Applications of CFD in the Oil Sand Industry

NETL Workshop on Multiphase Flow Science

Pittsburgh, PA

May 4th-6th, 2010

Kevin Reid

Syncrude

Securing Canada's Energy Future

Syncrude is located in Northern Alberta and has 8 oil sand leases with significant reserves.

Total Potential Recoverable Reserves = 8.3 Billion Bbls SSB

55 Years @ Planned Production Rates

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Who and What are the Oil Sands and Syncrude?

The Canadian Oil Sands are a rich and vast resource

- 1.7 trillion barrels in-place
- 300+ billion barrels recoverable
- More than 30% of Canada's oil production is from the oil sands
- Slated to increase to 50% by 2020

Syncrude here and how

- Largest oil sands producer in the world
- Largest single source of oil in Canada
- Major employer
- Top researcher
- Multi-billion dollar, triple bottom line business

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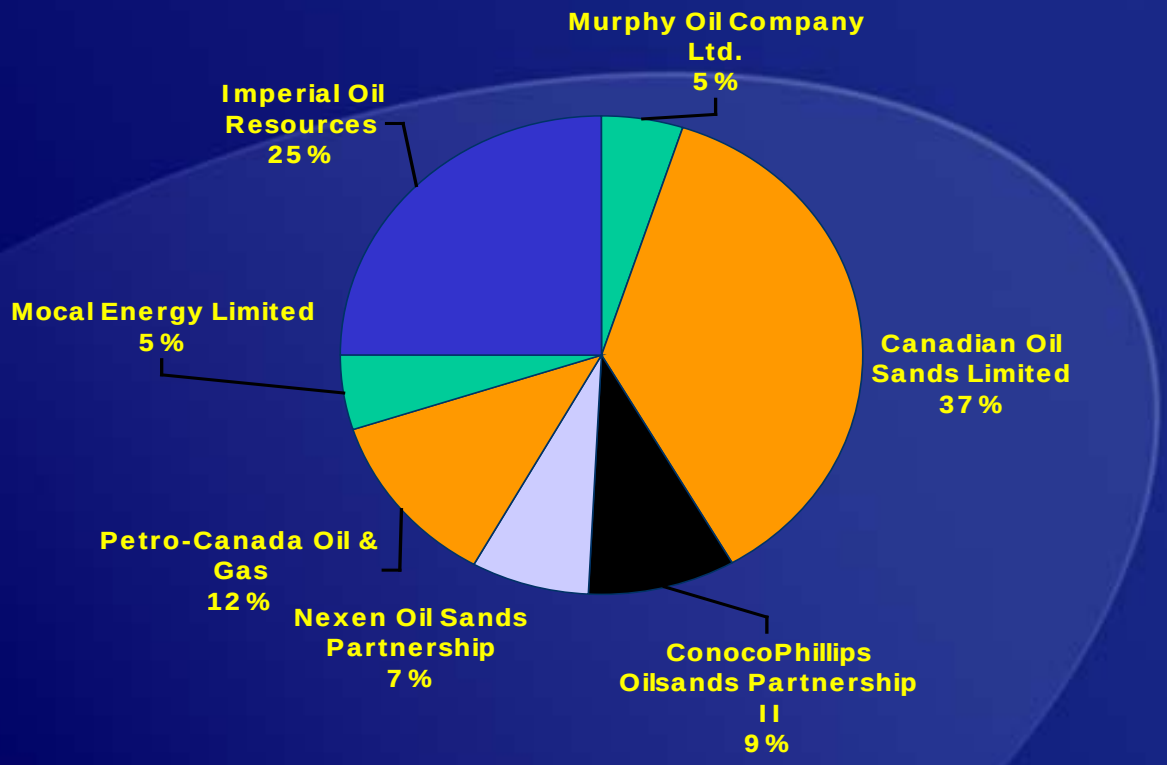
Who is Syncrude?

- Joint venture undertaking among:



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Syncrude operates mining, extraction, upgrading and utilities plants in order to produce synthetic crude from oil sand

Mining

Utilities

Bitumen Processing Operations

Upgrading

Bitumen Production Operations

Extraction

SSB

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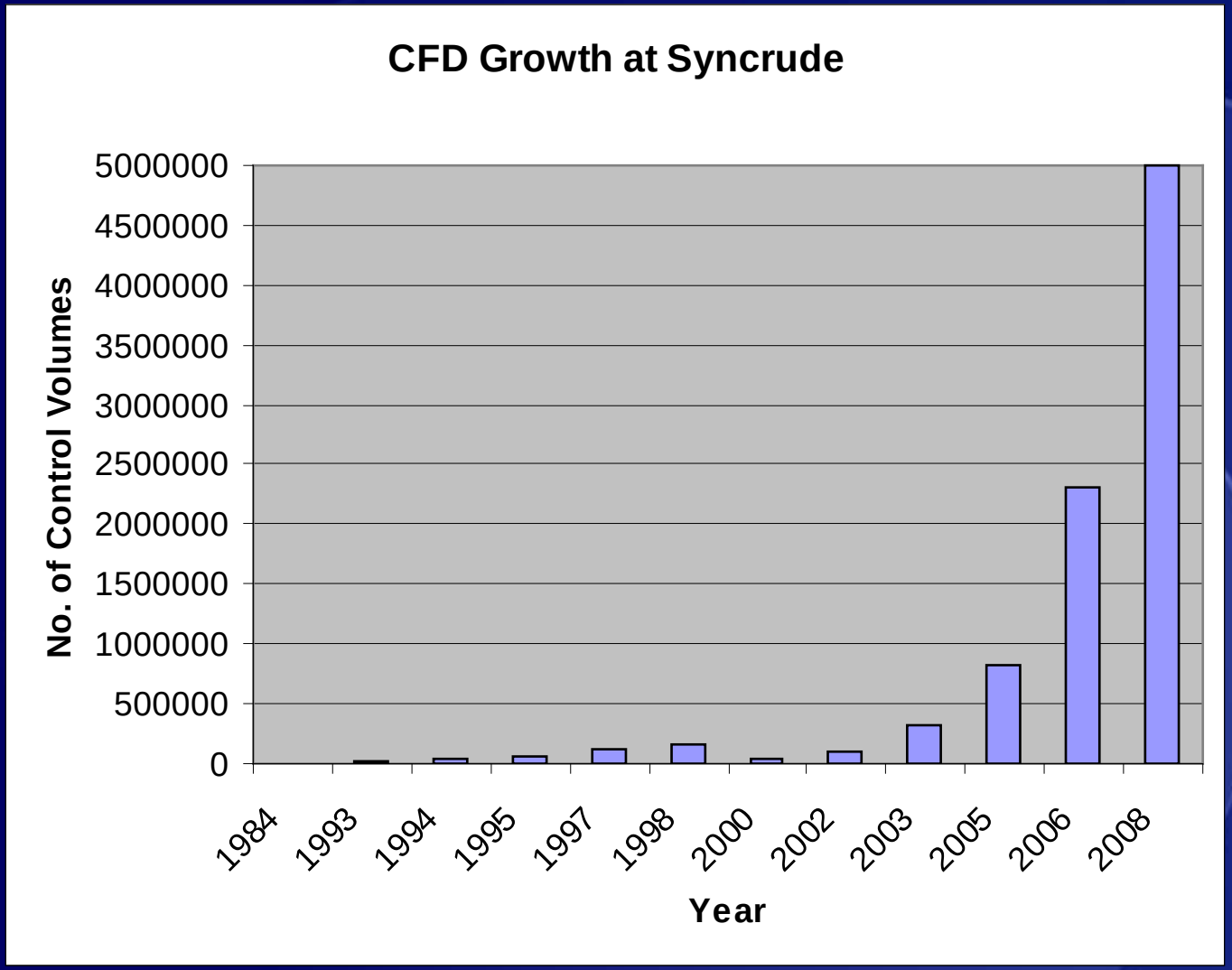
History of CFD at Syncrude

- 1984-1990
  - Simple 2-D single phase projects contracted out
- 1990 - 2000
  - Obtained first commercial code (Flow3D from AEA)
  - Ran two Unix computers
  - 3-D multiphase transient problems
  - Primarily used external contractors
  - Mostly exploring CFD capability – not integrated into research projects
- 2000 – Present
  - Larger and more complicated 3-D multiphase transient problems
  - Done in-house as well as through external consultants
  - Integrated into research projects to compliment experimental work

