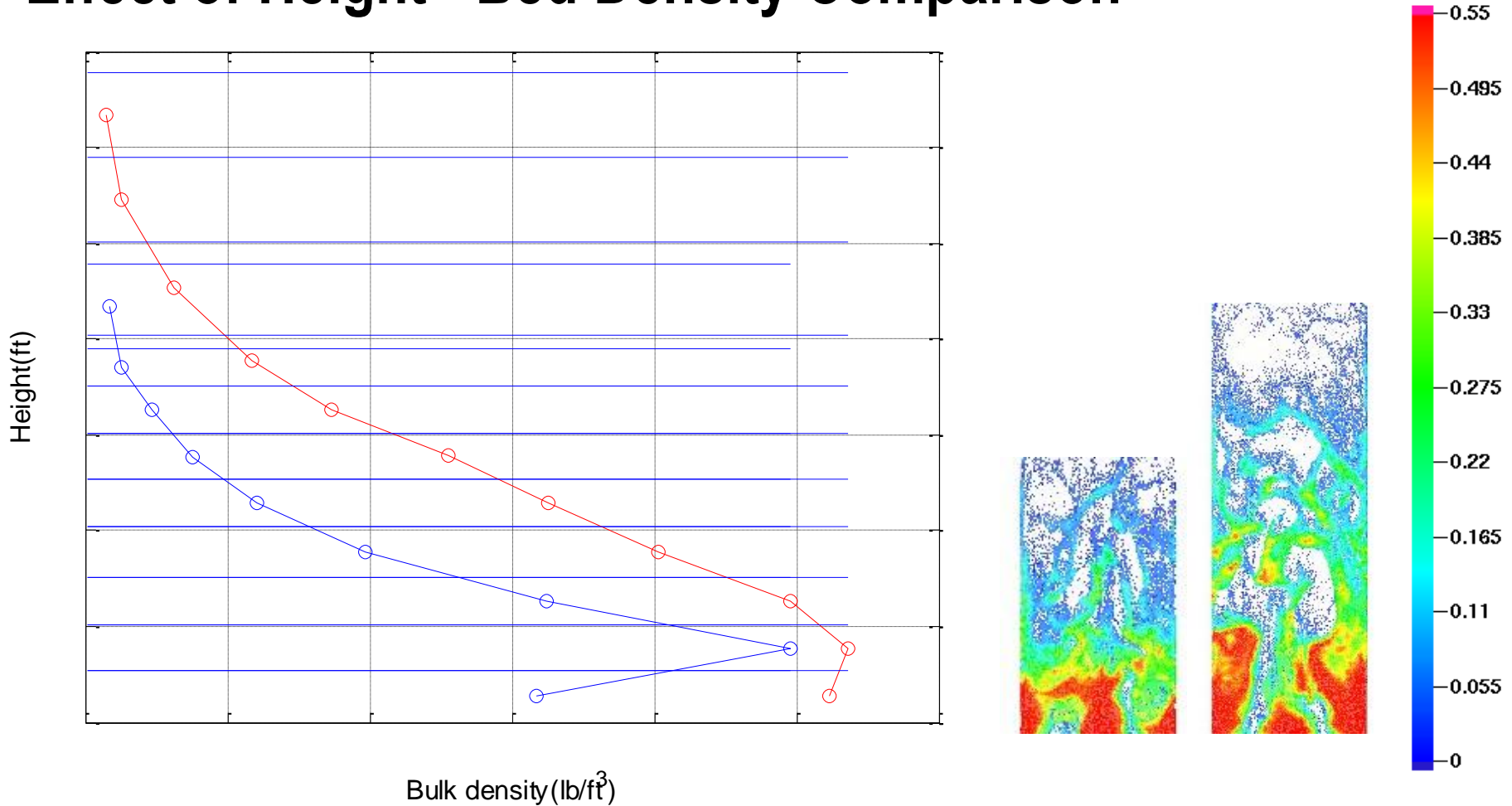


Baffles affect the bed density profile and the bubble size

# Effect of Baffles



# Effect of Height - Bed Density Comparison



**Bed height increases around 2 – 3 ft (depending on bulk density)**

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# Final Thoughts

- Advantages of Barracuda
  - Best for dense “fluidized” flows
  - Can model complete particle size distribution
  - Can model large number of particles using computationally efficient technique
  - Can model industrial scale fluid bed reactors
  - Can qualitatively model erosion and wear due to particle collisions.
  
- Limitations of Barracuda
  - Insufficient turbulence modeling for dilute flows (freeboard, riser flows)
  - Cannot predict individual particle level stresses
  - Cannot model regions with defluidized solids
  - Cannot model particle-wall contacts correctly – leads to incorrect buildups at walls

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# Final Thoughts

- Points to keep in mind
  - Effect of grid size on hydrodynamics – ability to predict bubble sizes
  - Effect of grid size on chemistry – Extent of local mixing
- Some useful information from Barracuda
  - Bed density with height from flux planes
  - Overall system holdup mass
  - Gas-particle contacting
  - Gas velocity change with height (volume change of gas)





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# Acknowledgements

- CPFD
  - Peter Blaser
  - Sam Clark
  
- Dow
  - Matt Pretz
  - Mark Stewart
  - Brien Stears
  - Dee Dickerson