Diversion Detection in Cyclus Archetpyes

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Objectives

- Timely detection of diversion relies on the identification of signatures and observables for unique facilities.
- Create high-fidelity diversion algorithms .
- Determine optimum detector and inspection locations in pyroprocessing facilities using the Cyclus framework.
- Adapt this work to be applicable to a wide range of nuclear fuel cycle facilities in cyclus
- Characterize required detection sensitivities and corresponding false positive rates.

Background

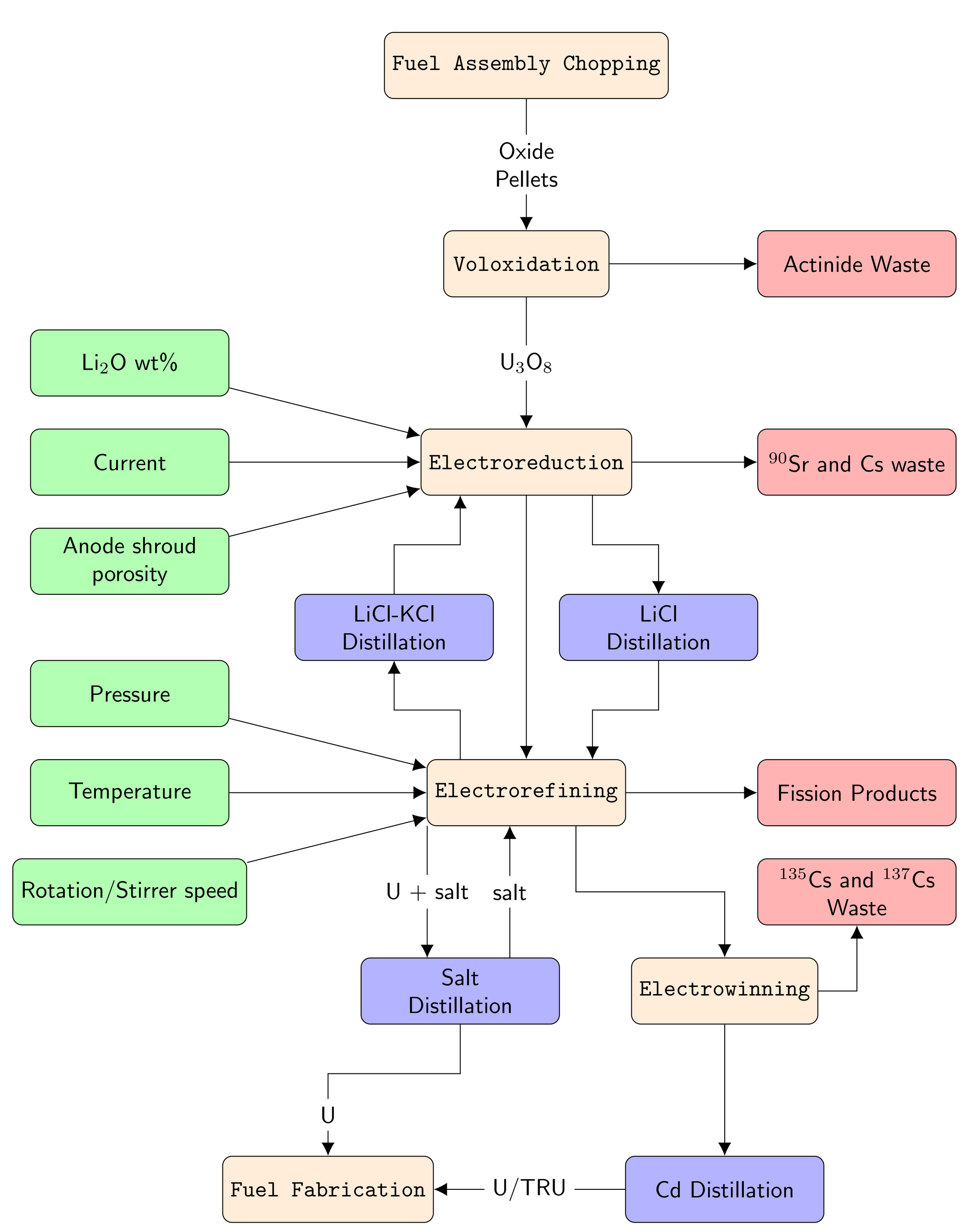

Figure: Archetpye design of the Pyre facility [1].