History of CFD at Syncrude



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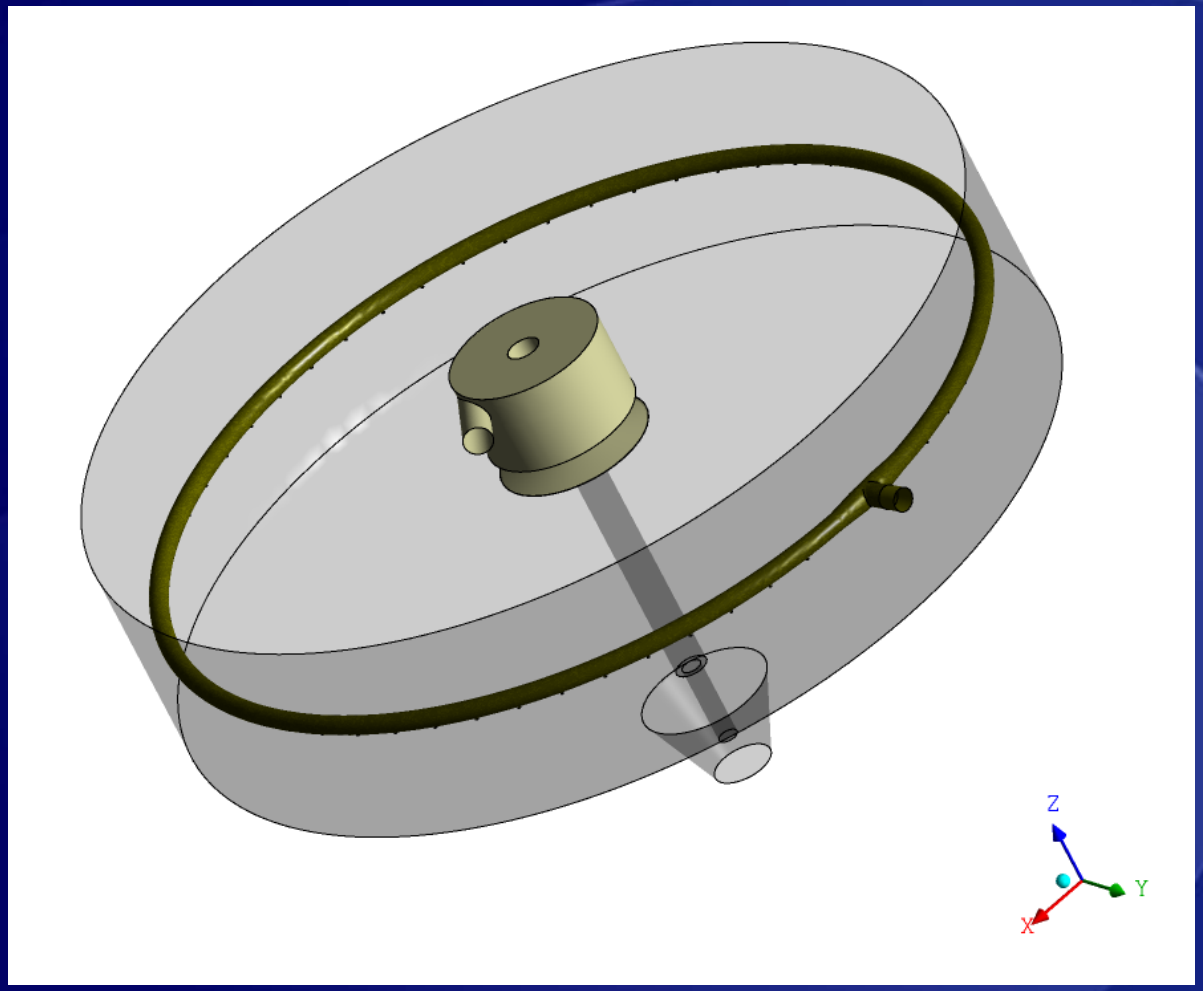
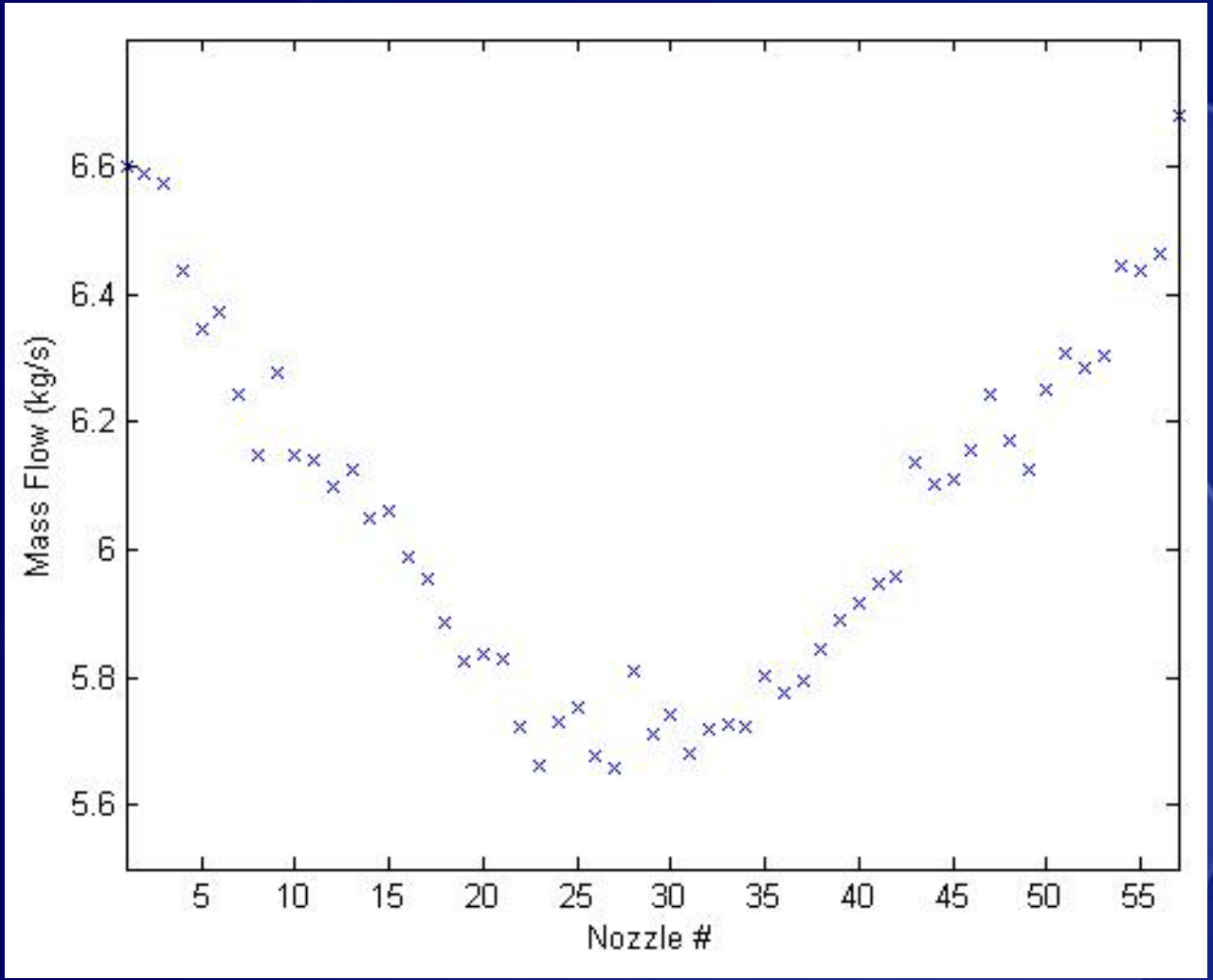
Primary Separation Vessels

Aurora PSV

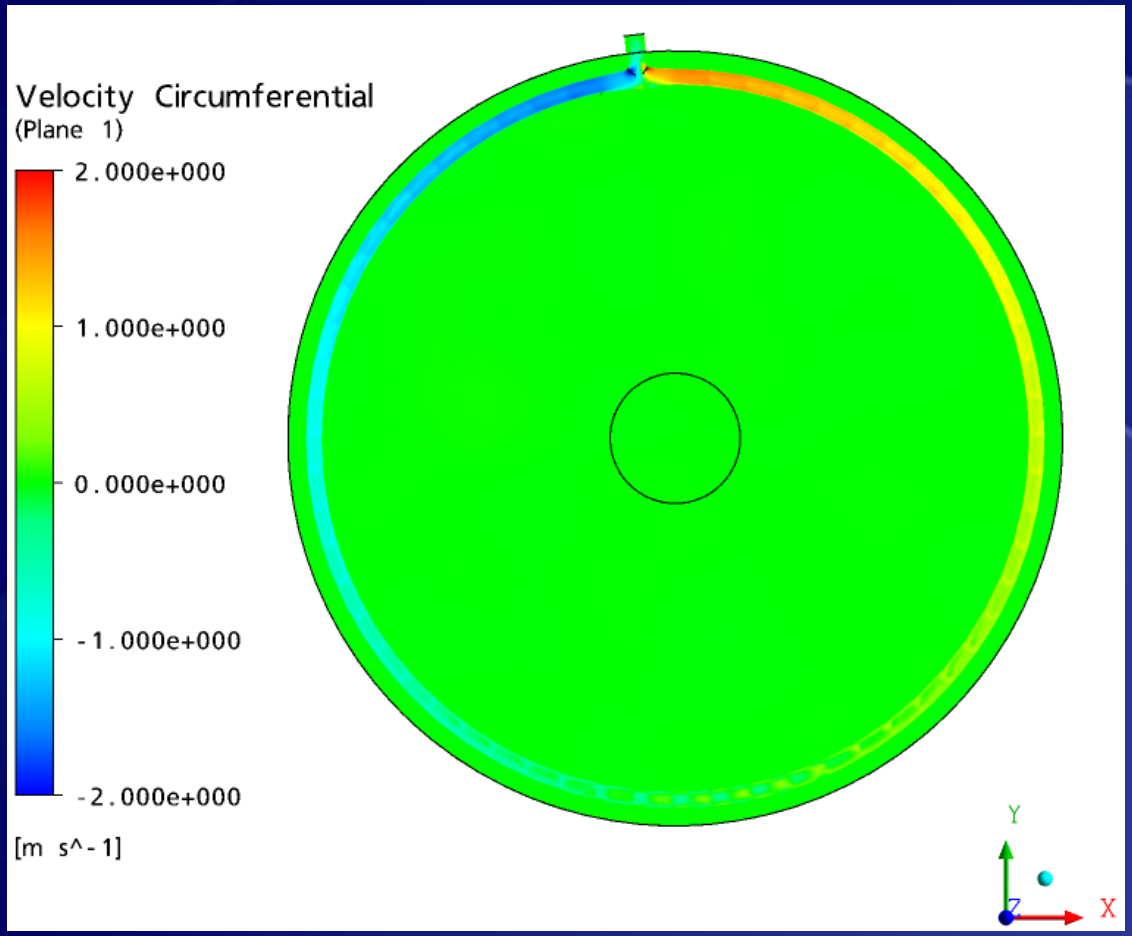
Full Bustle Design (Current)



