24.536 Reactor Experiments and 407.403 Advanced Nuclear Lab

HW #9: "Integral Blade Worth Curves" Post-lab Exercises

Introduction/General Tasks

The purpose of Reactor Experiment #3 is to use a variety of measurement techniques to actually measure the integral worth curve for one of the large control blades within the UMLRR -- we will do this using the Stable Period Method, the Inverse Count Rate Method, and the Inverse Kinetics Method. In addition, we also want to investigate how well the simple simulation tools used to model system behavior compare to the actual observed reactor behavior. Finally, we would like to validate the accuracy of the $\rho(t)$ predictions made by the Inverse Kinetics Method for general use as a reactivity meter and for generating blade worth curves with the UMLRR. The post-lab analyses requested here will address these topics/goals -- and they will use a combination of data generated during the lab, some archived data from a few years ago (for the Stable Period Method), and some data that was generated in our previous "Approach to Critical" lab (for the Inverse Count Rate Method).

The specific tasks and deliverables for this post-lab assignment are described below:

Summarize Results from Reactor Experiment #3: Integral Blade Worth Curves

Reordering the above list of tasks somewhat, the explicit post-lab analyses that are expected are given below. Please include your responses, analyses, and discussions, as needed, for each of these tasks as part of your complete package for HW#9.

1. Summarize the goals of the experiment and the overall steps/procedures that were performed. This should be a general overview of the goals and reactor sequence that was performed, not a list or copy of the formal procedure given to you. Write this as though you were describing the lab to a colleague.
2. Compare the P(t) profile obtained from the Phase I operational data with a best-estimate simulation of the actual blade movements that were made during the reactor run (be sure that the timing and magnitude of the blade movements in your simulation match exactly with the RegBlade movements observed in the actual experiment). Compare the actual reactor data and the simulation results on the same plot and comment on the goodness of the simulations. What can you say about the accuracy of our feedback-free simulations using point kinetics?
3. Compare the "measured" $\rho(t)$ profile obtained from processing the Phase I P(t) data through the inverse kinetics algorithm. Here you should convert the actual z(t) for the RegBlade into a $\rho(t)$ profile via use of the existing RegBlade worth curve. Again, plot the measured $\rho(t)$ data and the $\rho(t)$ profile from the actual blade position, z(t), and the RegBlade worth curves on the same plot and comment on your comparisons here. Does the Inverse Kinetics Method give a reasonable estimate of the actual $\rho(t)$? Did the experiment show the "reactivity drift" that was discussed in class? Explain…
4. Use the data given in the available *_DTdata_*.dat file (on the course Dropbox folder) that contains the doubling time data from the latest blade calibration for the blade of interest (BOI) to generate the desired worth curves using the Stable Period/Doubling Time Method.

These data were generated by the reactor staff during the annual blade calibration runs made in early 2012.

5. Use the startup counter data from the reactor history file saved following our previous Approach to Critical experiment to generate a portion of the integral worth curve for the BOI using the Inverse Count Rate Method. This can be normalized to the total worth (at the maximum blade location for the BOI in Lab #1) obtained from one of the other methods.
6. Use the reactor history data from the Phase II portion of the current experiment to generate the integral blade worth curve for the BOI using the Inverse Kinetics Method (note that much of the data processing here can be done directly in the **umlrr_data** GUI).
7. Compare the three measured worth curves for the blade of interest (BOI) with the most recent reactivity evaluation completed by the reactor staff (available within the **bw_display** GUI) and comment on your observations. Note that the data used for the Stable Period Method is from a different core configuration from 2012 (i.e. the M-2-5 core), so this one may not match as well as the other data.
8. As closure for this lab exercise, also briefly discuss your overall experience from this reactor experiment -- that is, did you gain a better understanding of the topics discussed here? Also, was the benchmarking exercise worthwhile -- that is, do you now have a better appreciation for the capabilities associated with the feedback-free kinetics equations? Finally, also please comment on any changes that could be made in future experiments of this type to improve the overall learning experience for the class -- your feedback here could improve the learning experience for future students…

Documentation and Submission of HWs

In general, I expect a professional, well-written, semi-formal report for each HW assignment in this course. Please refer to HW#1 regarding the format for each HW assignment in this course -- **they should all be done and submitted in a similar fashion!!!**

For this HW, you need to post-process the measured and archived data associated with each topic area and to discuss your overall results. In particular, please elaborate on the model validation study and on the measured worth curves for the BOI. Also address how the worth curves generated here compare to the current blade worth curve used by the reactor operators. As done previously, please put everything together, including all your Matlab m-files used to post-process the experimental data, in a single zip file -- **only one zip file per HW please** -- and **email this to me before 4 pm (UML time) on the Sunday before our next class…**

Good luck…