

# Thermal Cycling Absorption Process (TCAP) for Hydrogen Isotope Separation

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## Background

- TCAP is a displacement chromatography separation technology that can be used to separate hydrogen isotopes.
- The temperature of the SC is cycled in concert with input and output flows between the SC and TrC.
- Throughput mode – A gas mixture is fed and Raffinate and Product are withdrawn in every cycle.

## Rationale

- Importance of tritium control in nuclear reactors.
- Complexity & cost of current back-end detritiation processes.
- Deuterium and Tritium supply for Fusion Reactors.
- Current preparation drawbacks of TCAP absorbent material.

## Objectives

- Demonstrate successful operation of a high-pressure TCAP system as the basis for a design for a tritium removal system.
- Further develop/test TCAP absorbent materials

**Federal Stakeholder:** CNSC

## Project Status and Progress

### Absorbent Development/Production

1. Developed and characterized palladium-based absorbents by Precipitation Method.
2. Completed production and characterization of ca. 600 g of palladium-based absorbent to be used in the high-pressure experimental system.
3. Continue with the development of alternative/novel palladium-based absorbents:
  - a. Different supports with better thermal conductivity than silica.
  - b. Different palladium loadings.

### Process Development

1. Design, construction, commissioning and testing of a semi-automated low-pressure TCAP system for non-tritium separations (Max. pressure of 200 kPa – abs.).
2. Certified design for a high-pressure TCAP system for nontritium separations (Max. pressure of 1400 kPa – abs.)
3. Construction of the high-pressure TCAP system (non-tritium mixtures) started: • To be completed by October, 2019.

## Process Modeling

1. Development of a fundamental process model for the TCAP separation system (work still in progress):
  - a. Model developed in Fortran.
  - b. Focus on the transport phenomena within the SC (i.e., the TrC has not been modeled yet).

## Outcomes (March 2021)

An effective tritium separation process with potential to replace cryogenic distillation

- A functional high-pressure system for non-tritium separations (i.e., hydrogen and deuterium mixtures).
- A conceptual design for a high-pressure system for tritium separations (e.g., tritium and deuterium mixtures).
- A fundamental understanding of the dynamics of the separation through numerical modeling.
- Aim to improve operation and future designs of the TCAP process.