Full Bustle Design (Current)



Full Bustle Design (Current)



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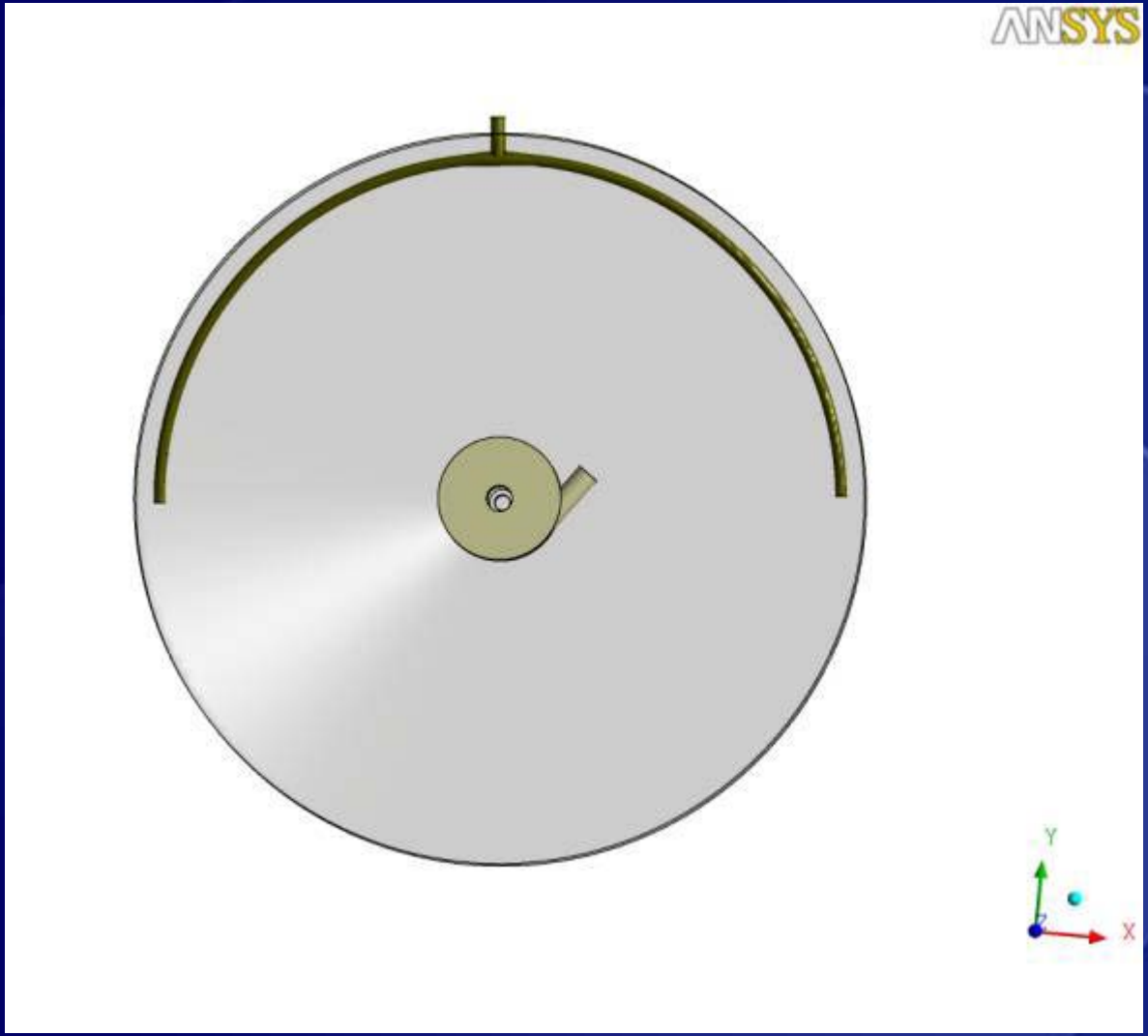
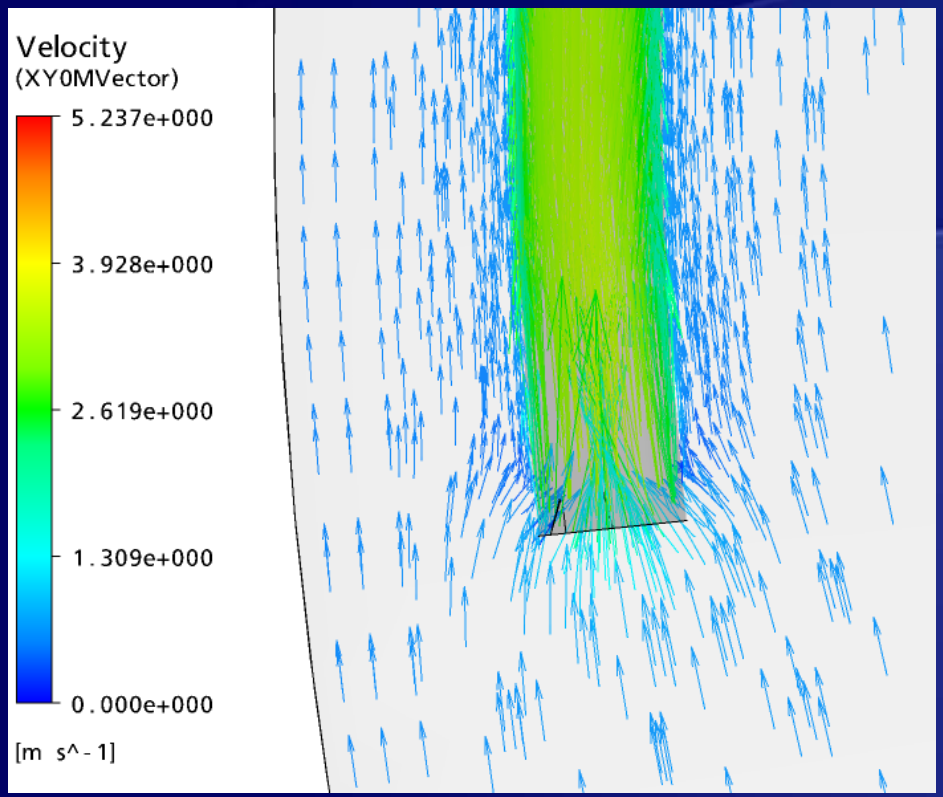
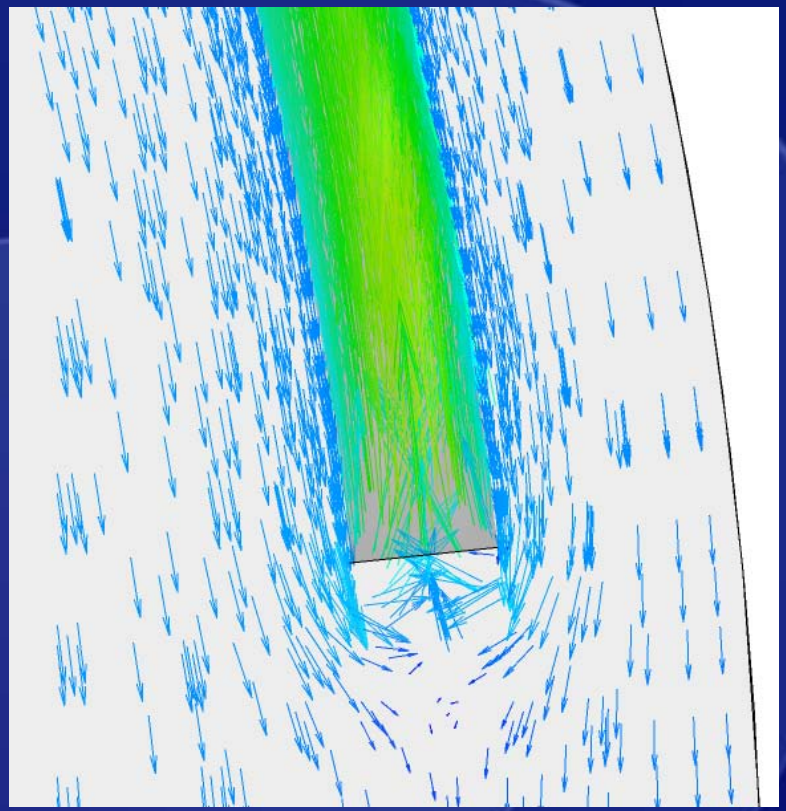
Half Bustle Design (Proposed)