Facility Simulation

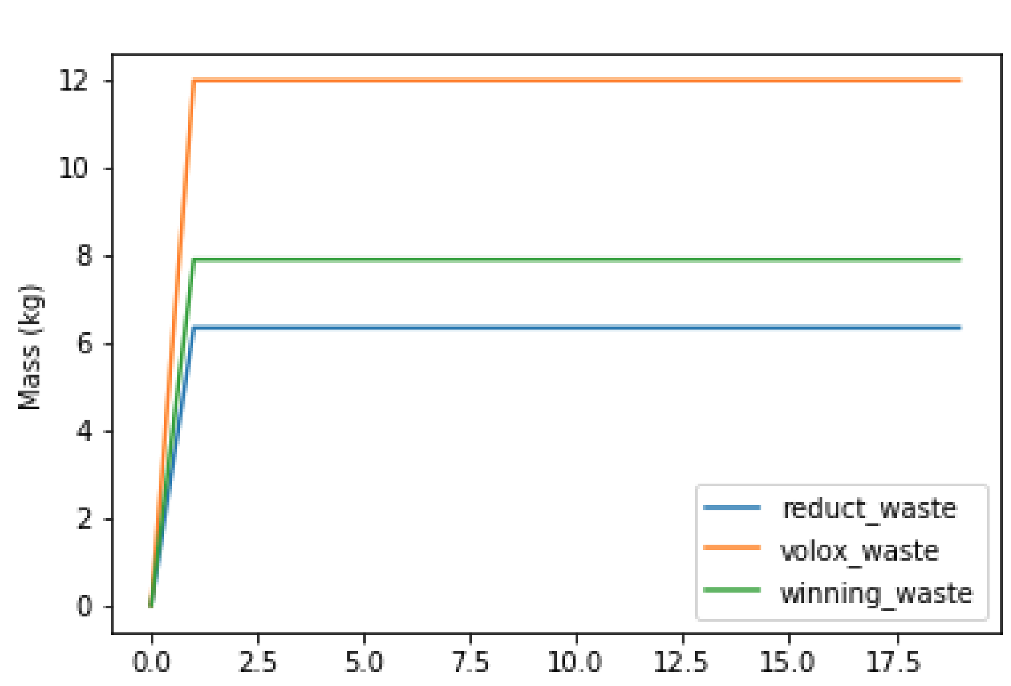

Figure: Example material transactions every time step.

