Chemical Engineering 512

Nuclear Reactor Transient Modeling

Lecture 4

RELAP5-3D Input Description

Spiritual Thought

"Are we listening? Are we hearing the words of the prophet? Or are we allowing ourselves, as Naaman did at first, to be blinded by pride and stubbornness, which could prevent us from receiving the blessings that come from following the teachings of God's prophet?

I make you a promise. It's a simple one, but it is true. If you will listen to the living prophet and the apostles and heed our counsel, you will not go astray."

-M. Russel Ballard

Objectives

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

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?

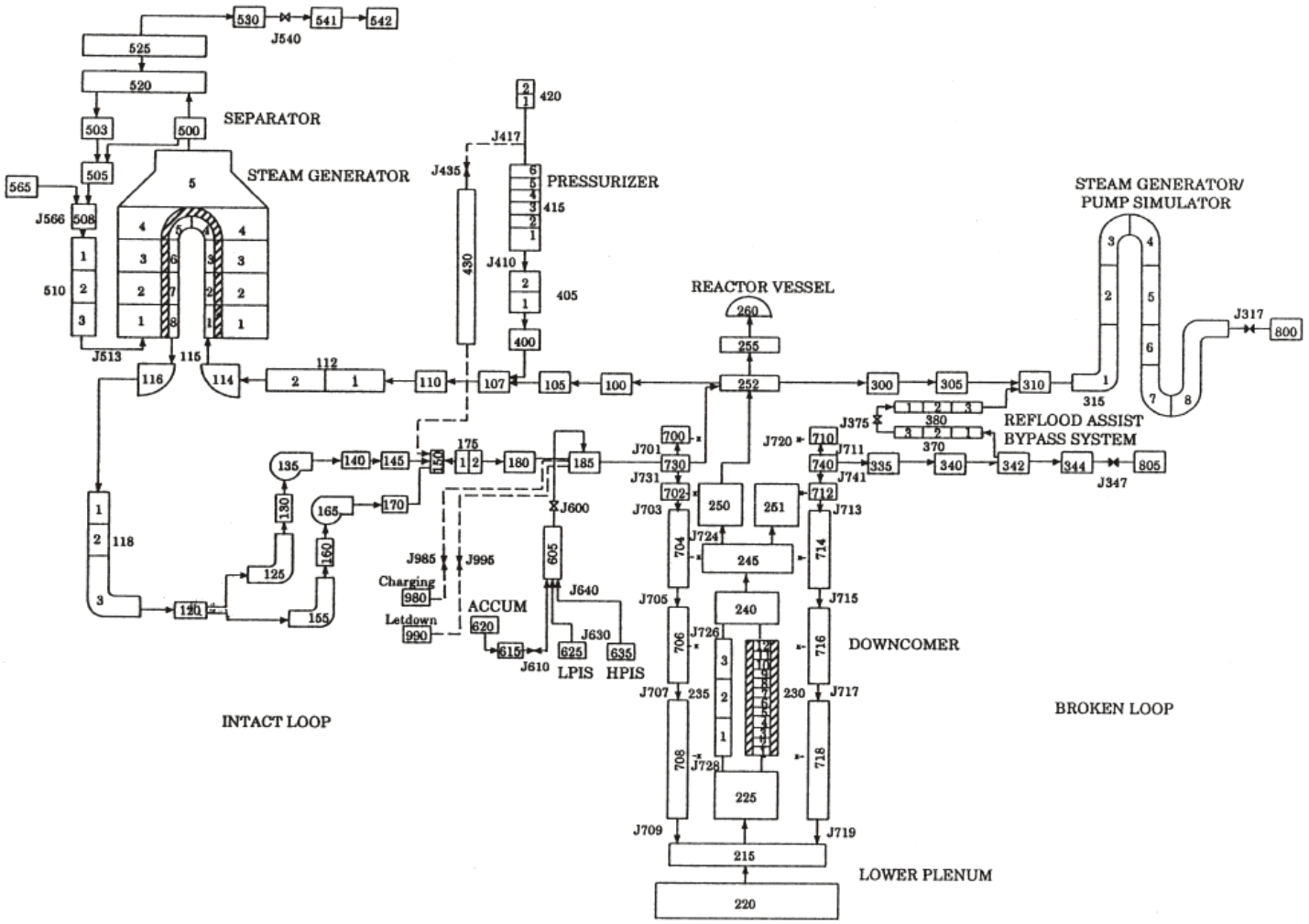
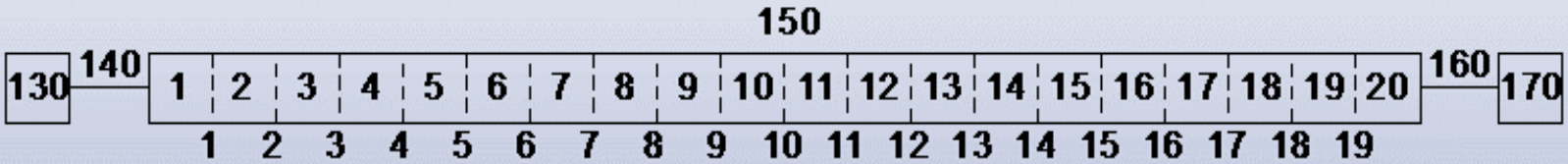


