

Reprocessing Settings in Serpent

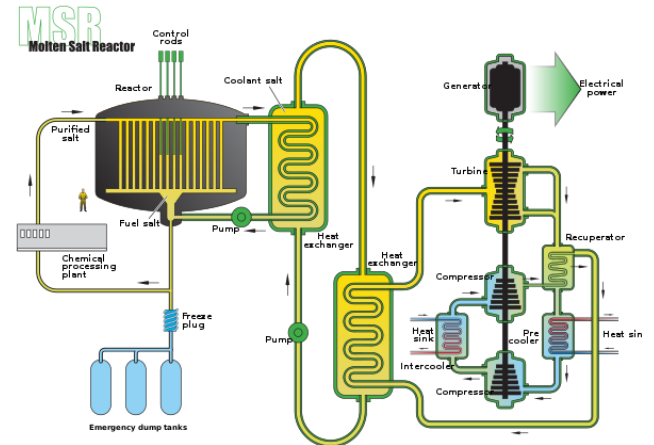
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9th International Serpent User Group Meeting

OUTLINE

- Need for online reprocessing
- Creating documentation
- Reprocessing types
- Example cases
- Changes in burnup steps



Reprocessing in Serpent

- Several reactor designs, including MSR, utilize online reprocessing: material feed and removal
- Step reprocessing in material compositions may have different results from continuous
- Limited documentation and testing

Syntax

- Define material flow rates

mflow {flowName} {element} {desiredRate}

- Specify which flow rates apply to which materials, define reprocessing regime

rep {reprocessName}

rc {fromMat} {toMat} {flowName} {setting}

- Include reprocessing regime in burnup steps

pro {reprocessName}

Equations for Rep 0

| Setting Value | Time Value | Additional Restrictions | Associated Equation |
|---------------|-----------------|-------------------------|-----------------------------------------------------------------------------|
| 0 | All time values | None | $\dot{m} = \left(\frac{V_{source}}{V_{destination}} \right) \dot{m}_{inp}$ |

- Constant rate
- Does not deplete source material
- Can result in more mass than initially defined

Equations for Rep 1

| Setting Value | Time Value | Additional Restrictions | Associated Equation |
|---------------|------------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------|
| 1 | Initial | None | $\dot{m}_0 = \left(\frac{V_{source}}{V_{destination}} \right) \frac{(1 - e^{-(\dot{m}_{inp})(\Delta t)})}{\Delta t}$ |
| 1 | All other than initial | None | $\dot{m}_{new} = (\dot{m})(V_{source})(\rho_{source})$ |

- Depletes source material
- Total flow rate deponent on source amount

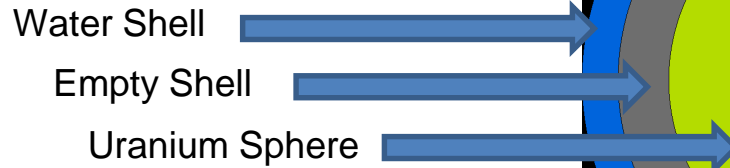
Equations for Rep 2

| Setting Value | Time Value | Additional Restrictions | Associated Equation |
|---------------|------------------------|----------------------------------------------|-------------------------------------------------------------------------------|
| 2 | Initial | Time step cannot cause discontinuity of mass | $\dot{m}_0 = \left(\frac{V_{source}}{V_{destination}} \right) \dot{m}_{inp}$ |
| 2 | All other than initial | None | $\dot{m}_{new} = (\dot{m})(V_{source})(\rho_{source})$ |