Half Bustle Design

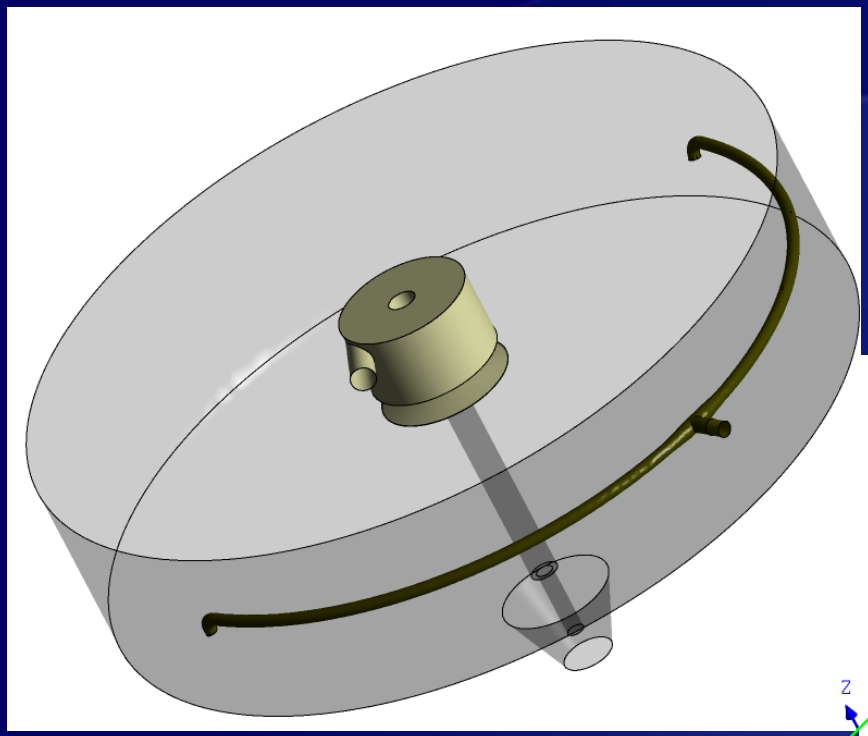


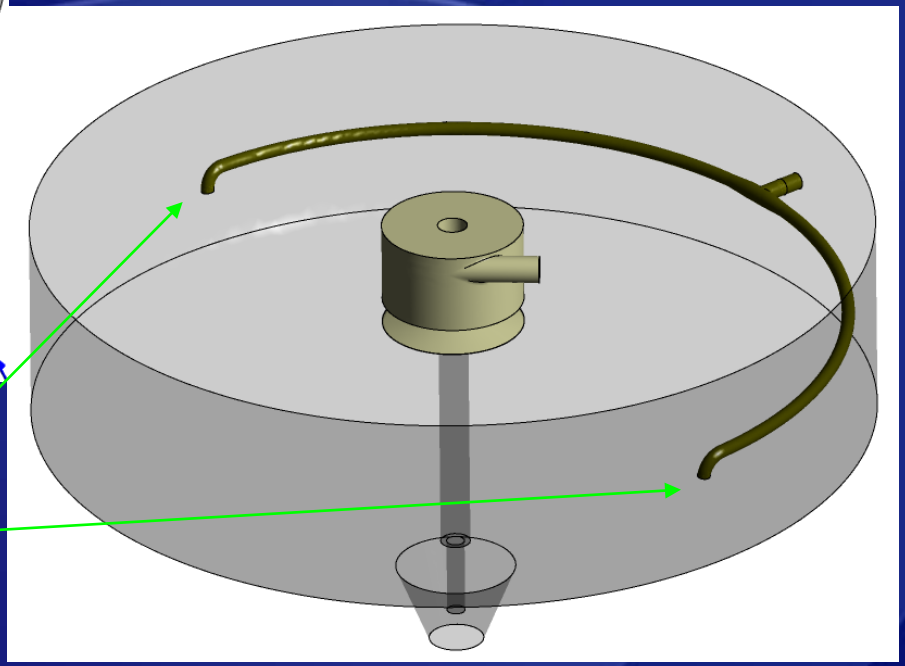


Left Middlings Inlet

Right Middlings Inlet

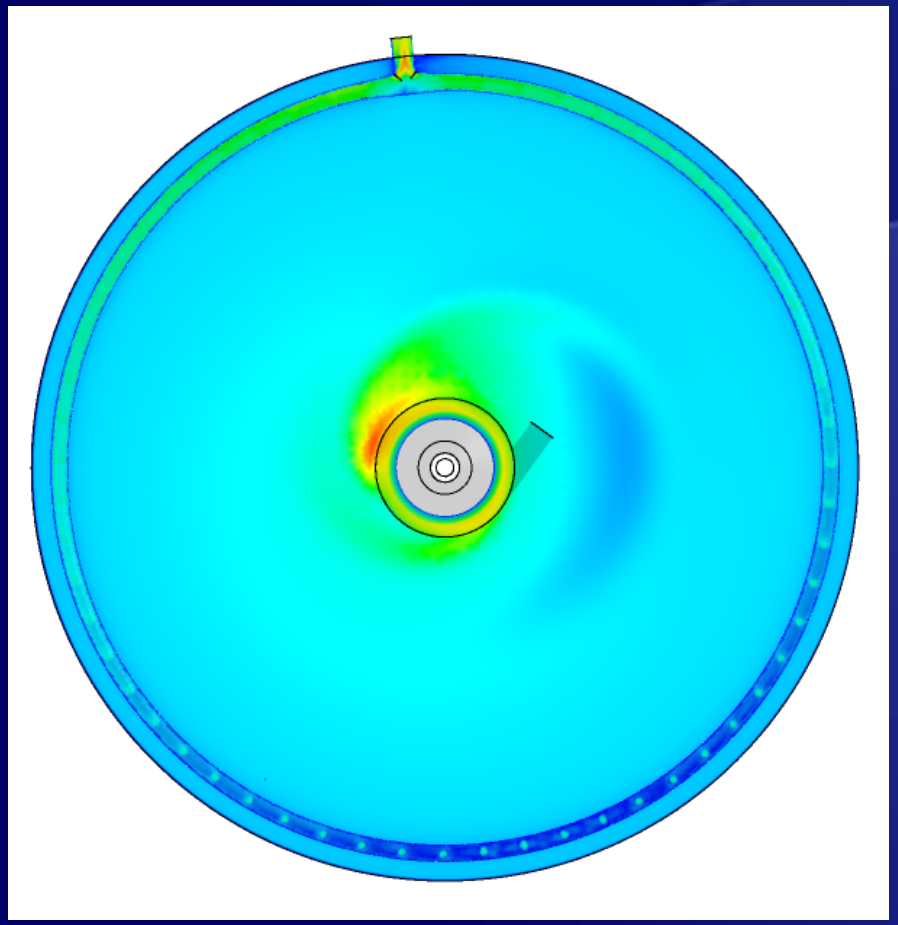
Half Bustle Elbow Design

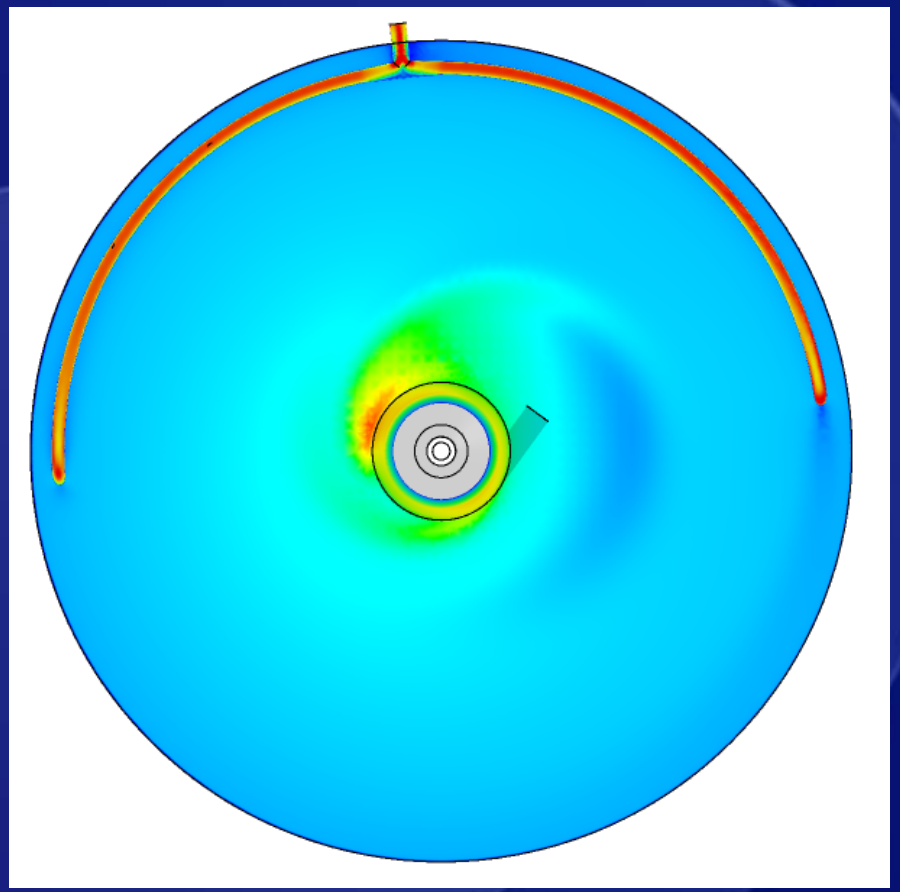




- 90° / 1.5D Elbow
- rotated 10° towards center of vessel

