Karlsruhe Institute of Technology

Institute for Applied Materials

The Reprocessing and Activation of Advanced Tritium Breeder Pebbles

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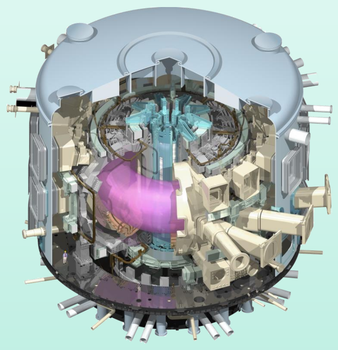
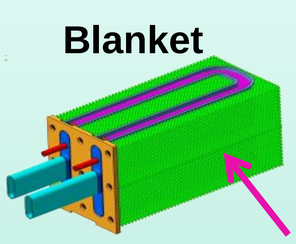
Introduction

Tritium Breeding for Fusion





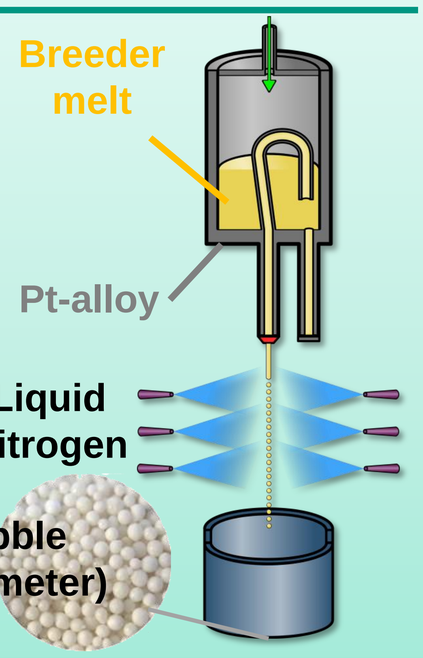
DT-reaction in plasma

$D + T \rightarrow n + He$

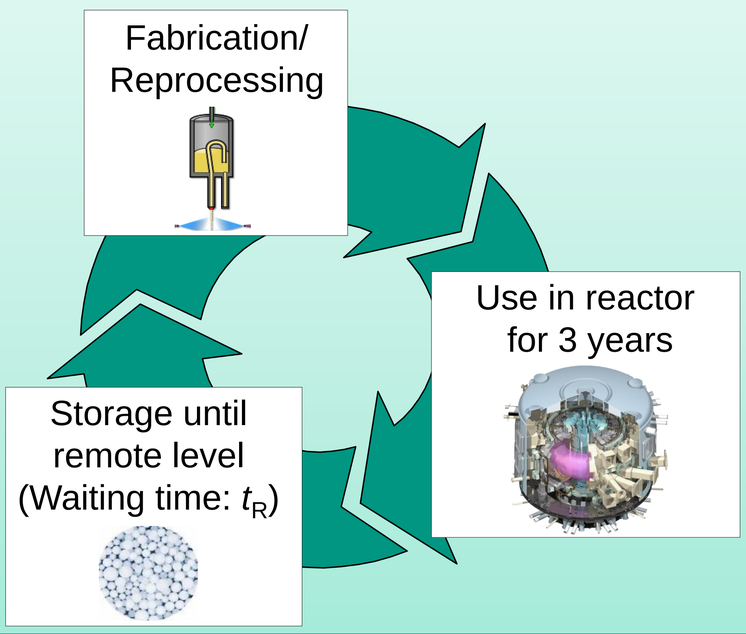
Tritium breeding in blanket

$Li + n \rightarrow T + He$

Breeder Pebble Fabrication



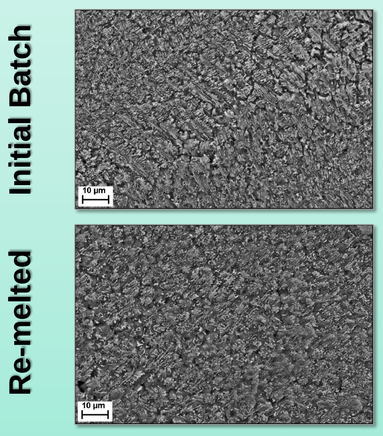
Recycling Schedule