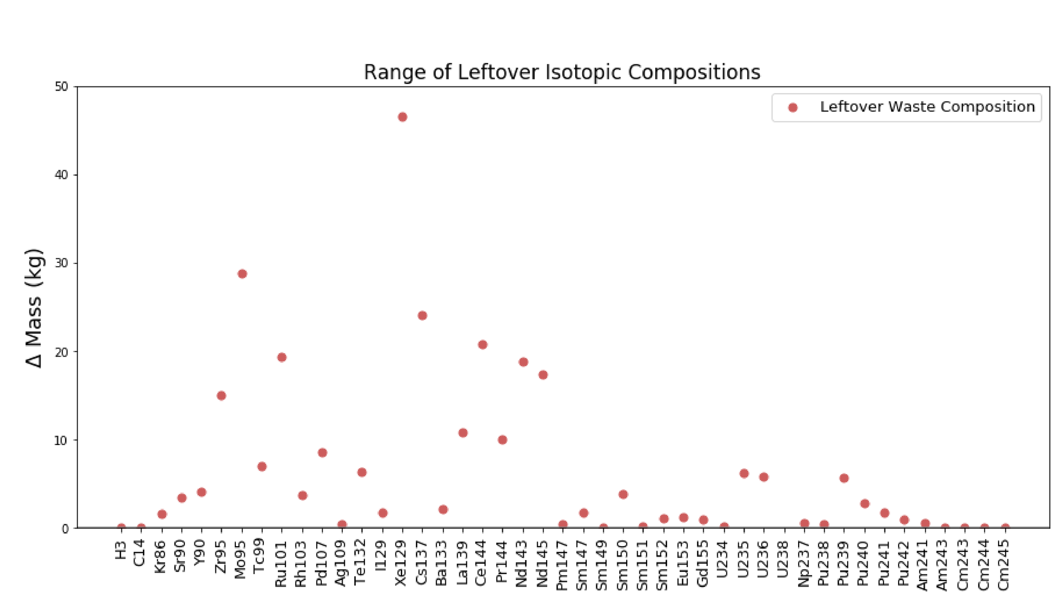

Figure: The isotopic breakdown of material transactions in the facility.

Material Detection

Material diversion occurs in two different modes: nefarious or operator. Nefarious diversion is the simplest as a bad actor will steal material at certain time steps. Operator diversion occurs when one of the facility operators is attempting to siphon off material by increasing productivity of the plant (or throughput) and taking off excess.

Nefarious Diversion

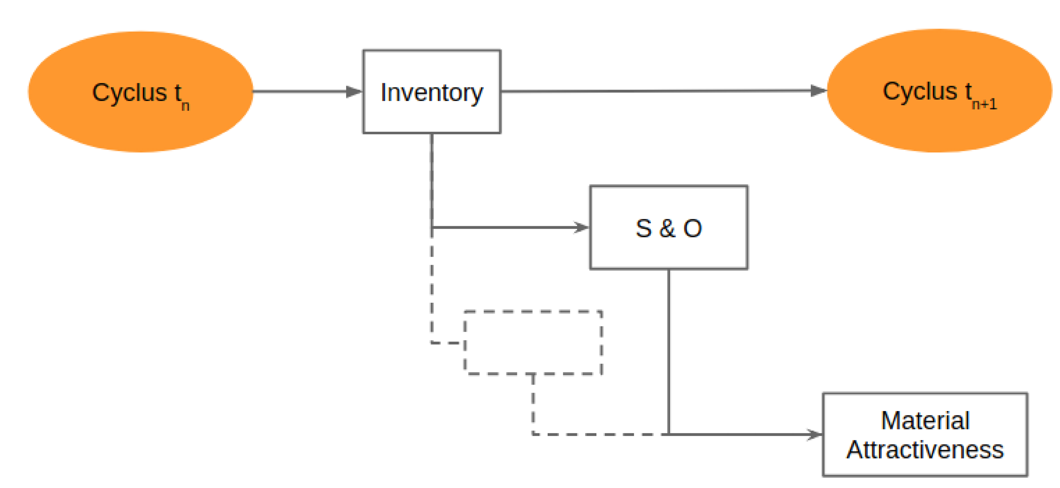

Figure: Illustration of nefarious diversion of cyclus inventory [3].