Radial (X = 0 m) Plane
Time Averaged Velocity





Commercial Bustle Pipe

FLUID COKING™ Unit Overhead Line

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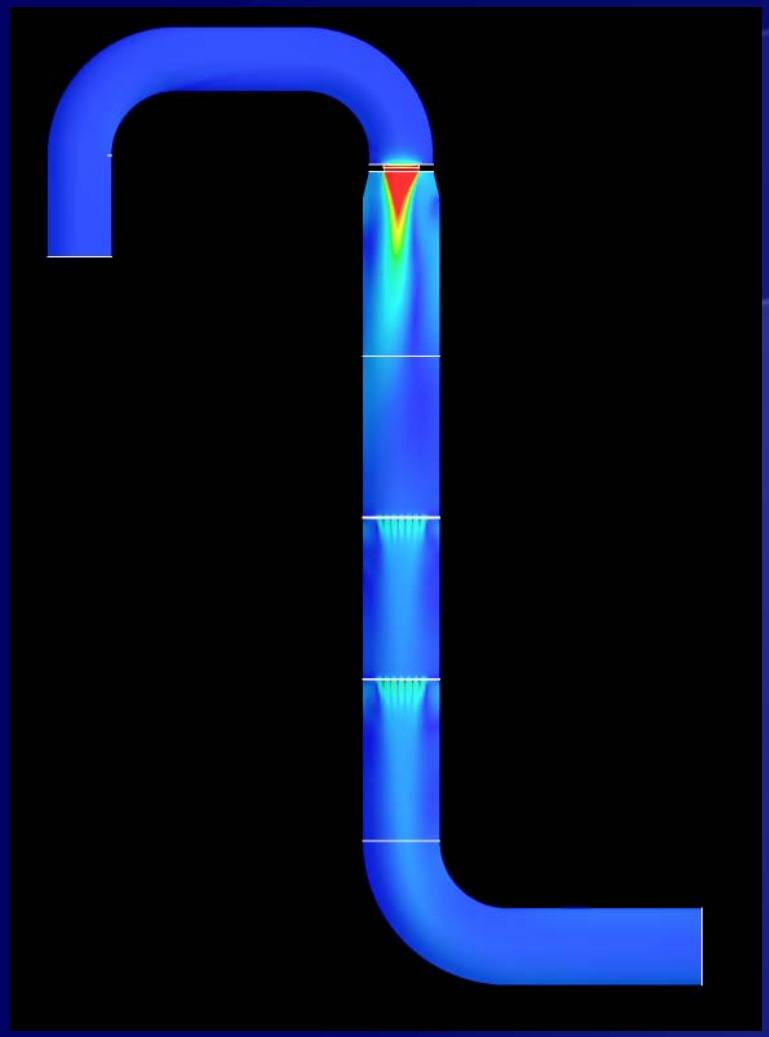
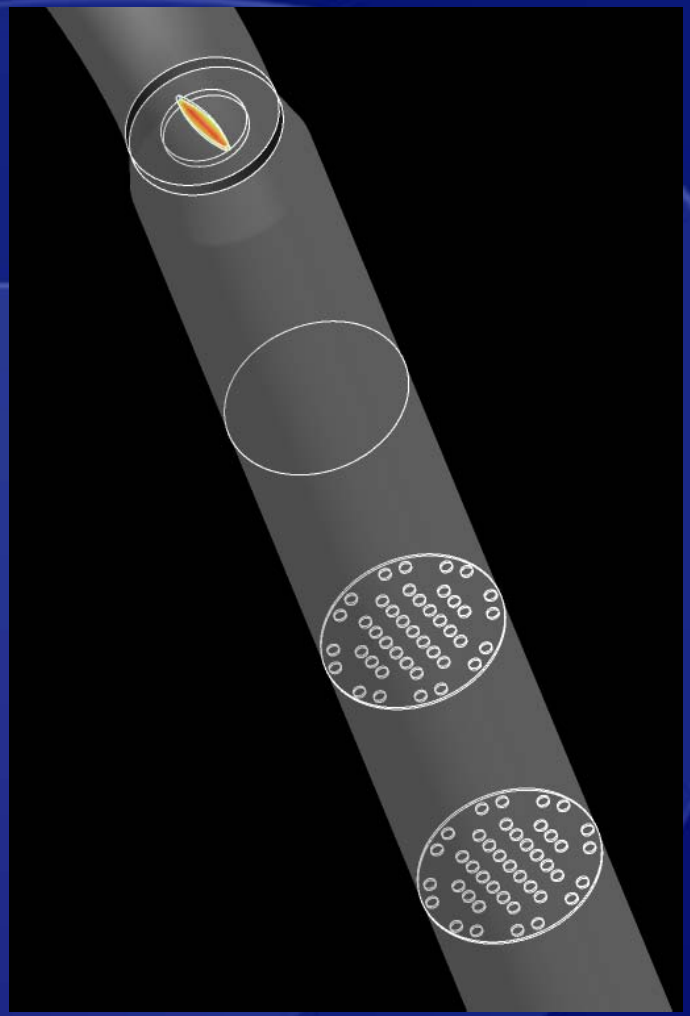
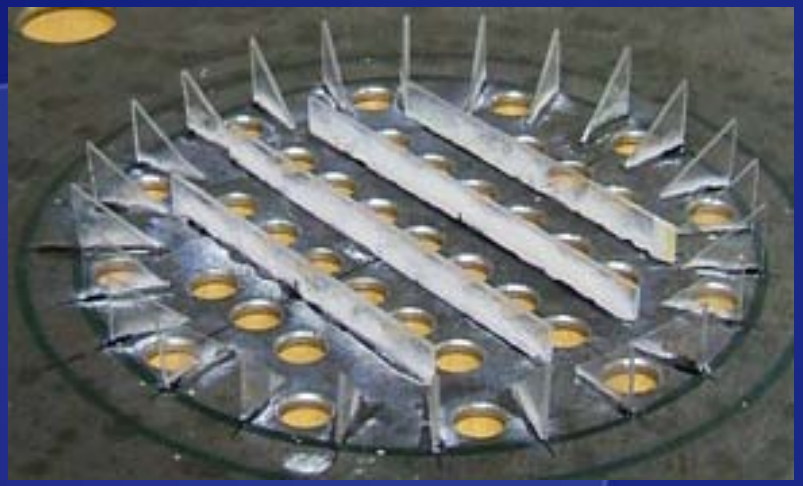
FLUID COKING Unit Overhead Line





