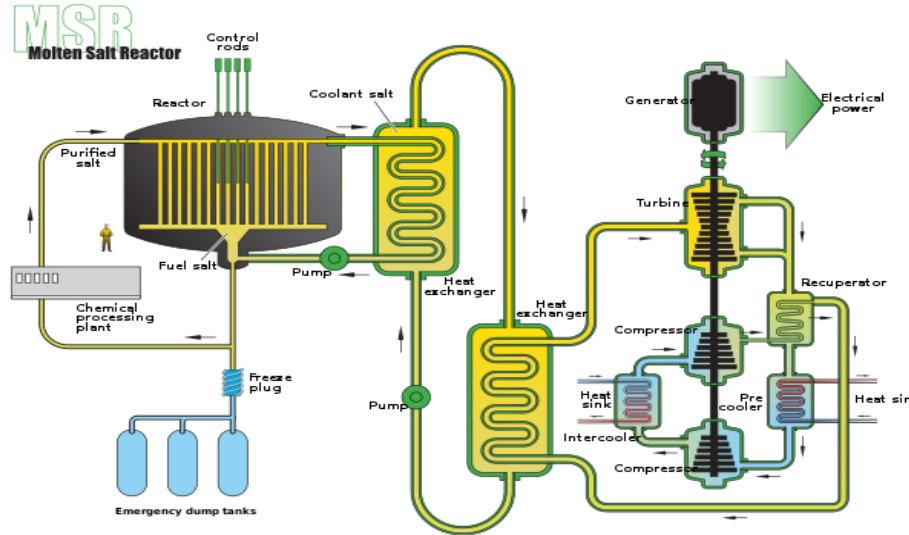


Material Flows and Online Reprocessing in Serpent

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Overview

- Purpose
- Syntax
- Equations
- Test Case
- Example case
- Conclusions and Future Work

Purpose

- **Problem:** Useful for Molten Salt Reactors but not well documented.
- **Solution:** Describe equations used, create example cases to illustrate, make a test suite from the cases, and expand cases.

Syntax

```
mflow {flowName}
```

```
  {element} { $\lambda$ }
```

```
rep {reprocessName}
```

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

```
dep pro {reprocessName} {stepType}
```

```
  {t1} {t2} ... {tN}
```

Equations (0)

$m_{source}(t) \text{ (g)}$	$m_{source}(0)$
$m_{destination}(t) \text{ (g)}$	$m_{destination}(0) + t\lambda m_{source}(0)$
$\dot{m}(t) \text{ (g/s)}$	$\lambda m_{source}(0)$

Equations (1)

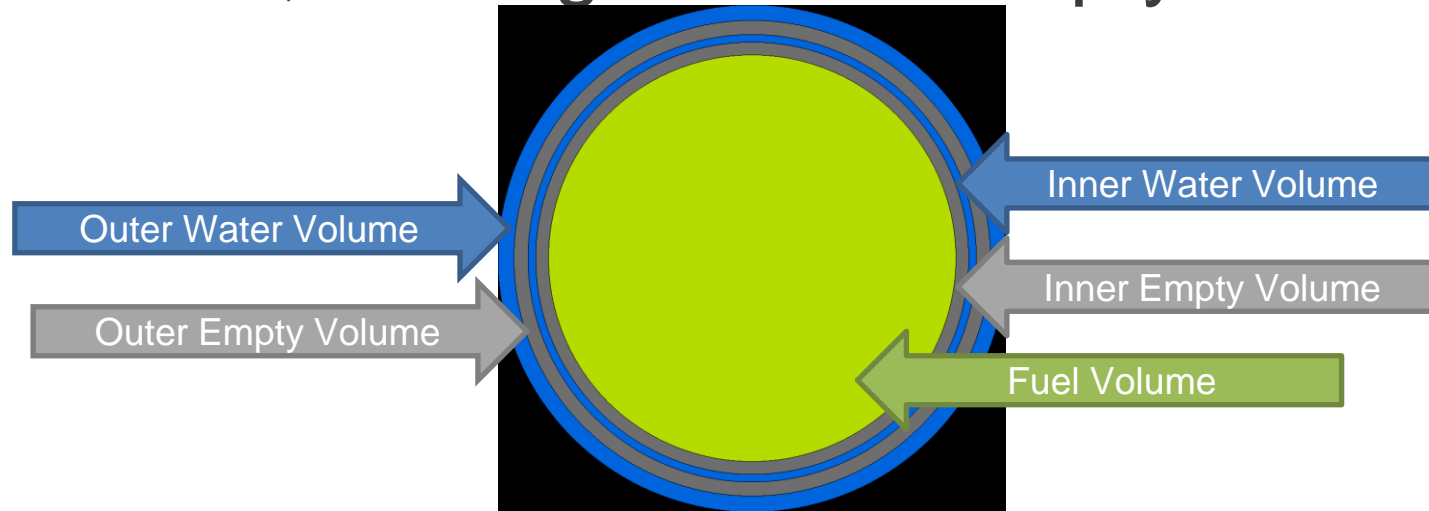
$m_{source}(t) \text{ (g)}$	$m_{source}(0)e^{-\lambda t}$
$m_{destination}(t) \text{ (g)}$	$m_{destination}(0) + m_{source}(0)(1 - e^{-\lambda t})$
$\dot{m}(t) \text{ (g/s)}$	$\lambda m_{source}(t)$

Equations (2)

$m_{source}(N + 1) \text{ (g)}$	$(1 - \Delta t_N \lambda) m_{source}(N)$
$m_{destination}(N + 1) \text{ (g)}$	$m_{destination}(N) + \Delta t_N \lambda m_{source}(N)$
$\dot{m}(N) \text{ (g/s)}$	$\lambda m_{source}(N)$

Test Case Overview

- Two water volumes and two empty volume, moving water to empty volume.

