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Savannah River NUCLEAR SOLUTIONS[SM]
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HYDRIDE BED ISOTOPIC EXCHANGE

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SRTE SAVANNAH RIVER TRITIUM ENTERPRISE

SRNL SAVANNAH RIVER NATIONAL LABORATORY
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

Summary

A hydride bed, was isotopically exchanged to recover tritium. Development and implementation of a new heating method led to recovery of significant additional tritium.

- *Heating of the bed promotes increased exchange between deuterium and tritium.*
- *Cycling gas between loss-of-cooling tanks and the bed by varying temperature results in the equivalent of multiple traditional exchange cycles*
- *Maintaining the temperature above 80ºC during cycling promotes deuterium-tritium exchange.*
- ***Additional 20% - 25% tritium heel recovered using technique described***

Introduction

$LaNi_{4.25}Al_{0.75}$ can be used as a hydride storage material. Over time, as tritium stored on the beds decays, its byproduct, helium-3, accumulates. In addition, helium-3 in-growth traps a portion of the hydrogen (the heel) [1,2,3].

Prior to replacement, beds can be isotopically exchanged to recover tritium. Isotopic exchange involves repeatedly absorbing protium or deuterium into the $LaNi_{4.25}Al_{0.75}$ and desorbing hydrogen isotopes from the bed [4].

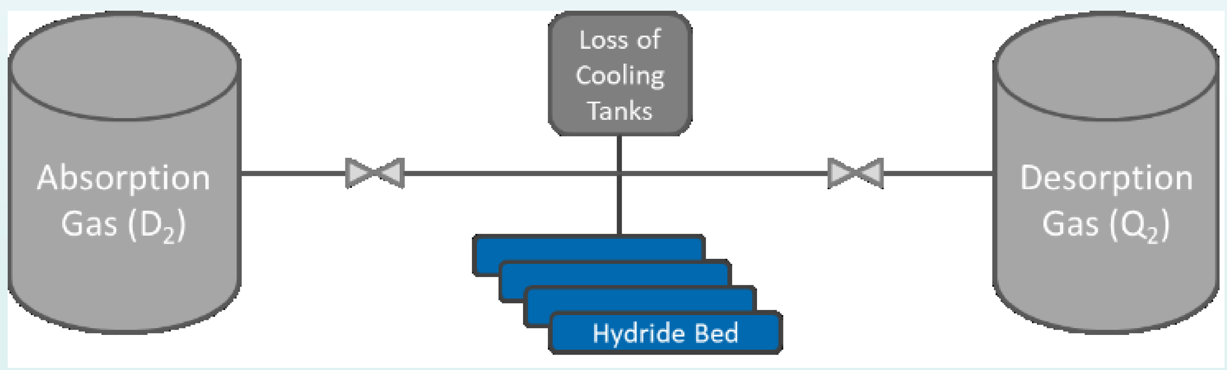

Figure 1. Depiction of isotopic exchange major components

Methodology

Twelve exchange cycles were performed.

Cycle	Type	Status
1-6	Traditional	Significant tritium heel remains, additional traditional exchanges unlikely to remove.
7-8	Heated	Tritium removal increases relative to previous traditional cycles.
9-12	Cycled	Tritium removal efficiency further increases.

<u>Heated Exchanges</u> - bed heated within a confined volume following absorption to encourage exchange between deuterium and tritium.

<u>Cycled Exchanges</u> - bed cycled between 80°C and 120°C 10 times to drive gas between bed and integral loss-of-cooling tanks. Takes advantage of the preferential absorption of lighter isotopes at temperatures above 80ºC [5].

Results

Following traditional, heated, and cycling exchanges at elevated temperatures, at Cycle 12, heel reduced to approximately 1% of original. Tritium remaining on the bed during the final 4 cycles appears to follow a theoretical reduction assuming perfect mixing of the absorption gas with the heel gas.