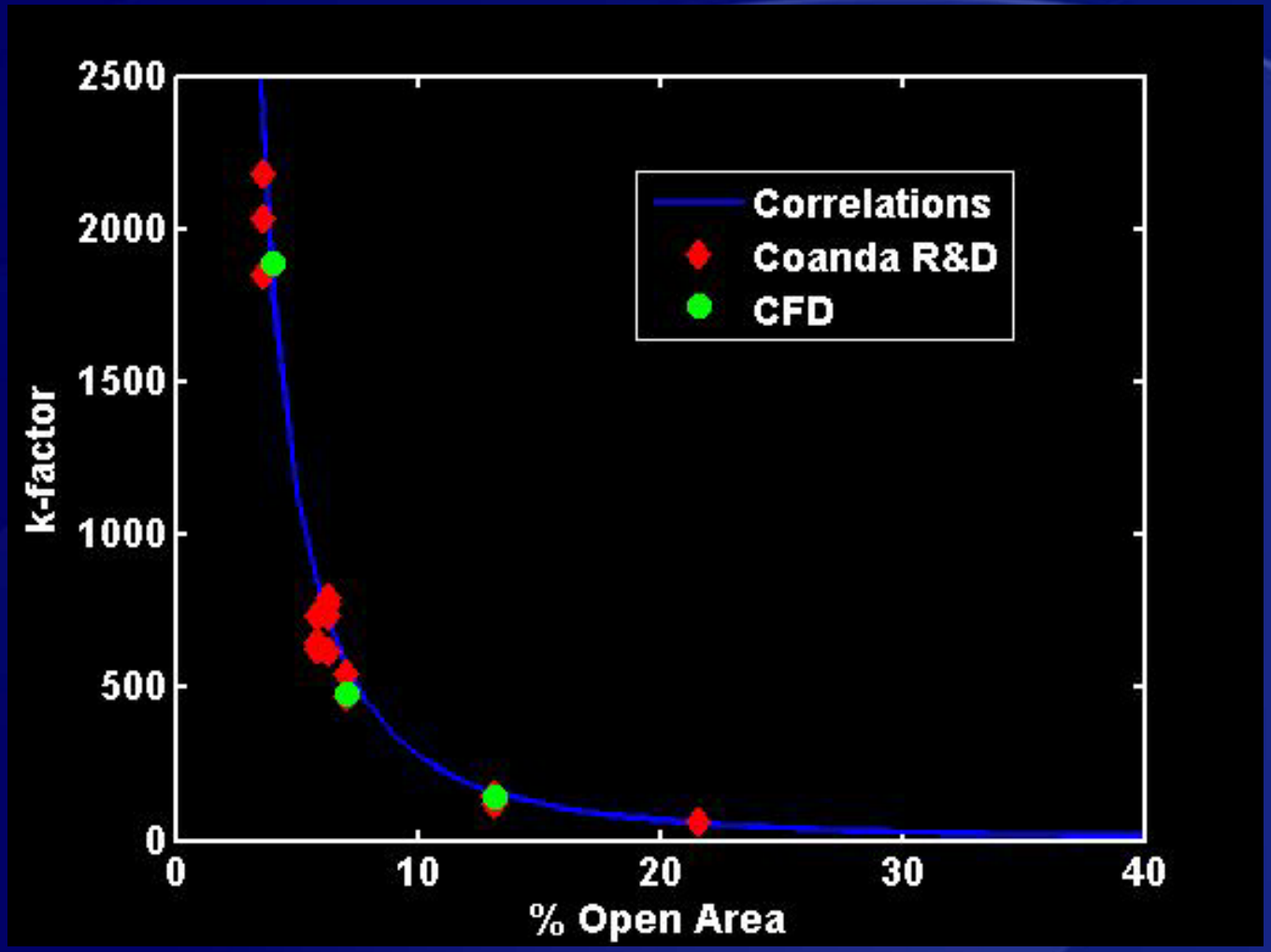
Commercial Orifice Plate & Coanda R&D Model

Commercial Scale



Coanda Model Scale

CFD Validation – PV23



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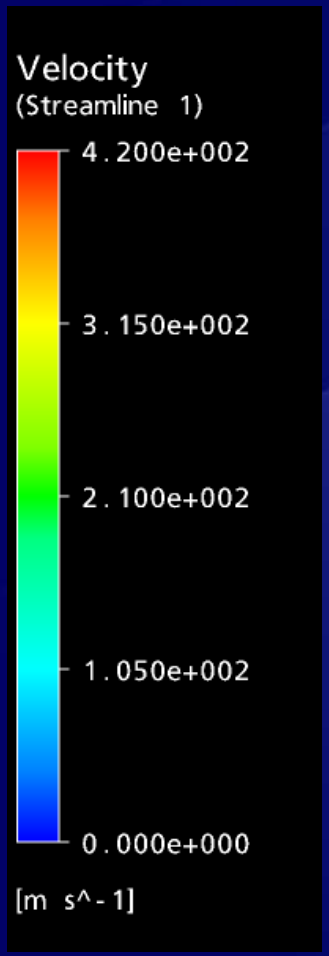
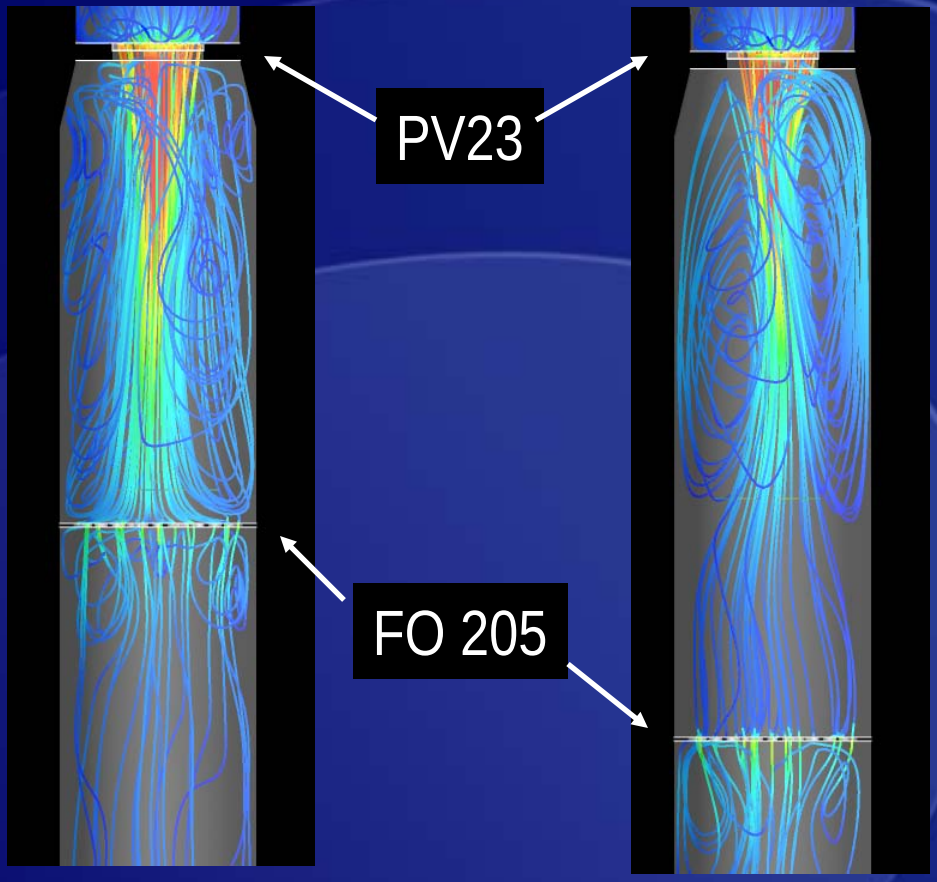
PV23 / MHO Spacing





20’ Spacing **30’ Spacing**

FLUID COKING Units

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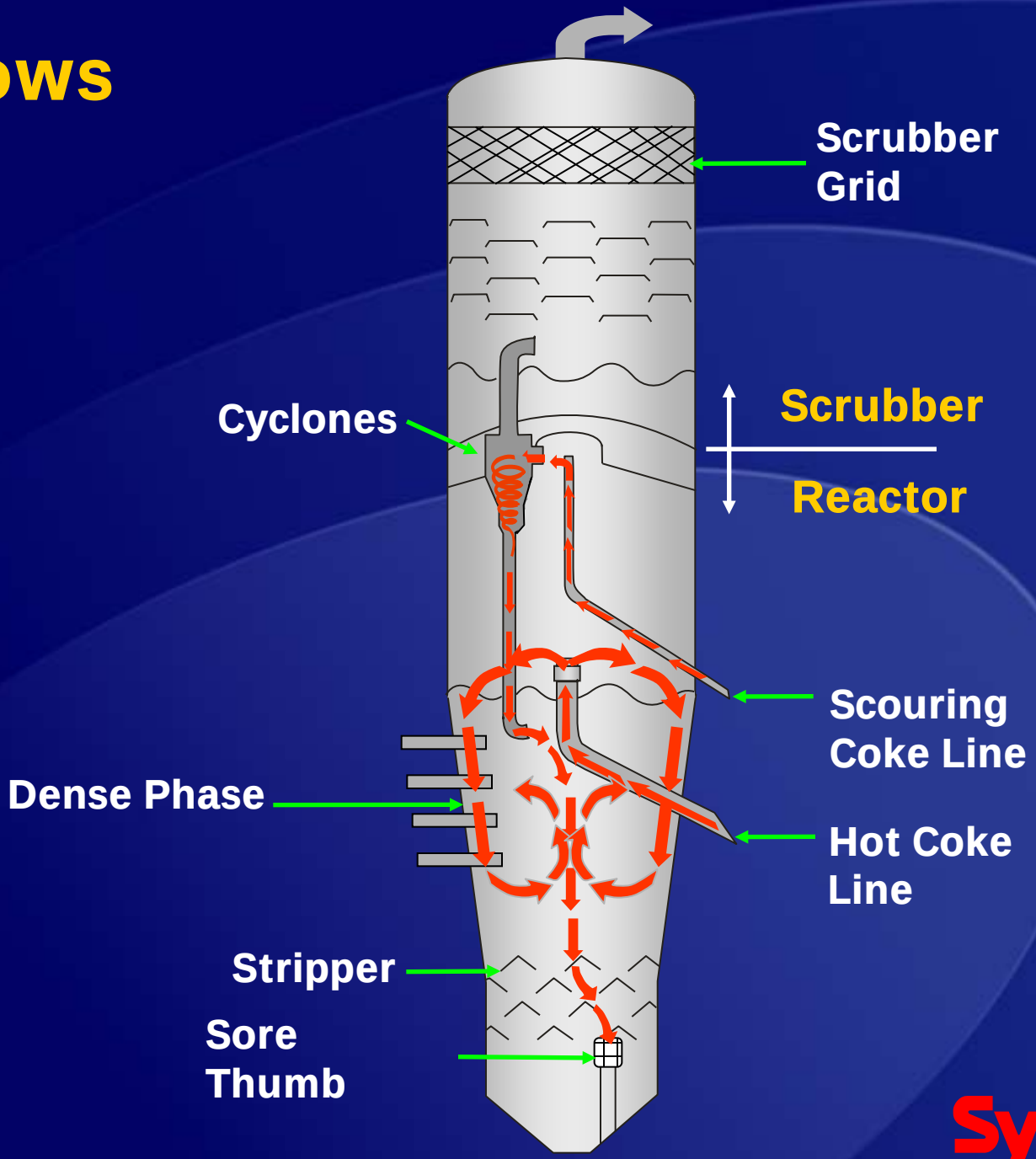
Solid Flows