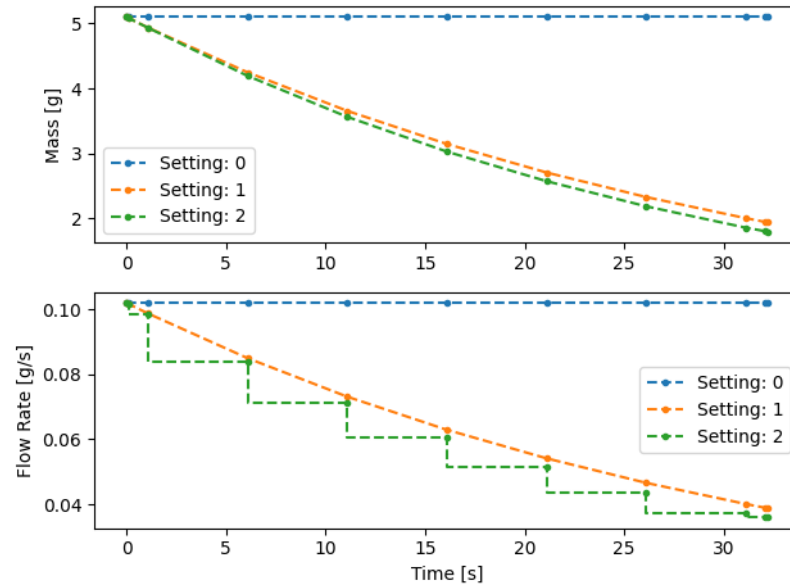


Test Case Values

- Time inputs
 - 0, 0.1, 1.1, 6.1, 11.1, 16.1, 21.1, 26.1, 31.1, 32.1, 32.2
- Inner-flow
 - $\lambda_1 = 0.03, V_s = 2, \rho_s(0) = 1.7, V_d = 3$
- Outer-flow
 - $\lambda_2 = 0.015, V_s = 5, \rho_s(0) = 0.8, V_d = 4$

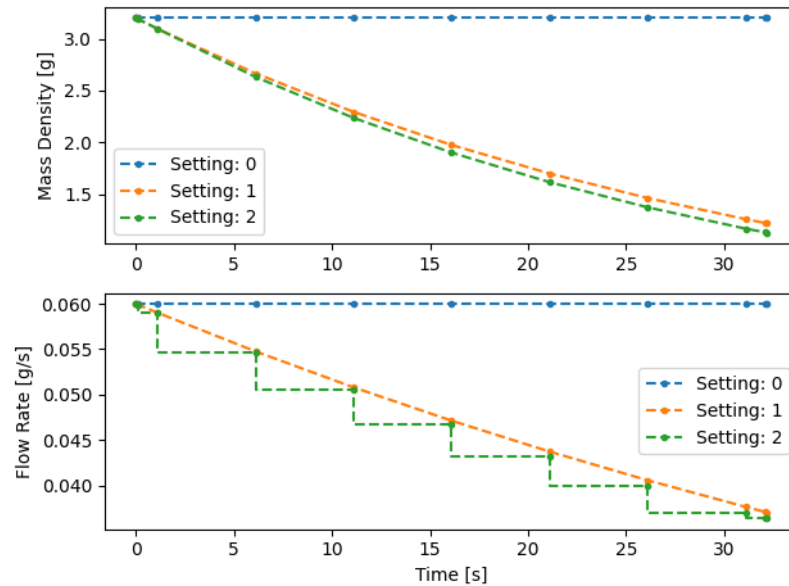
Test Case Inner-flow

$$\lambda_1 = 0.03, V_s = 2, \rho_s(0) = 1.7, V_d = 3$$



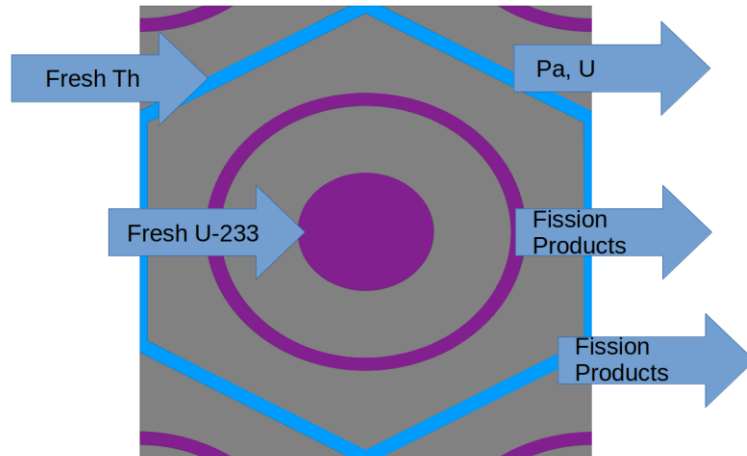
Test Case Outer-flow

$$\lambda_2 = 0.015, V_s = 5, \rho_s(0) = 0.8, V_d = 4$$



Example Case Overview

- Thorium molten salt breeder reactor
- FLiBe with $^{233}\text{UF}_4$ and $^{232}\text{ThF}_4$



Example Case Approach

- Previously setting value of 2 used for fuel salt refueling due to error, fixed now.
- Current models use setting of 1.
- Setting value of 1 used for all other flows.

Conclusions

- Each reprocessing setting is unique
- A paper is in progress to provide documentation for reprocessing functionality

Future Work

- Make tools to automate flows using equations
- Generate tests with equations
- Add documentation to wiki

Questions / Feedback

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