Performance Prediction of Irradiated TREAT Fuel

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Calculating Displacements per Atom (dpa)

- Irradiation damaged graphite has reduced thermal properties: 41.8 W/mK saturates at 1.046 W/mK \(^{(1)}\).
- Acts as serial thermal resistor increasing the temperature of the particle during pulses.
- Some fission energy ballistically transported by fission fragments leaving the particle.
- Particle size influences irradiation damage layer.

Simulating Pulses with Varying Damage

- Single EOS pulse produces 2.6 GJ \(^{(2)}\).
- TREAT operated 35 years before shutdown producing 2,600 GJ \(^{(3)}\).
- Assume every pulse is a 2.6 GJ TREAT EOS pulse.
- Assume all particles are a single size.
- TREAT operates with reduced thermal properties from irradiation damage.

Conclusions

- Larger particles receive more irradiation damage than smaller particles.
- Fissions per particle increase by \(r^3\) as particle size increases.
- Graphite damage increases by \(r^{1.237}\) as particle size decreases.
- Temperature difference is larger in larger particles.
- Temperature differences increases with irradiation damage over time.
- Larger particles experience larger increases in peak particle temperatures.

Future Work

- Take into account graphite annealing during pulse.
- Include effect on feedback through multi-physics coupling.
- Improve correlation between fission fragment damage and degraded thermal properties of graphite.