- Same as rep 1 except for initial step

Example Case

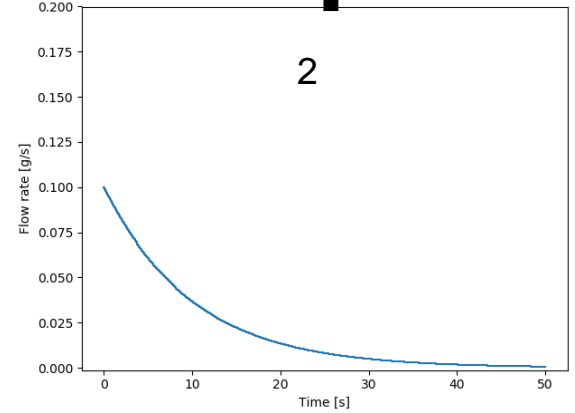
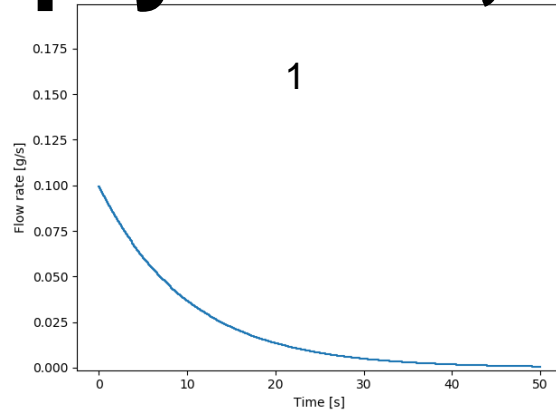
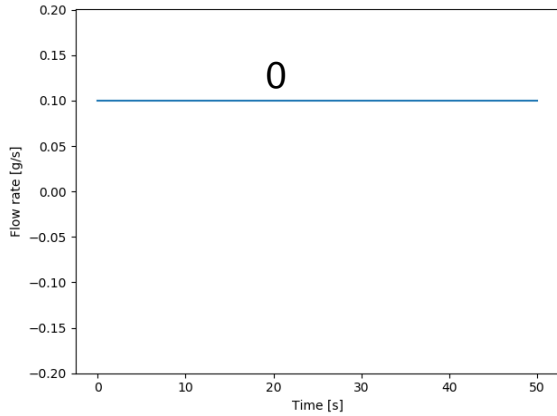
- Nested spheres 1 cm³ volume each
- Same mflow with different settings



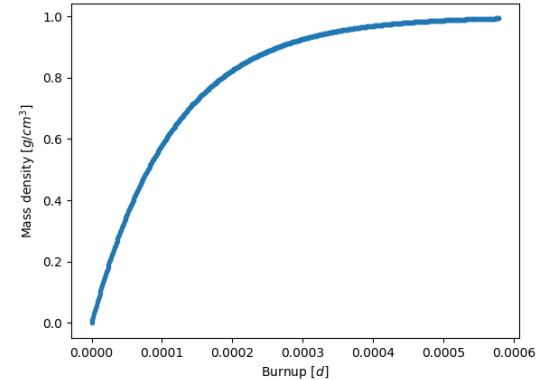
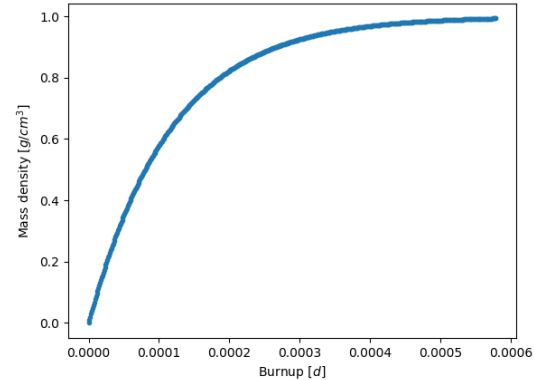
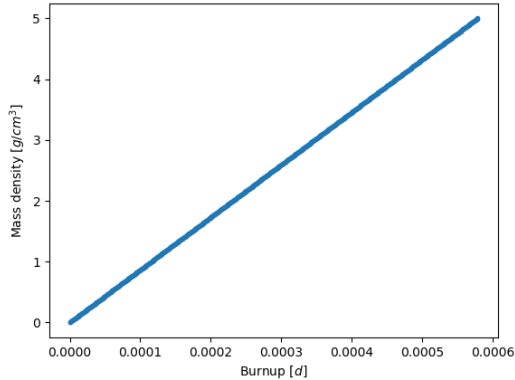
- The mflow card rate set to 0.1
- Above 10s intervals wont work for 2

