Chemical Engineering 512

Nuclear Reactor Transient Modeling

Lecture 4

RELAP5-3D Input Description

Spiritual Thought

"To establish Zion in our homes, branches, wards, and stakes, we need to (1) become unified in one heart and one mind; (2) become holy people; and (3) care for the poor and needy. We cannot wait until Zion comes for these things to happen—Zion will come only as they happen."

-Elder D. Todd Christopherson

Objectives

- Go over questions from DVDs
- Learn about nodalization diagrams
- Review hydraulic diameter
- Practice these concepts with Sample Problem 1

Questions From DVDs

- Input Description (Part 2)
- Input Description (Part 3)

Nodalization Diagrams

- Used to visually show what our code is representing
- A good diagram is well documented
- All junctions and volumes should be labeled
- Does not have to be to scale
- Allows us to identify what roll each hydrodynamic component plays

Why Nodalization Diagrams?

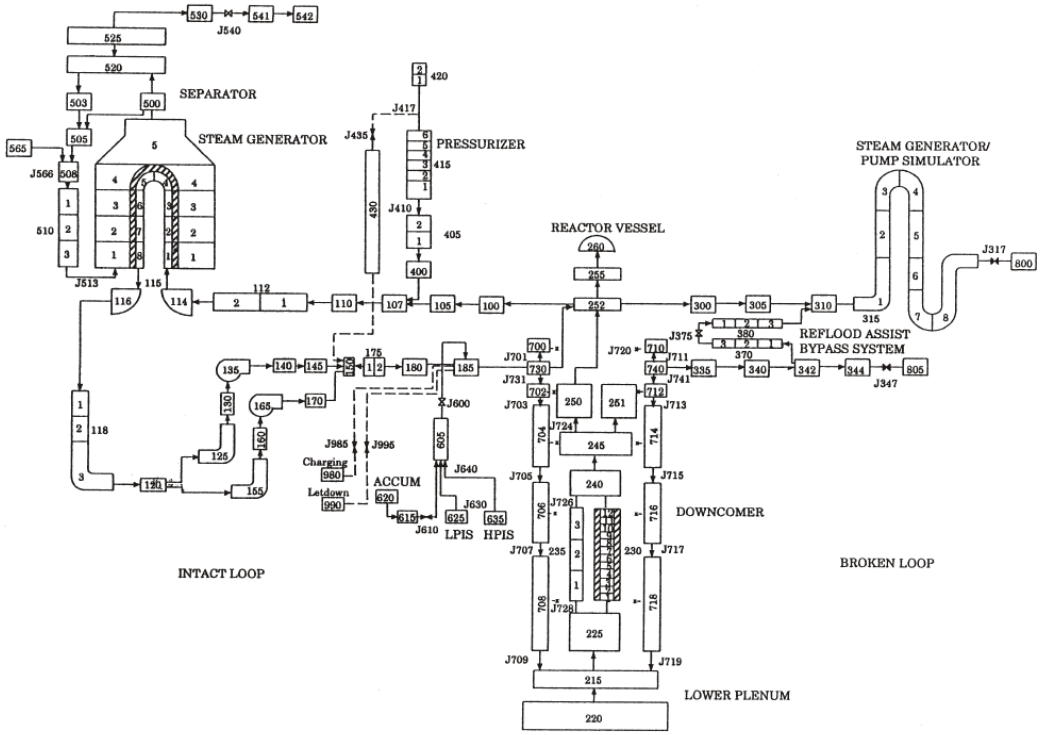
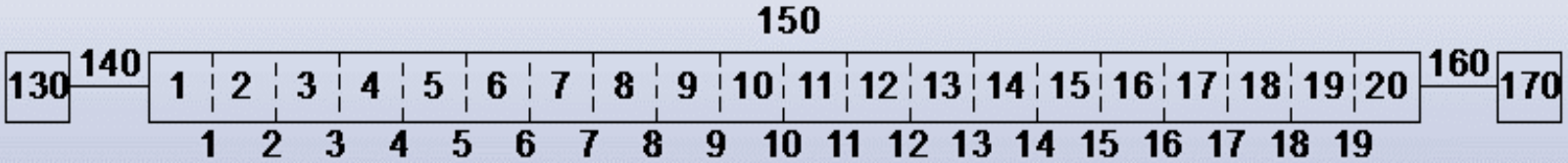


Figure 5.5-2. RELAP5-3D nodalization for the LOFT facility Experiment L2-5 (1-D vessel).