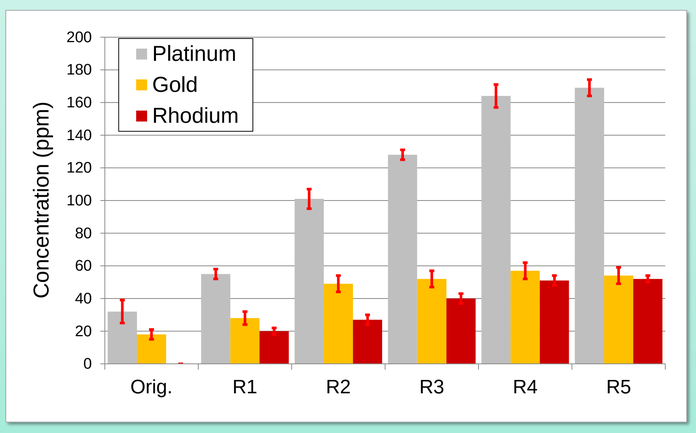


Reprocessing

In order to prove the viability of melt-based reprocessing, it must be possible to re-melt the used pebbles using the standard process while maintaining the original material properties

- A large batch of pebbles was produced using ultra-pure starting powders.
- The pebbles were then refilled into the crucible and reprocessed multiple times and analysed after each batch

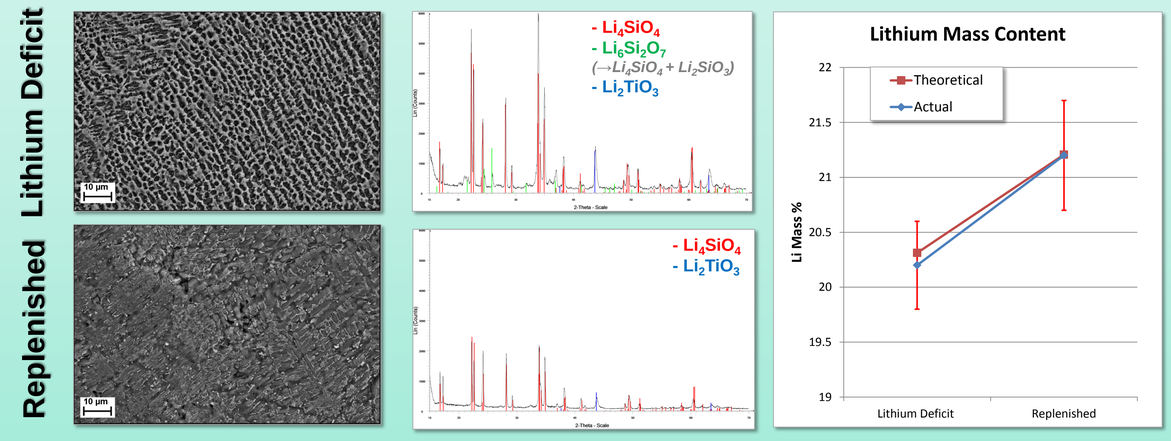




Lithium Replenishment

Due to the burn-up of lithium while in operation, it is essential to prove the ability to replenish the lithium while reprocessing

