Linking 3-D Electrical Tomography Imaging to Fluid Flow Patterns in an Annular Fixed-Bed Reactor

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3-D Model for Annular Bed Catalytic Reactor

Contents

• Prior experimental work
• Creating a 3D model using networks-of-zones
• Some typical results
  - flow maps
  - RTD curves
  - theoretical 3D images
• Conclusions
Flow field predicted for annular reactor
Experimental 3D tomographic images

Response to a pulse injection

VCIPT
Flow map created from experimental images

Velocity vectors from differentiating tomographic fronts

VCIPT
3D network of zones model

Networks-of-zones flow configuration for the annular fixed-bed reactor
flows around each zone

the general $i,j,k$ zone showing flows and dispersive exchanges
Reactor as 3D network

3-D network-of-zones

VCIPT
Inlet flows?

Uniform input flow distribution

feed pipe

VCIPT
Inlet flows?

feed pipe

Inlet flow increases towards the outside

VCIPT
Inlet flows?

feed pipe

Inlet flow decreases towards the outside

VCIPT
Inlet flow distribution and zonal flow redistribution rules determine the zonal flow pattern. Software is fully flexible allowing any possibility.

### Slice flow map showing preferred flow towards the outside

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VCIPT
### Zonal flow maps

Slice flow map showing more uniform flow

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VCIPT
What do you see at the exit?

Residence time distribution!

VCIPT
Pulse response predictions in 3D

Model predictions composed into tomographic format

VCIPT
Exit concentrations for semi-batch injection
Semi-batch tracer injection for 45 seconds
CONCLUSIONS

• Generalised software has been written to analyse flows and mixing in an annual flow reactor

• The software has in-built flexibility making it useful for “deconstructing” the interior 3D patterns

• The capability has been demonstrated to predict
  - residence time distributions (at the exit)
  - interior concentration fields

• The predictions can be presented in equivalent tomographic 3D formats using see-through solid-body graphics