Mass in Empty Shell, 0.1s steps

Flow Rate In

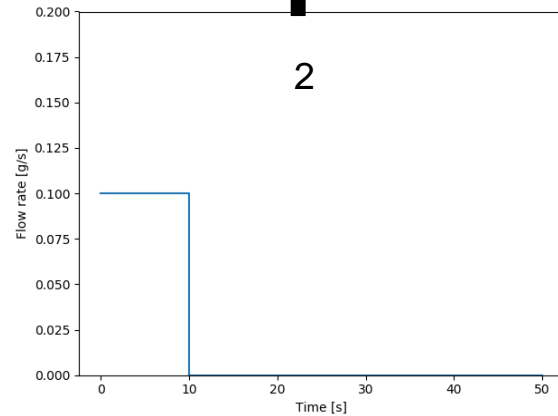
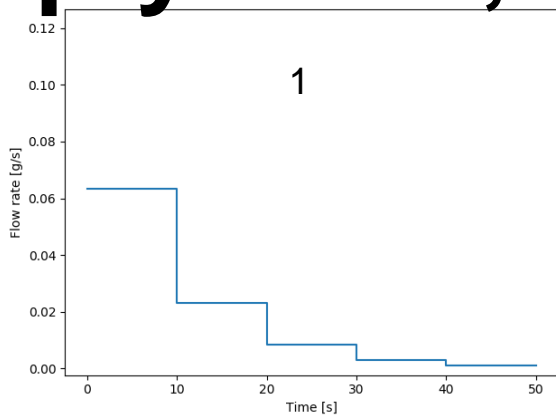
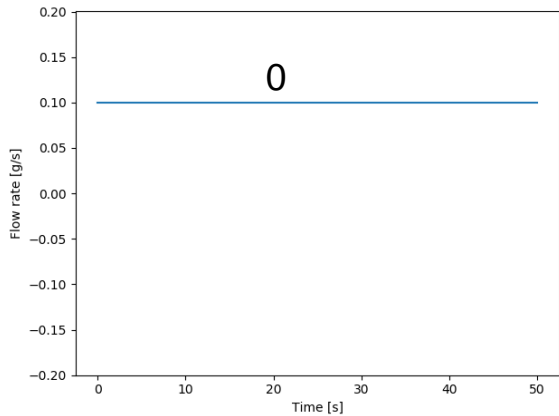


Total mass density

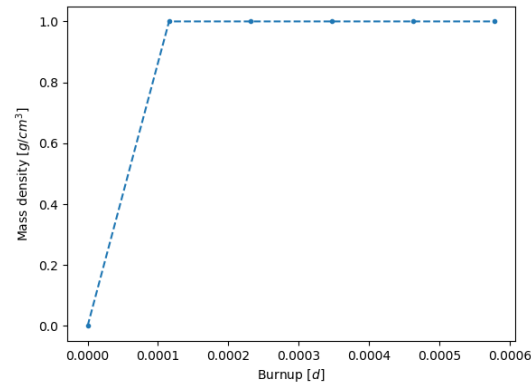
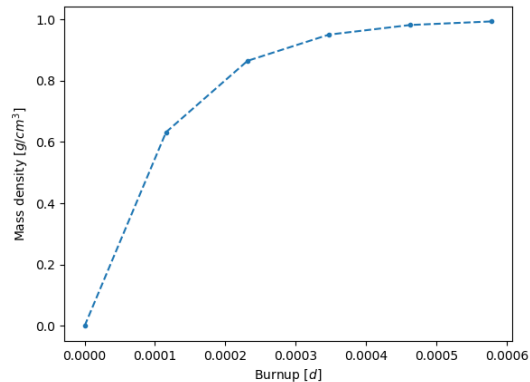
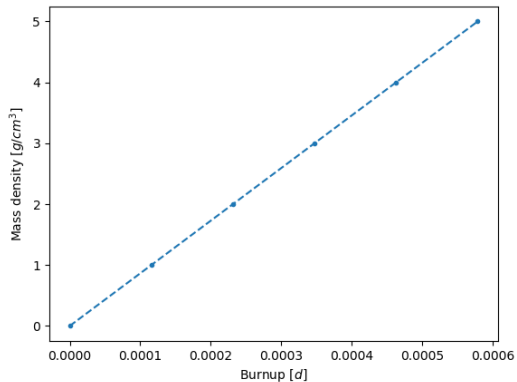