Figure 5.5-2. RELAP5-3D nodalization for the LOFT facility Experiment L2-5 (1-D vessel).

Let's 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

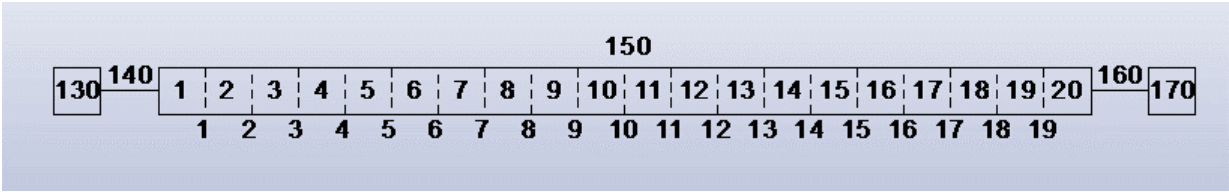
$$D_h = \frac{4 * cross\ sectional\ area}{perimeter}$$

- 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

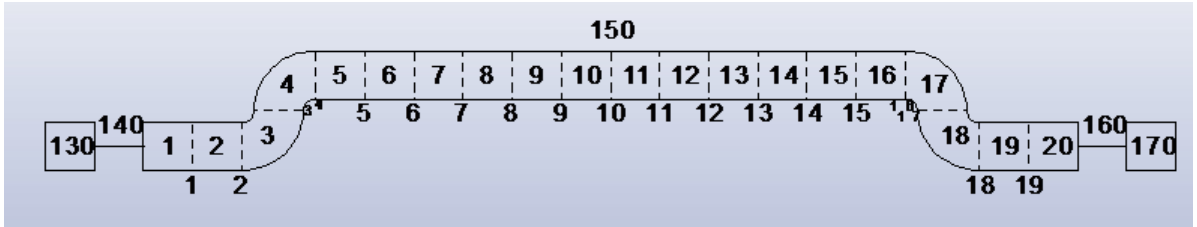


Variation 1

- 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
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8
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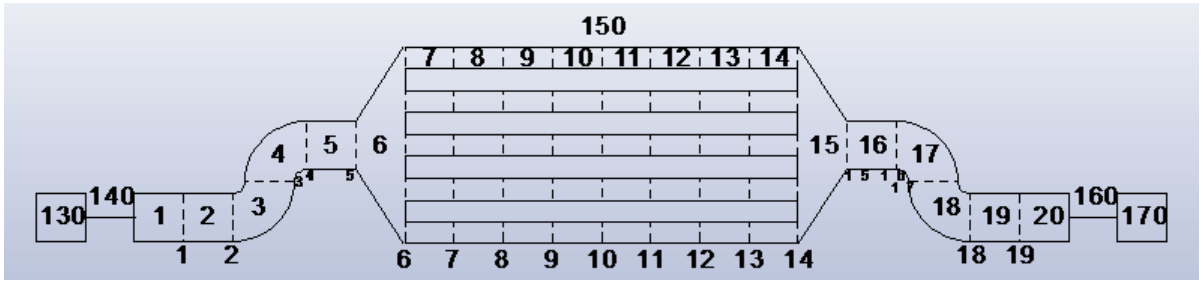
10
11
12
13
14
15
16
17
130
140
1
2
3
18
19
20
160
170
1
2
18
19

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 Thursday (9/18)

Objectives

- Go over questions from DVDs
- Learn how to build an input deck
- Review hydraulic diameter
- Build a sample input deck (Sample Problem 1)