Operator Diversion

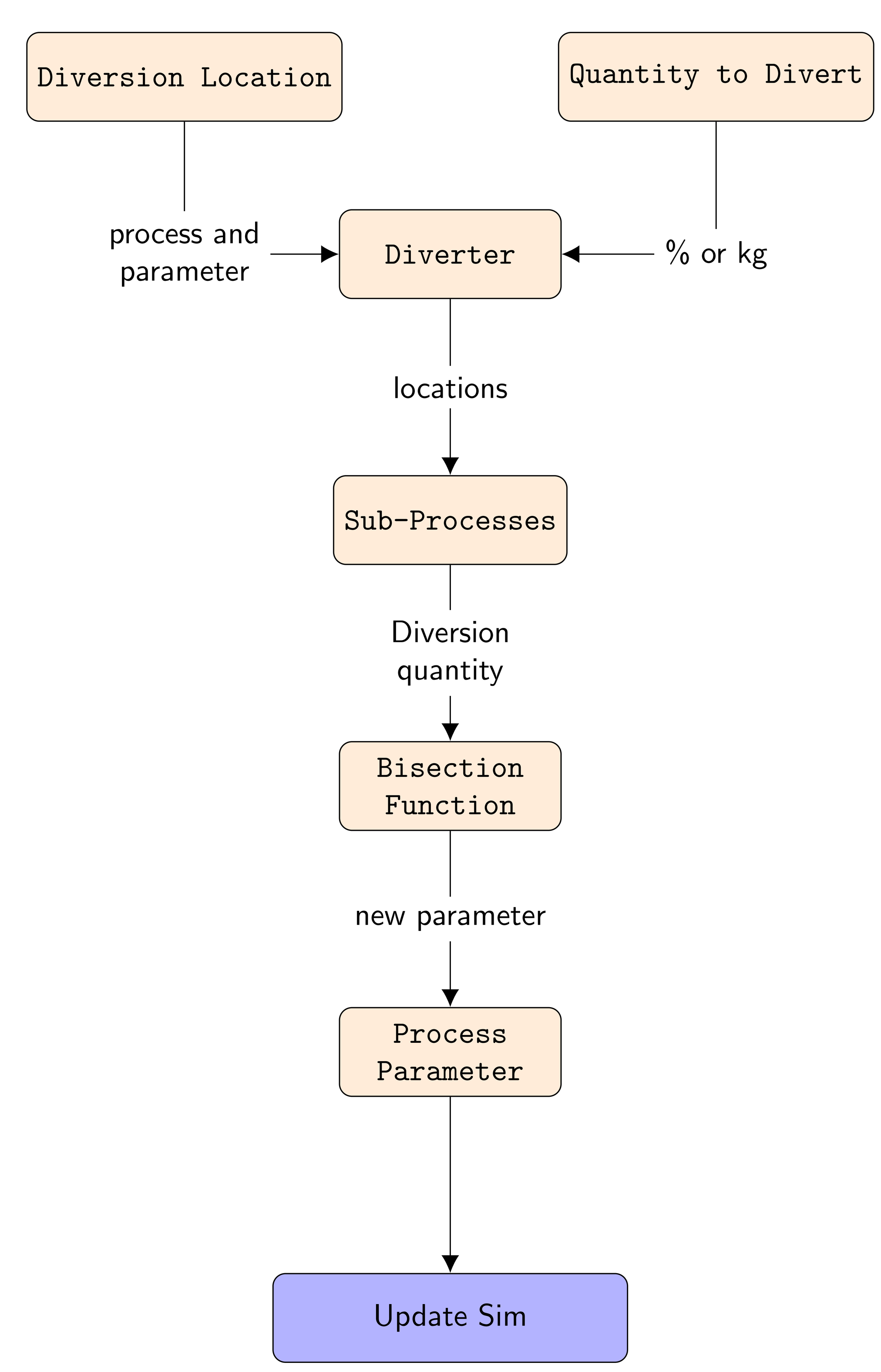

Figure: Procedure for generating operator diversion values inside a simulation.