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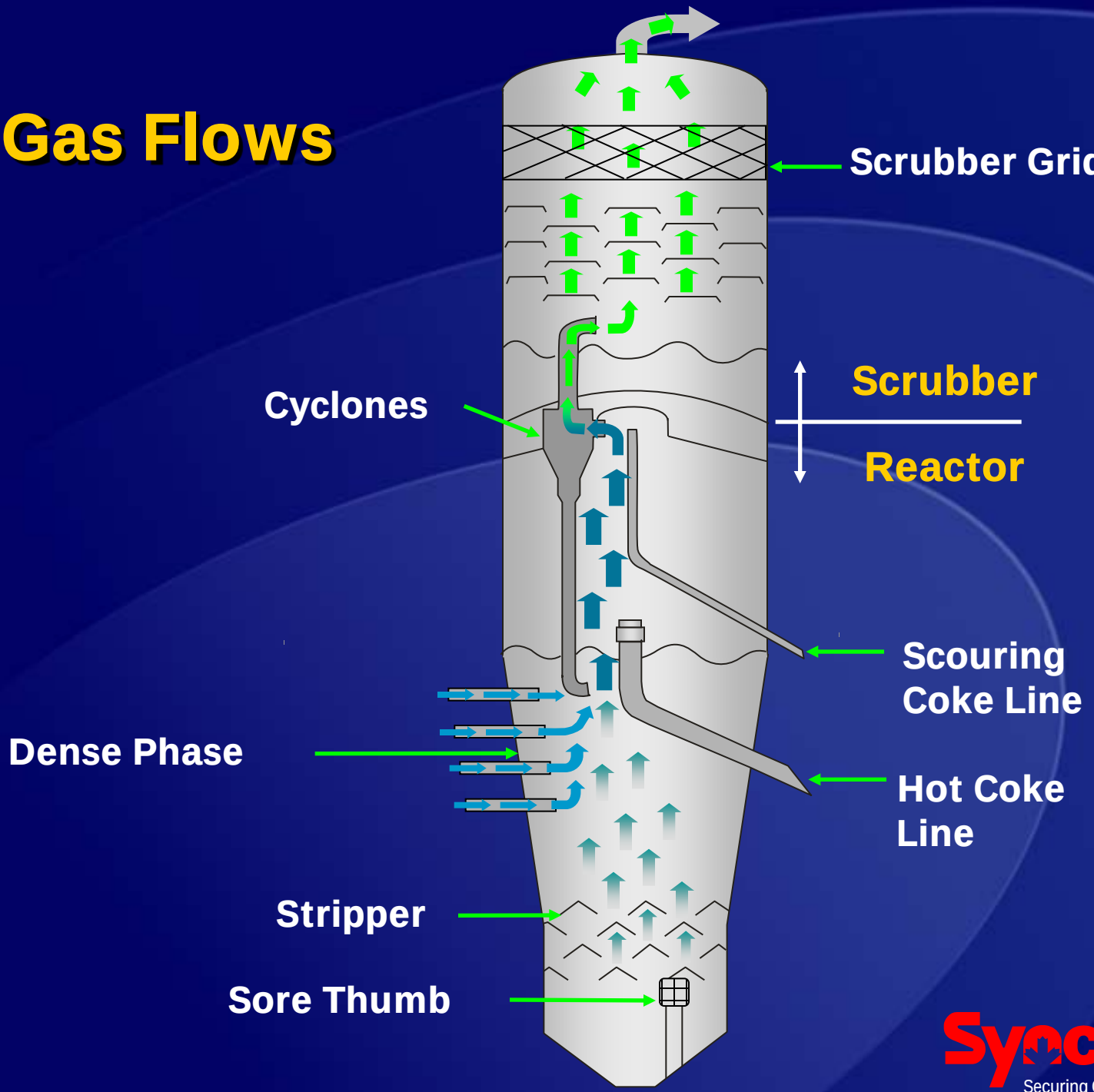
Gas Flows



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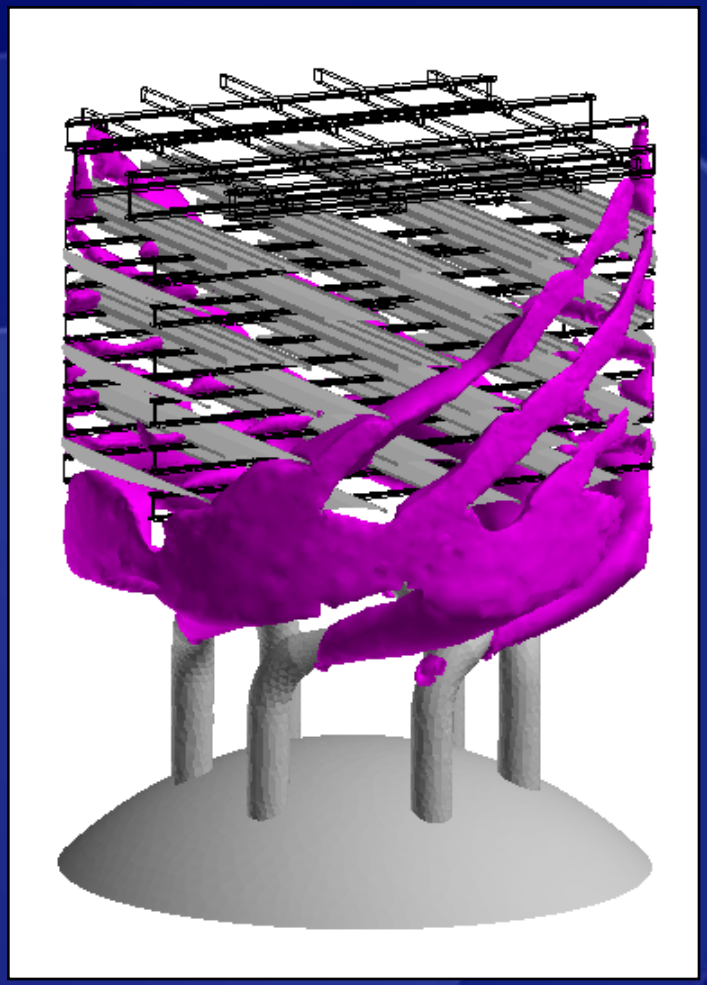
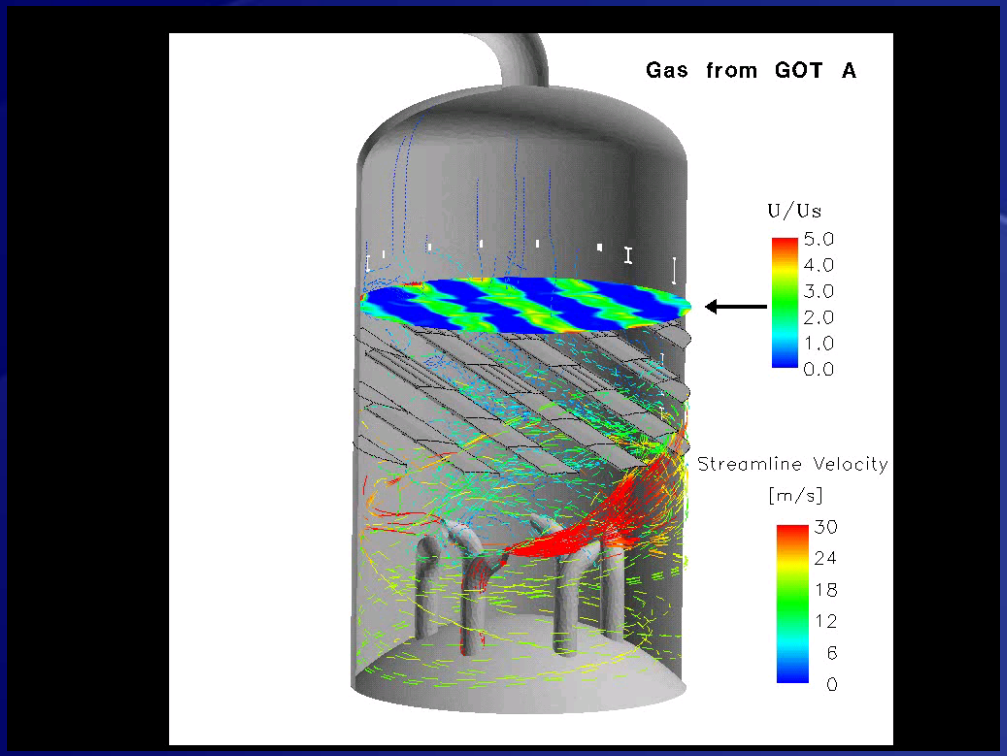
FLUID COKING Unit Scrubber Improvements to Reduce Clay Carryover