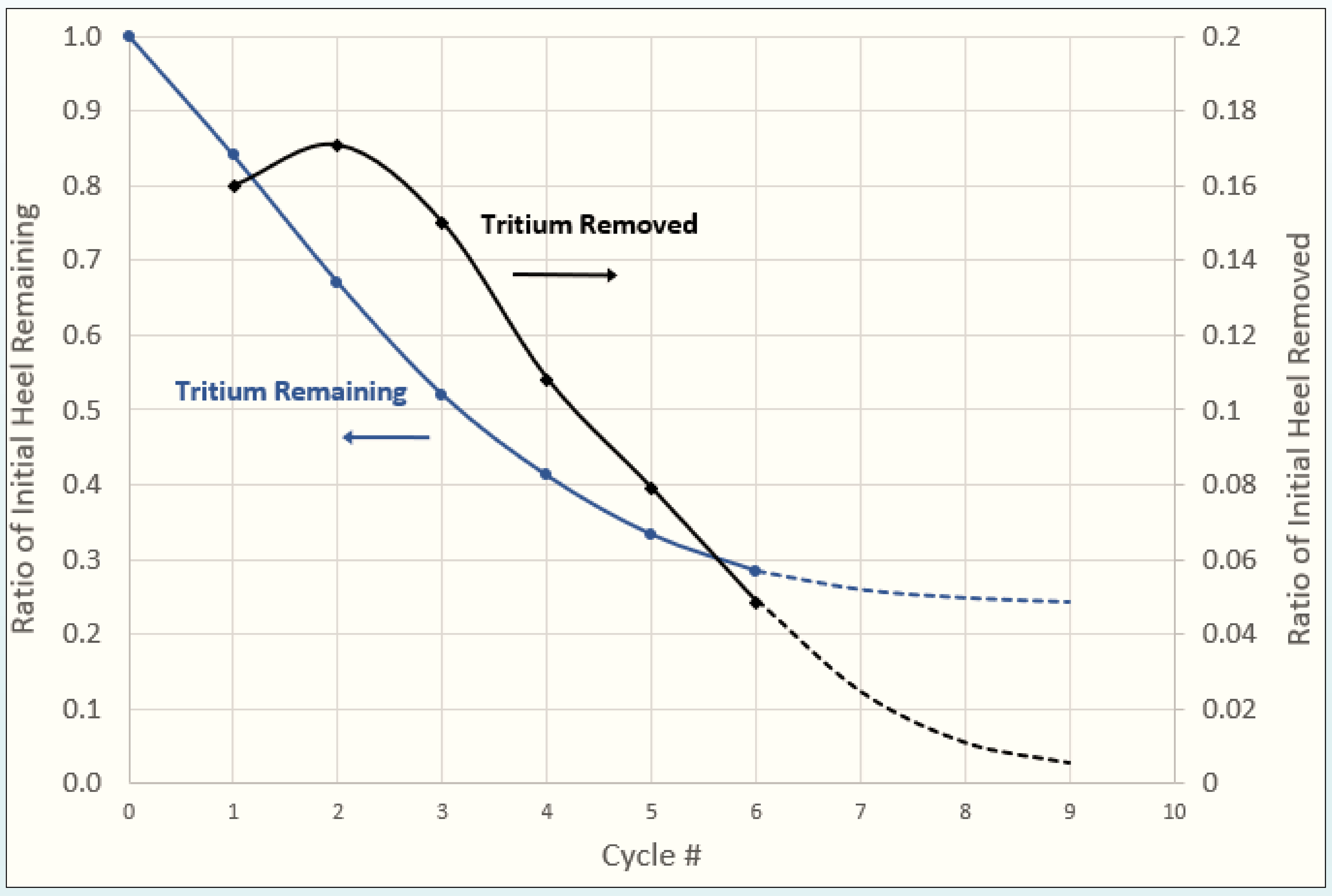

Figure 2. Ratio of Tritium remaining, tritium removed and projected path as a function of traditional cycles (1-6)

