MOOSE project report grading:

Shehab

614 K centerline temp is too low. temperature drop over the fuel from analytical equation is LHR/4/pi/k, which yields ~400K temperature drop. Your scaling from LHR to Q was wrong, and I’m not sure how you got 0.318. Wouldve been good to show your work here. Wanted to see a comparison to analytical equations.

1-d transient didn’t converge. Points to simulation set up being improper. Is there a temperature drop over the gap in the transient or the 2-D cases? Seems like there isn’t. (Typo in fuel kth.) 2-D has same problem with the heat source being too low. Using the higher heat source allows systems to converge.

Axial profile is implemented correctly.

Good use of graphs to report results.

Verifying against an analytical result in the 1-D case would have solved a lot of your issues and shown that the heat source was wrong.

Any comment or discussion on the thermal expansion? Temperature-dependent thermal expansion?

You should have provided more context or analysis of the results, rather than just dumping the results as is.

Overall, pretty decent and you got a lot of the implementation correct.

+5 for turning it in on time

Grade: 85+5 = 90

Mahmoud

Well written intro and background. Good description of problem setup.

Good analysis of the individual blocks. Well implemented heat source and material properties. Correct implementation of both transient and SS 1-D models.

Correct implementation in 2-D, but we should still have linear temperature drop across gap and cladding. I would have to read more closely to see why you didn’t see that. Max temp should not be at midpoint, but at ~60% up fuel column.

Didn’t get the kth(T). But reasonable approach to thermal expansion.

Grade: 90

Jess

Good setup overall, but your mesh is SUPER dense. This is going to take a long time to run. But your design of different meshing for each system is a good one. You used the LHR value when your Heatsource uses a volumetric measure. You only have one BC, but you need two. The neumann BC at the “left” side, center of the fuel pin. Deriving the equations in class, we used both the fixed BC and the dT/dx=0 BC. You didn’t need the thermal contact, and it messed some things up. If you had plotted the temp vs R, you would have seen the super drop in the temp in the gap. You had things prescribed twice, so I am not even sure what MOOSE decided to do in your case.

Appropriate material properties. Well written report. Incomplete 2-D system. I wish you had come to me with questions, so we could have solved your issues with the 2-D. Please come and ask questions, even via email or slack. I feel like I have spoken to you the least of the students, but I was willing to help.

Incomplete part 3. You were making progress on it, but seemed to just run into road blocks that prevented completion.

Grade: 70

Rubyea

Units on material properties would be good. What is your mesh? Why do you not see a temperature drop across the gap? Why is there a difference against the analytical solution? They should match exactly for this scenario.

You performed the transient analysis, but didn’t provide any context. This is different from the SS? Can you match an analytical solution to the end point? How was the function implemented, and what function was used?

For 2D case, should the temperature be at a maximum at Z0? We talked in class about how the max centerline temp is ~60% up the fuel column. These centerline temperatures are very low, and the cladding inner surface temperature is lower than the inlet temperature? Does your temperature profile in Fig 4 make sense? Or Fig 5? Do you analyze the data?

How was your thermal expansion implemented? Only axial expansion? It seems like it, and you don’t have any radial expansion? You don’t tell me what I am supposed to be seeing in your figures.

Grade: 75

Bobby

Good intro. Appropriate material properties. What do you mean by “scripting errors”? The results in the 1-D SS should match exactly with the analytical solution. What do you think was implemented incorrectly? You can compare the end-state 1D transient to an analytical solution as well.

2-D looks ok, but what about the axial dependence? How does the centerline vary with z? Not sure I follow your 2D boundary condition completely. You don’t discuss that at all. You report a centerline temperature, but at what axial position?

Don’t have any of the thermal expansion work…

Why would the high initial temperature cause a higher centerline temperature? If you have the same boundary condition, the initial temperature does not matter at all, it is the heat transport.

You were in the ballpark on this, but there are clearly still some errors that are present, and some of the work is missing.

Grade: 75

Daniel

Excellent introduction and overview. Very thorough and descriptive. The value you pulled for fuel thermal conductivity cant be for UO2, far too high. That might be W/mK, not W/cmK. We typically used 0.03 W/cmK. Usage of air as your gap isn’t appropriate, we don’t use air, but He. Thus your gap conductance is too low.

Did you put a dT/dr=0 @r=0 BC? Plotting from bottom left to top right distorts your distance dimension in the plot. You can specify the points for the line in paraview to plot a horizontal line, and thus accurately capture the radial variation. The 1-D SS should match exactly the analytical. That it does not points to issues in your implementation. The same assumptions for the analytical are included in this form of the MOOSE sim.

The 2D looks to be set up correctly, other than the BC of T=400 at the top boundary. The inlet is these reactors is at the bottom, and only the coolant should be at 400, not the full fuel pellet. Thus, you don’t get the appropriate axial profile, which should peak at ~60% up the fuel column.

Your Fig. 6 temperature profile makes zero sense. The temperature decreases going from the clad to gap? How can that be possible?

Do your stresses make sense? Didn’t we derive equations for the thermal expansion stress in the fuel? There are a number of errors and a seeming lack of understanding of how these systems are supposed to behave. But, you did ok at implementing some of it and you performed an analysis of the results, even if the analysis was not insightful.

Grade: 80

Patrick:

Would have been good for you to report what the actual values are. Did you apply a Neumann BC on the left side? Would have liked more description or information about how the input file was constructed or what you are using. It is pretty bare bones your description of your methods. Decent part 1 analysis. You should restate what your transient function is. Would be good to show your work/equations on the 2-D implementation.

Should the peak centerline temp be at the top? No it should not. We covered in the notes that peak centerline should be at ~60% up the fuel column. Not sure what you meant by your comment on DNB.

Acceptable to perform polynomial fitting on the kth data. What did you do for the third part? You don’t fully discuss what you are doing or how it is being done. How does your stress profile compare to what we talked about in class? If this is a 1-D problem, why is there axial dependence?

You were pretty close on a lot of things, with some errors sprinkled through. Some analysis and discussion could be improved, combined with including understanding from class to provide context.

+ 5 for turn in on time

Grade: 90+5 = 95