Mass in Empty Shell, 10s steps

Flow Rate In

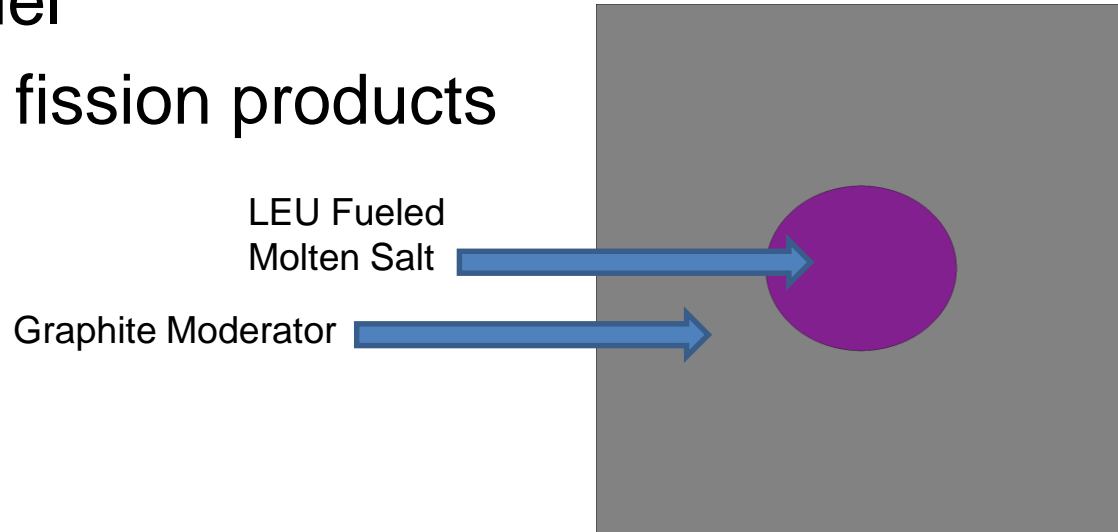


Total mass density

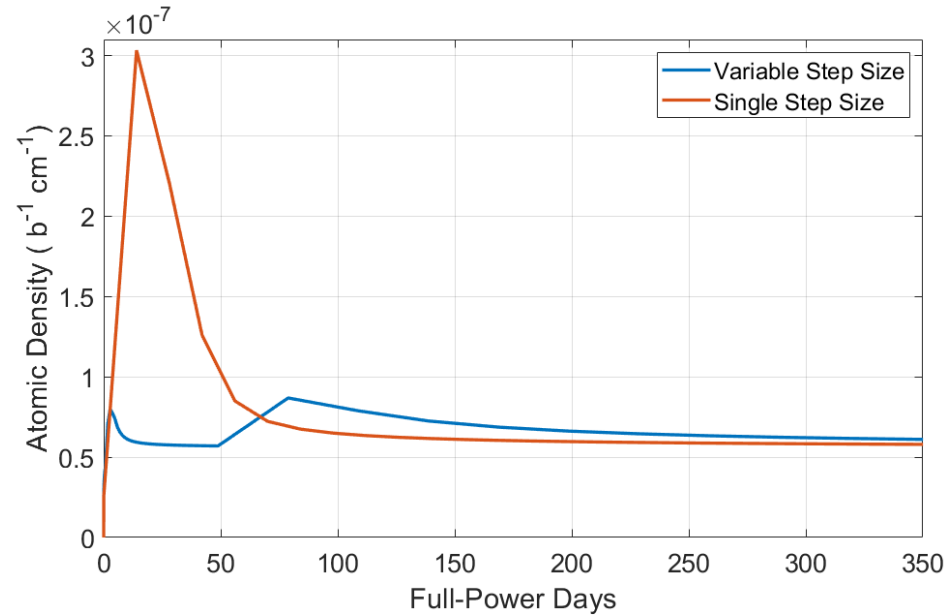
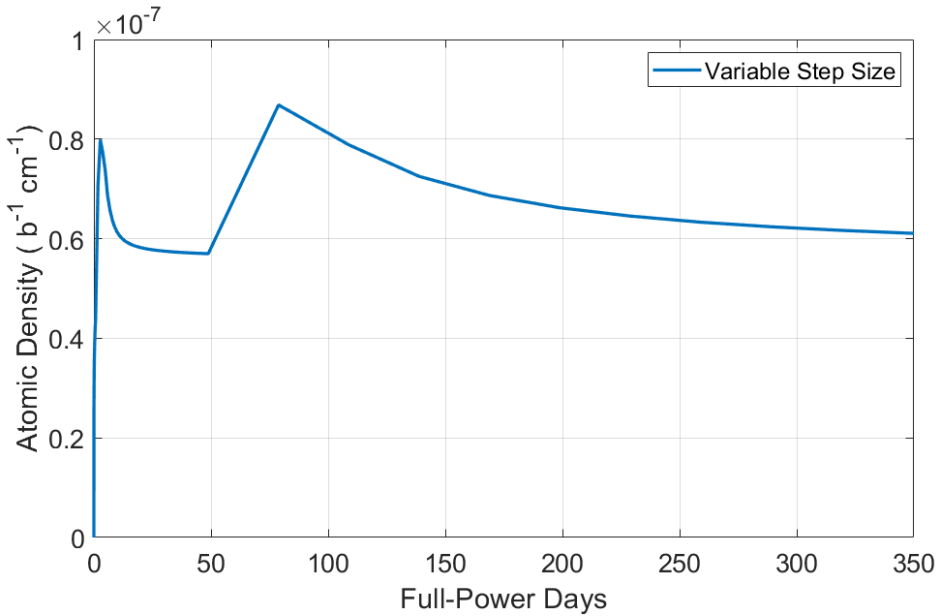