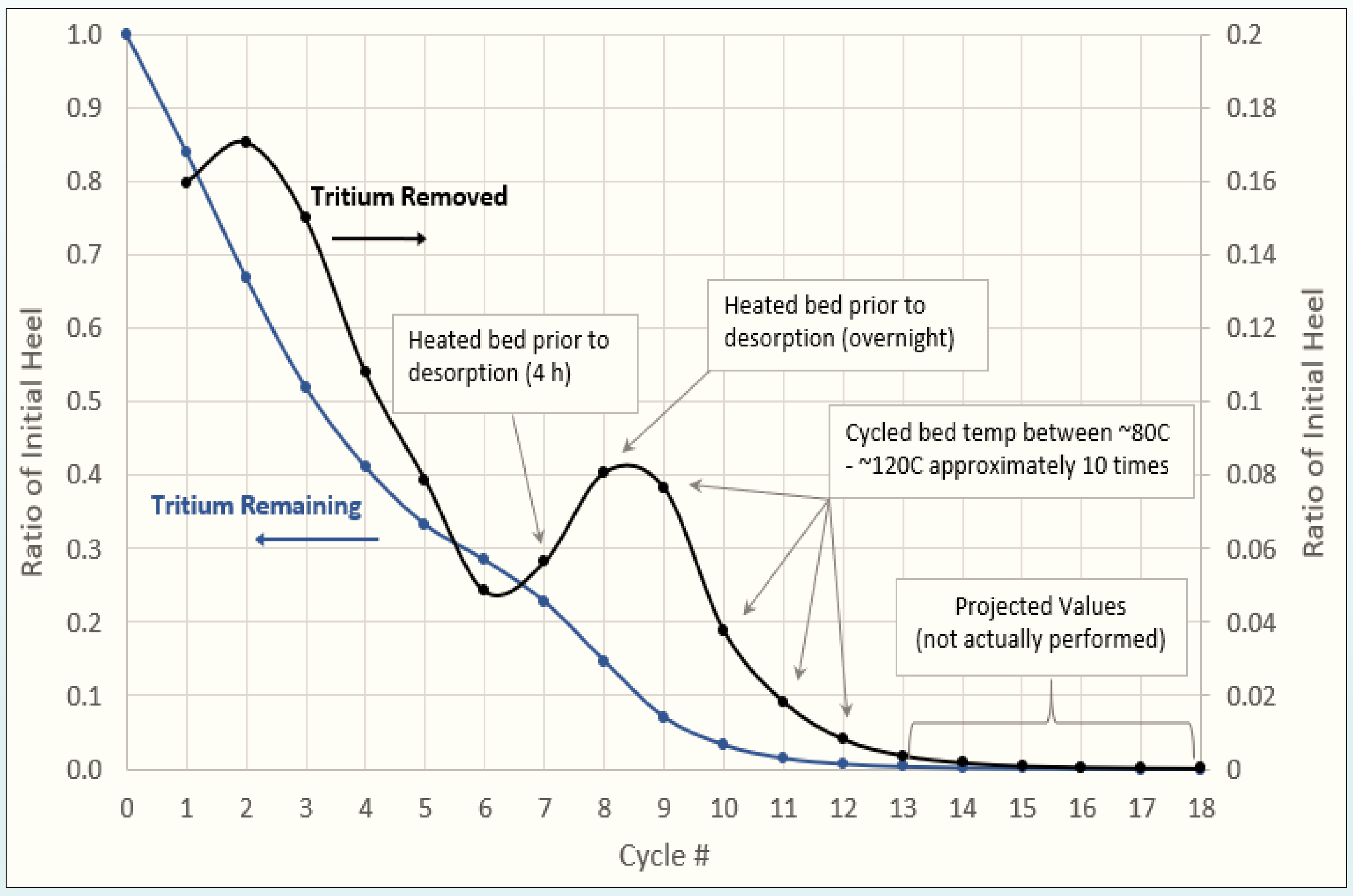

Figure 3. Ratio of Tritium remaining and tritium removed as a function of traditional cycling (1-6) – see Fig 1. – heated cycles (7-8), and cycles performed between 80°C and 120°C (9-12)

Conclusions

- Heating hydride bed promotes increased exchange between deuterium and tritium.
- Cycling gas between loss-of-cooling tank and the bed by varying temperature results in the equivalent of multiple traditional exchange cycles
- Maintaining temperature above 80ºC during cycling promotes isotopic exchange.
- **Additional 20% - 25% of a tritium heel recovered that otherwise would have been wasted**

References

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