RELAP5-3D

Lecture 13

Control Variables/Tables

Spiritual Thought

"Perhaps this time is a rare opportunity to practice stillness—to invite the Spirit and learn how He communicates with me, to recognize the Lord's hand in my life, to realize how open the heavens are to me—to truly "hear Him," my Savior, Jesus Christ, as President Russell M. Nelson has invited all of us to do."

Chakell Wardleigh

Objectives

- Learn about control variables
- Learn about tables
- Practice making a control variable
- Practice making a table

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Notes

- Remember to start working on gathering the data needed for your reactor
- One more day of watching videos
- Commenting looks better

Control Variables

- Provides the capability to evaluate simultaneous algebraic and ordinary differential equations
- Intended to simulate control systems typically used in hydrodynamic systems
- Also useful for auxiliary output quantities

Control Variables – Input Description

*	Card Format				
20500000	999				
*	Name	Type	Scaling	InitVal	InitValFlag
20510000	qdot	sum	1.0	0.0	1
*	Ao	A1	VariableCode	Parameter	
20510001	0.0	1.0	cntrlvar	108	
*	A2	VariableCode	Parameter		
20510002	1.0	cntrlvar	109		

$$Y = S(A_0 + A_1V_1 + A_2V_2 + \ \dots + A_jV_j)$$

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Control Variables - Example

- Example: Compute the volumetric flow rate at junction 110.

Qdot = $\alpha_g v_g A + \alpha_f v_f A$ where $A = 1.0\ m^2$

SUM: Y = S * (A0 + A1*V1 + A2*V2 + ...)
MULT: Y = S * V1 * V2 * ...

```
20510800    qvap    mult 1.0 0. 1
20510801    voidgj  110010000   velgj  110010000
*
20510900    qliq    mult 1.0 0. 1
20510901    voidfj  110010000   velfj  110010000
*
20511000    qdot    sum 1.0 0. 1
20511001    0.0     1.0  cntrlvar  108
20511002        1.0  cntrlvar  109
```

Control Variables - Uses

- Model real control systems
  - Steam generator level control
  - Reactor power control
- Solve ODEs
  - Valve dynamics
  - Feedwater turbine
- Compute convenient auxiliary results
  - Water levels
  - Mass inventories

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Control Variables - Practice

- Create a control variable input to make the following calculation:

$$W = \alpha_g \rho_g v_g A + \alpha_f \rho_f v_f A$$

- Do this for volume 105-01
- Assume the area is 0.55 m^2

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Control Variables - Practice

```
20501010  vap.prod  mult  0.55  0.0  1
20501011  voidg 105010000  rhog 105010000
20501012  velg 105010000
20501020  liq.prod  mult  0.55  0.0  1
20501021  voidf 105010000  rhof 105010000
20501022  velf 105010000
20501030  vol.flow  sum  1.0  0.0  1
20501031  0.0  1.0 cntrlvar 101  1.0 cntrlvar 102
```

$$W = \alpha_g \rho_g v_g A + \alpha_f \rho_f v_f A$$

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Tables

- Tables are used to input data into RELAP5-3D
- They are structured just as a normal tables with columns and rows
  - Rows are defined by card number
  - Columns are defined by spaces
    - Line up your data so it looks like a table
- Used to conveniently implement various numerical functions into a problem

Tables - Uses

- Thermal Property Data
  - Can input custom thermal conductivities and heat capacities for materials at different temperatures
- Power Table
  - Can help define reactor power output at different times
- General Tables
  - Many available