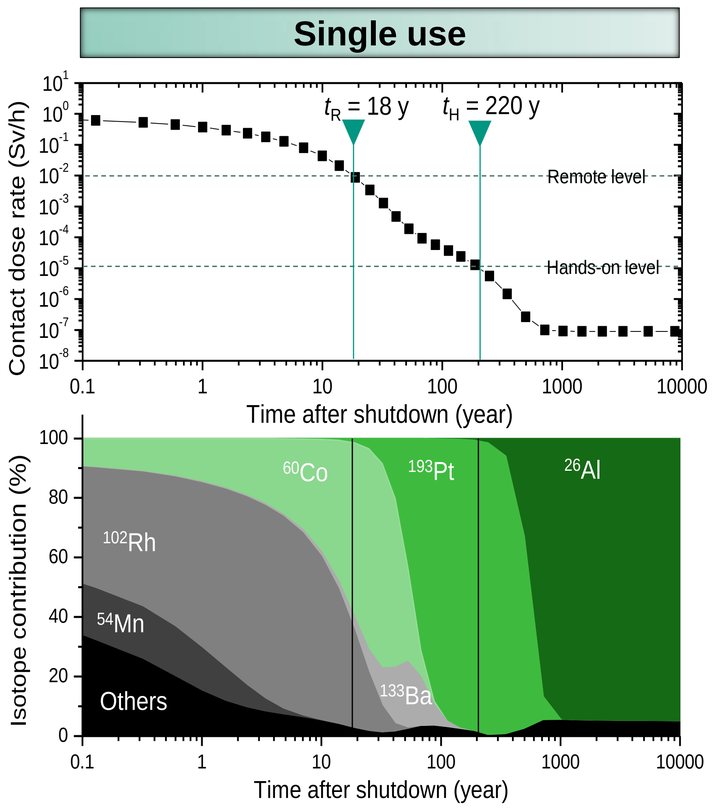
- Pebbles were produced with a simulated lithium deficit that is expected after usage in the reactor
- The pebbles were then reprocessed using the original process with corresponding additions of $LiOH \cdot H_2O$



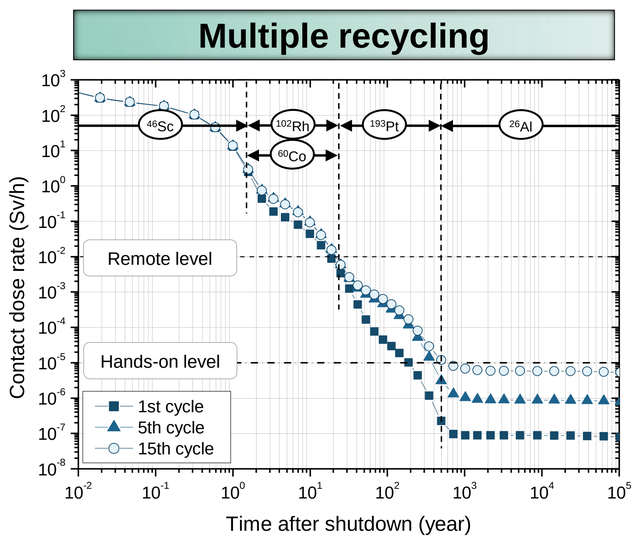
Simulation

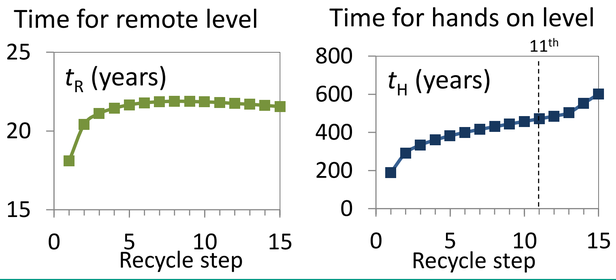
- Averaged activation property of breeder pebbles (i.e. contact dose rate [Sv/h]) after single-use/multiple-recycling was calculated by MCNP and FISPACT code.
- Waiting periods for remote level and hands-on level (t_R and t_H) were estimated.

Single use



Multiple recycling





* P. Pereslavtsev et al. Fusion Eng. Des. 89 (2014)1979–1983

Conclusions

- Breeder pebbles can be successfully recycled using the melt-based process
- Only elements found in the crucible alloy accumulate upon re-melting
- Pebbles with depleted lithium levels can be re-enriched by re-melting the pebbles with additions of LiOH using the standard process
- The reprocessing does not affect the pebble properties
- Critical radio-nuclides have been specified
- Multiple use of the breeder pebbles is feasible with a 22 year waiting period (t_R) even after 15 operation cycles

These findings prove that melt-based, single stage recycling is a viable option for the reprocessing of breeder pebbles