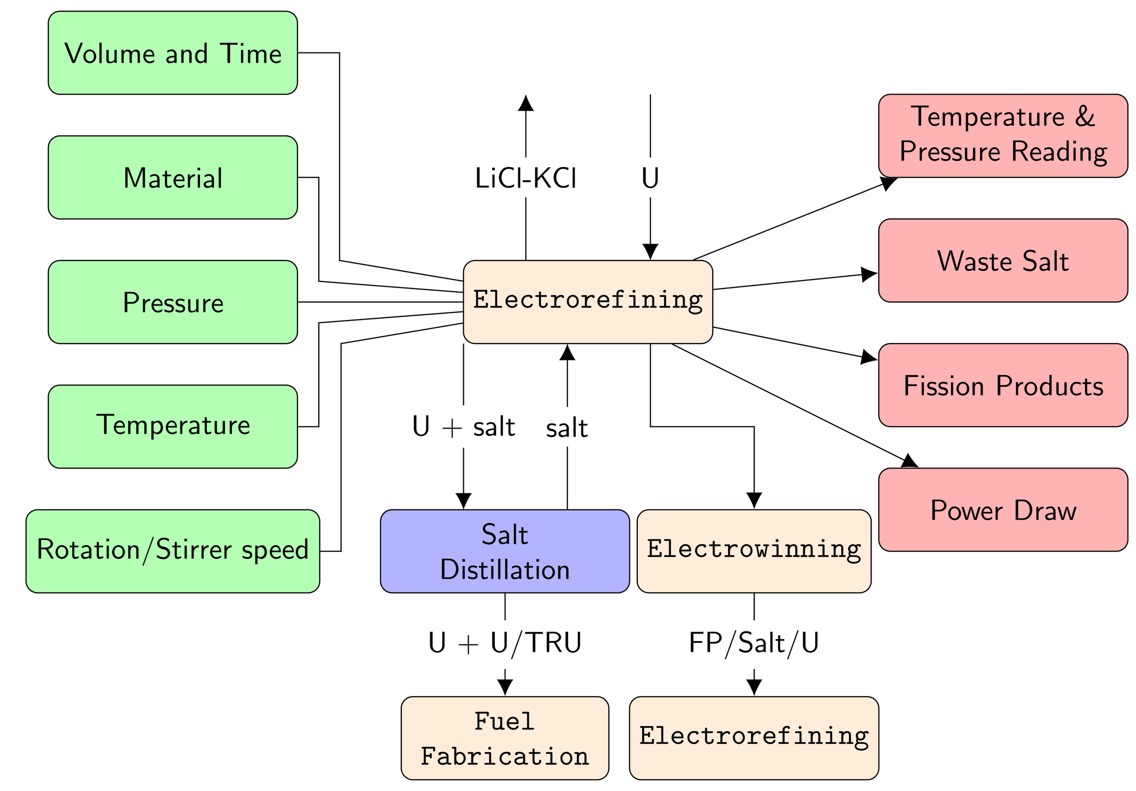

Figure: Example material balance used over a sub-process for diversion detection.

Diversion Detection

To maintain customization of the archetype the diversion detection algorithm will not know mean values for transactions. It is assumed that diversion will occur a number of time steps after startup, allowing the cumulative sum to approximate a mean based on simulated data.

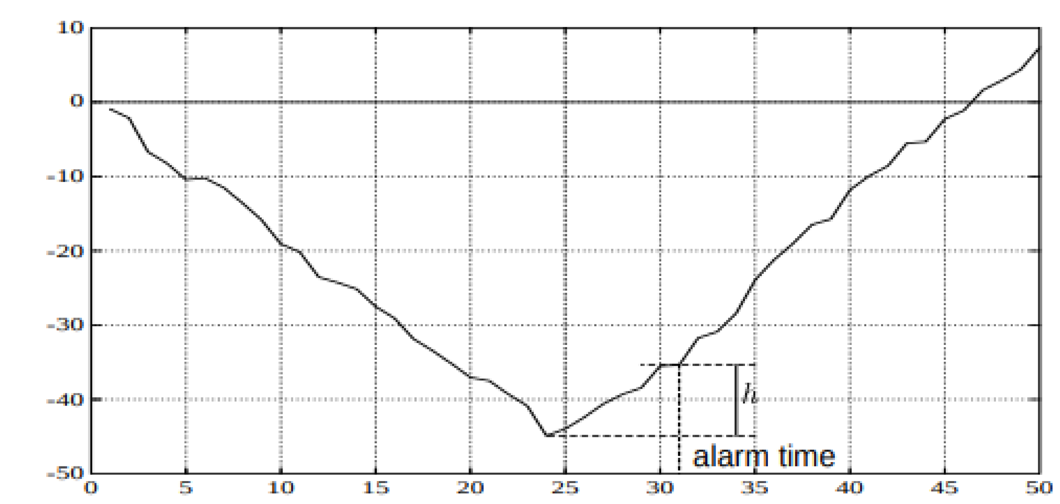

Figure: Cumulative sum method being used to detect a change in material flow [3].

Future Work

The goal of this poster is to outline what has been accomplished in cyclus diversion detection and review challenges and properties specific to pyroprocessing. What needs to be accomplished proceeding this work is as follows:

- Sensitivity analysis of diversion methods.
- Compare Cyclus output for various facility configurations.
- Assess capability of using Cyclus as online detection.

In addition to completing the diversion detection module for pyroprocessing, the goal is to expand this to be accessible to other Cyclus archetypes as well [2]. Other capabilities to be added include accounting for a variety of diversion times, currently the algorithm is capable of routine and set times for diversion.

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