Lets Practice

- Draw a nodalization diagram for a 20-volume, horizontal pipe that is connected to a source volume at the beginning and a sink at the end. Number the components as the following:
  - Source volume – 130
  - Junction – 140
  - Pipe – 150
  - Junction – 160
  - Sink – 170

Answer


150
130
140
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
160
170
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Hydraulic Diameter

- Hydraulic Diameter
- Should be used when geometries are not circular
- Should be used when modeling multiple tubes

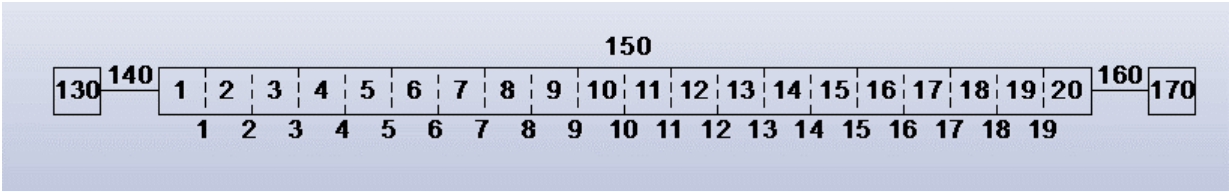
$$D_h = \frac{4 * cross\ sectional\ area}{perimeter}$$

- What is the D_h of a pipe with diameter 0.1m?
- What is the D_h of 10 tubes each with diameter of 0.1m?
- What is the D_h of a square duct with side length 0.1m?

Sample Problem 1

- Develop a model for a 60 m long horizontal pipe with a flow area of 0.196 m^2. Divide the pipe into 20 cells of equal length.
- Initialize the fluid in the pipe at 5.0 MPa and 500 K, which are also the conditions of the source volume.
- The sink volume has the same temperature, but its pressure is 4.9 MPa.
- Start the flow at zero, and increase it linearly to 400 kg/s over 20 s. Then hold the flow steady until 300 s.
- Draw a nodalization diagram for this problem
- Complete an input deck
- Run the deck to ensure it works properly
  - How do we do this?

Sample Problem 1

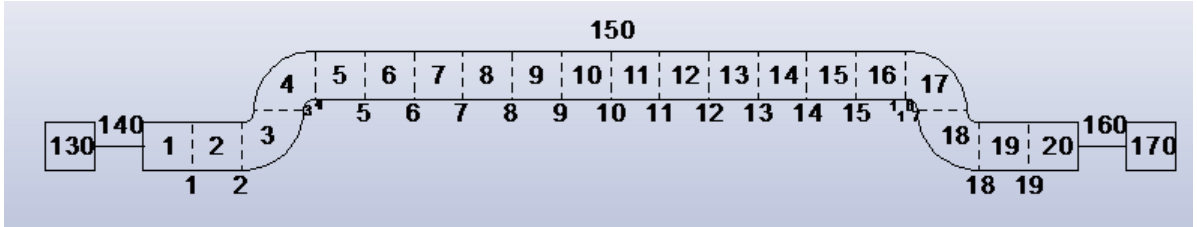


Variation 1

- Change the pipe so that the third and fourth volumes rise a total of 6 m, and the 17^{th} and 18^{th} volumes descend a total of 6 m.

- Draw a nodalization diagram for this problem
- Complete an input deck
- Run the deck to ensure it works properly
  - How do we do this?

Variation 1

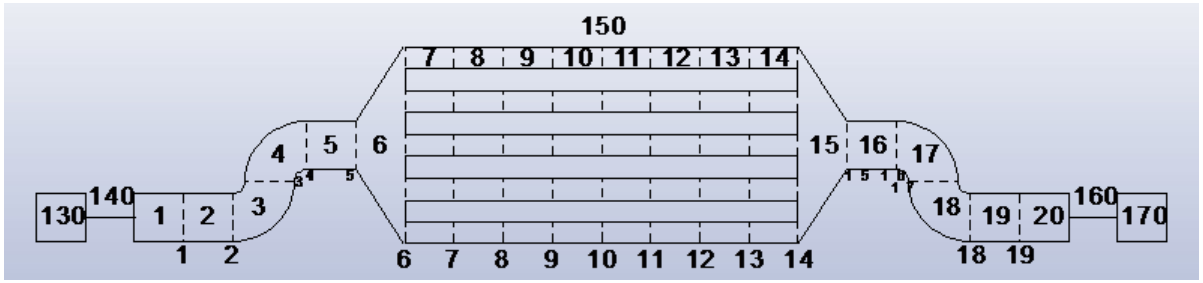

150
4
5
6
7
8
9
10
11
12
13
14
15
16
17
130
140
1
2
3
18
19
20
160
170
1
2
18
19

Variation 2

- Increase the area of volumes 6 and 15 to 0.4 m^2, simulating the inlet and outlet plena of a heat exchanger.
- Volumes 7 through 14 now simulate 625 tubes with an inside diameter of 0.02 m.
- The connection from the plenum to the piping is a smoother area change, while the tube sheet is an abrupt area change.

- Draw a nodalization diagram for this problem
- Complete an input deck
- Run the deck to ensure it works properly
  - How do we do this?

Variation 2


150
7 8 9 10 11 12 13 14
4 5 6 15 16 17
130 140 1 2 3 160 170 18 19 20
1 2
6 7 8 9 10 11 12 13 14
18 19

Assignment

- Watch DVD sections 12-17 before next class
- HW 2 due Tuesday (9/19)

Objectives

- Go over questions from DVDs
- Learn how to build an input deck
- Build a sample input deck