Example Case with Burnup

- Single cell, periodic boundary, salt fuel channel
- Rep 2 for LEU refuel
- Rep 1 for gaseous fission products

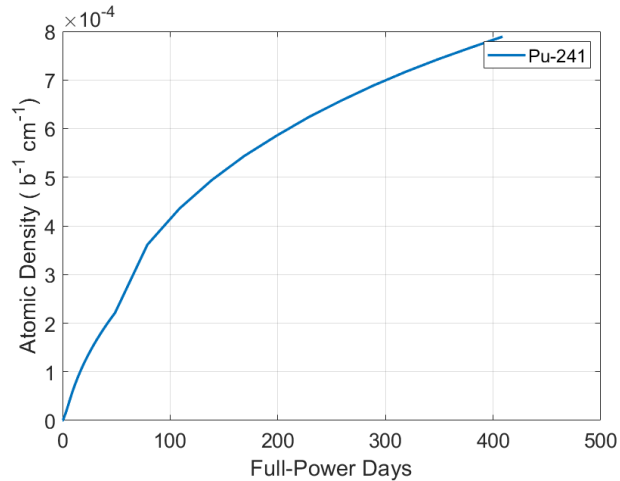


Gaseous Fission Products

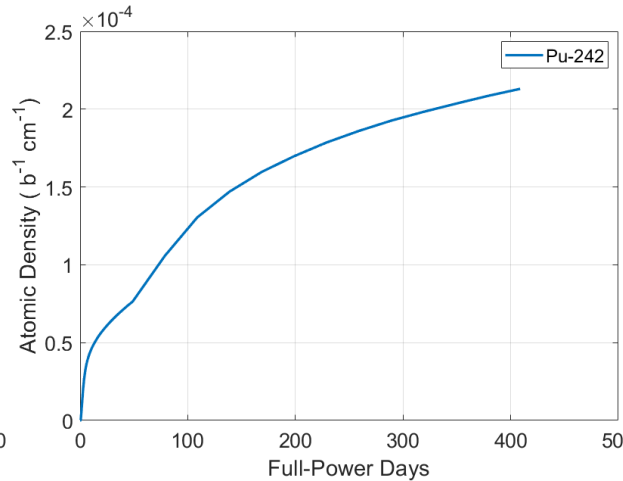


Concentration of Transuranics

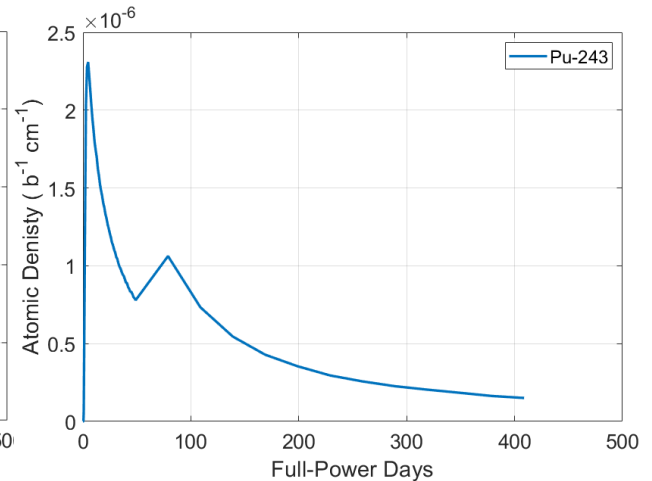
Pu-241



Pu-242



Pu-243



Conclusions/Discussion

- Validation and/or QA test suite currently work in progress
- Paper planned to provide documentation for reprocessing functionality
- Unresolved discontinuity in variable step sizes