- CFD Simulations
  - Performed at CSIRO
  - Led Cold Flow Work
  1. Gas Phase Only
     - Swirl Noted
     - Baffles Disrupted
  2. G\L Phase
     - Droplet breakup/coalescence model
     - Heat transfer and flashing included



FLUID COKING Unit Scrubber Improvements to Reduce Clay Carryover: CFD Simulations



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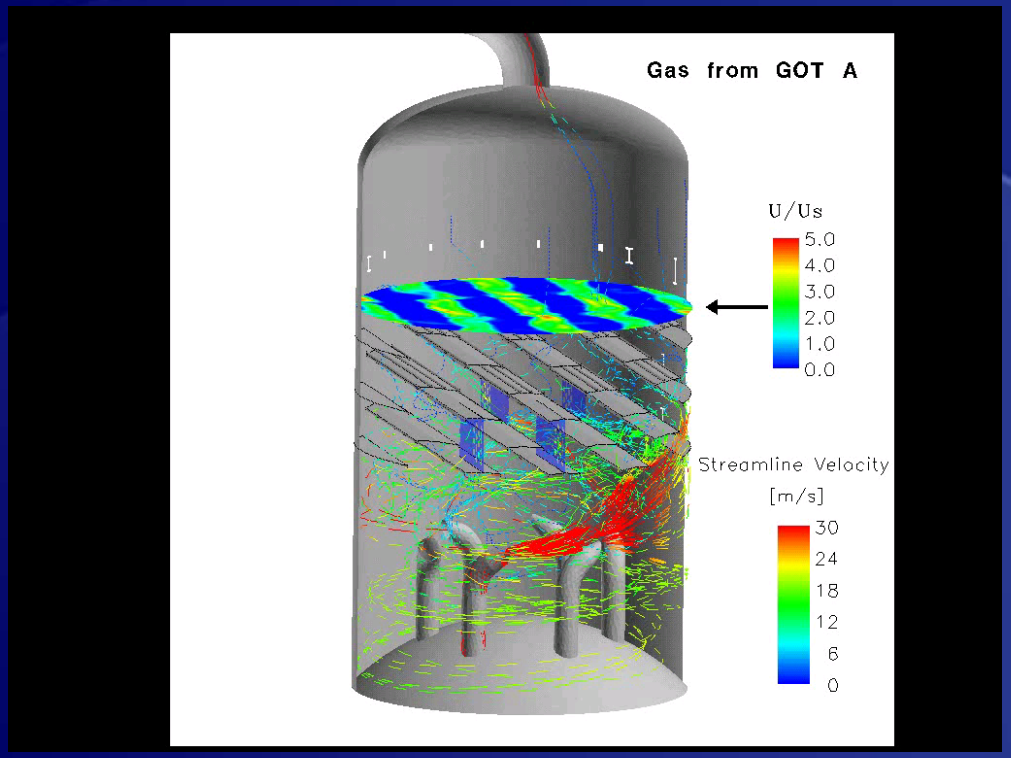
FLUID COKING Unit Scrubber Improvements to Reduce Clay Carryover: CFD Simulations



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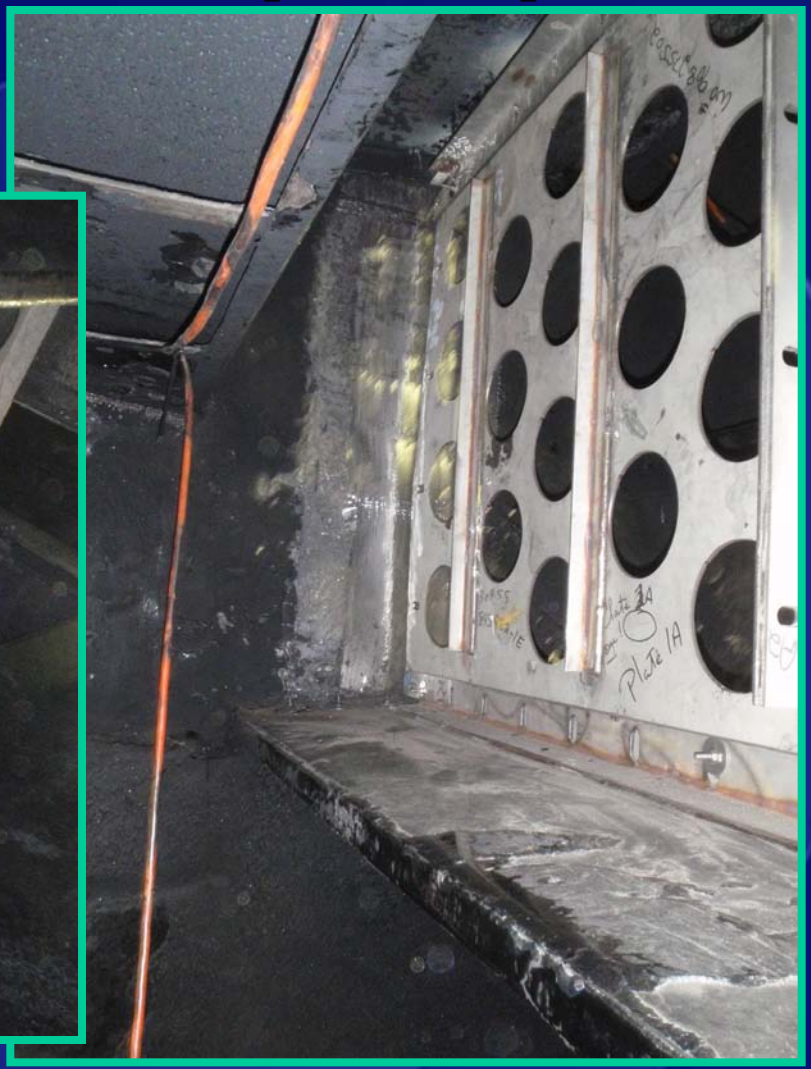
FLUID COKING Unit Scrubber Improvements to Reduce Clay Carryover

Commercial Installation



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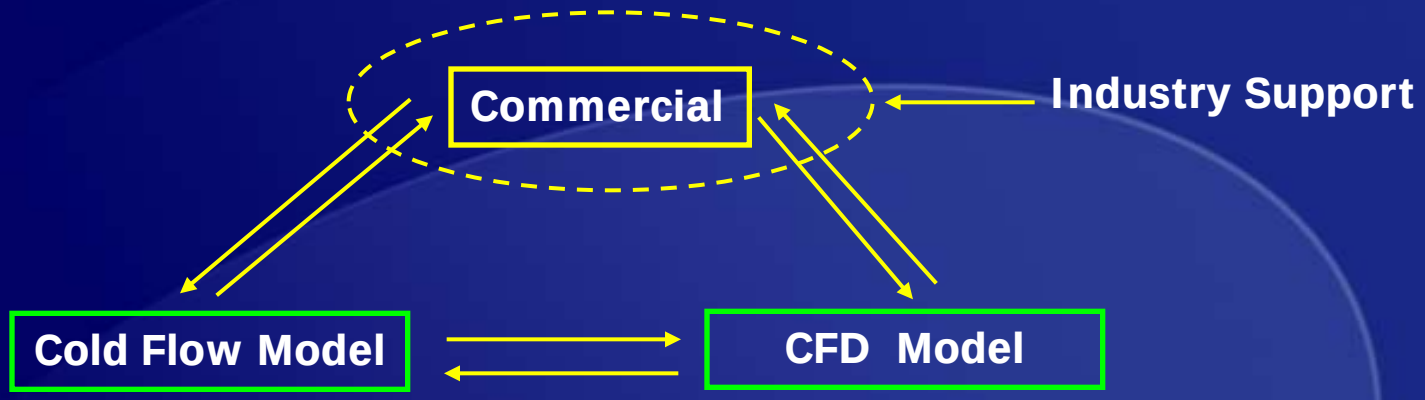
Conclusion

- How does Syncrude use CFD Today?



Innovation Cycle

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  - Barry Bara
  - Michael Wormsbecker
  - CSIRO
  - PSRI
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