Tables - Input

202TTTNN

- TTT – Table Number
- NN – Card Number within Table

*	table type	trip num	factor 1	factor 2
20290000	power	900	1.0	1200.e6

*	time	power
20290001	0.0	1.0
20290002	0.5	0.97
20290003	0.9	0.93

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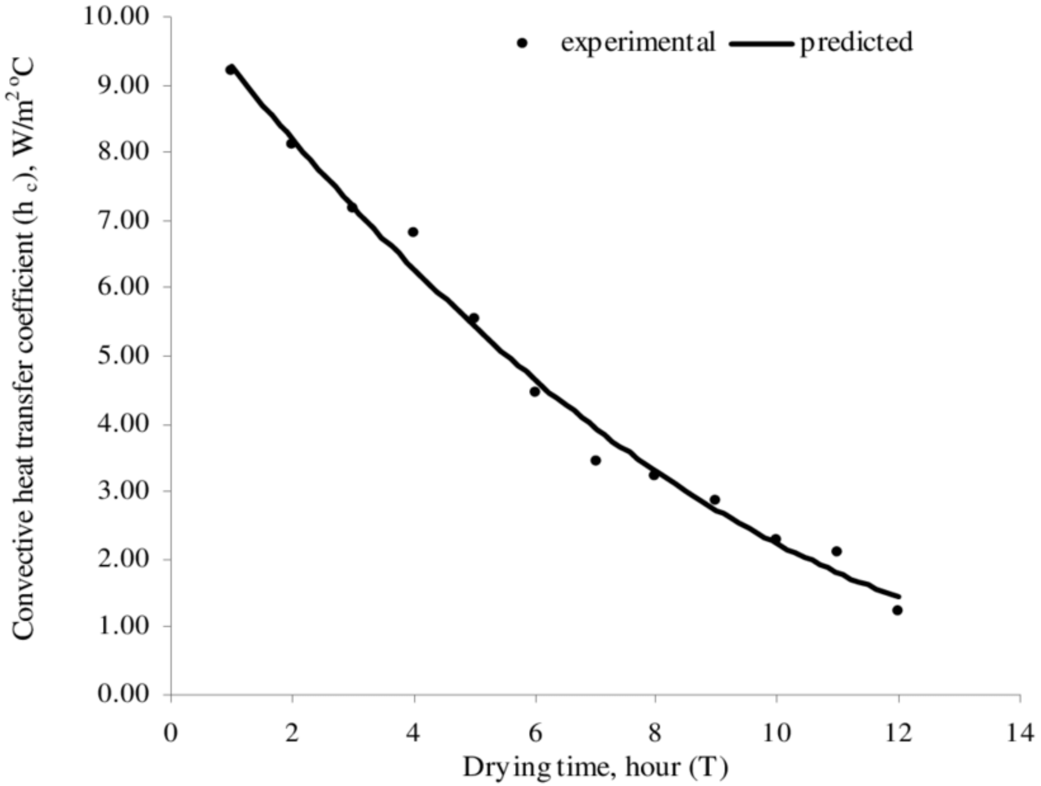
Tables - Practice

- Create a table to specify the heat transfer coefficient versus time and using the following plot.



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Heat Structure Thermal Property Data

201MMMNN

- MMM – Composition Number
- NN – Card Number within Table

*	MaterialType	k	cp
20110000	s-steel/tbl/fctn	1/2/3	1/-1/2

Heat Structure Thermal Property Data

201MMM01-201MMM49

- MMM – Composition Number
- NN = 01-49 – Thermal Conductivity

If tbl:

*	Temperature	k
20110001	500	500000
20110002	600	600000
20110003	…	…

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Heat Structure Thermal Property Data

201MMM01-201MMM49

- MMM – Composition Number
- NN = 01-49 – Thermal Conductivity

If fctn:

*	LowT	UpT	A0	A1	A2	A3	A4	A5	C
20110001	300	5000	11.833	-.0065	.00002	0.	0.	0.	0.

$$k = A_0 + A_1(TX) + A_2(TX)^2 + A_3(TX)^3 + A_4(TX)^4 + A_5(TX)^{-1}$$

where TX = T - C, T is the temperature argument, and C is a constant. E

Heat Structure Thermal Property Data

201MMM51-201MMM99

- MMM – Composition Number
- NN = 51-99 – Volumetric Heat Capacity

If tbl:

*	Temperature	density*cp
20110051	500	500000
20110052	600	600000
20110053	…	…

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Heat Structure Thermal Property Data

201MMM51-201MMM99

- MMM – Composition Number
- NN = 51-99 – Volumetric Heat Capacity

If fctn:

*	LowT	UpT	A0	A1	A2	A3	A4	A5	C
20110051	300	5000	2305550.	2035.26	0.	0.	0.	0.	0.

$$\rho C_p = A_0 + A_1(TX) + A_2(TX)^2 + A_3(TX)^3 + A_4(TX)^4 + A_5(TX)^{-1}$$

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Property Data – Practice

- Choose a material, find data for the material (either tabular or functional), create that material in RELAP
- My advice is pick one you may need for your project/homework

Homework Introduction

- Use tables to input Stainless Steel data
  - Do we expect results to be different than RELAPs built-in values?
  - Plot it and evaluate

- Use control variables to calculate:
  - Total mass in tubes
  - Total mass in shell
  - Water level inside shell
  - Break status

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Next Class

- Learn about modeling a PWR reactor core
  - How to model a fuel rod
  - How to connect to cooling loops
  - Combining knowledge of many different components

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Assignment

- Watch DVD Sections 72-78 before next class
- HW 7 due next Tuesday 10/24