

Performance Characterization of Hydrogen Isotopic Exchange and Recombination Catalysts for Tritium Processing

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AECL's hydrogen isotopic exchange and recombination catalysts have been successfully applied in a wide range of industrial tritium-removal applications. These catalysts are used for Liquid Phase Catalytic Exchange and for gas-phase and trickle-bed recombination of hydrogen isotopes. Low-temperature recombination of hydrogen isotopes and oxygen in these processes using AECL's specialized wetproofed catalysts have led to process simplification, improved safety and operational advantages. In particular, under trickle-bed mode of operation, AECL's wetproofed catalyst recombiners can use water cooling, avoiding dilution of the hydrogen feed stream at low temperatures in a safer, more compact and economical manner.

Catalyst performance design equations derived from laboratory testing of these catalysts have been validated against performance under industrial conditions. A wide range of detritiation factors, between 100 and 46000, were demonstrated in a Combined Electrolysis and Catalytic Exchange (CECE) detritiation plant at operating conditions of 50°C, 110-120 kPa, 14-16 mol·m⁻²·s⁻¹ gas flow and 12-16 mol·m⁻²·s⁻¹ liquid flow. In the same demonstration, an analysis of the recombiner efficiency was also carried out as a function of catalyst activity over the wide range of detritiation factors. A steady-state process simulation used to model and design the hydrogen-water isotopic exchange processes, such as the CECE detritiation plant, was validated using the results of this demonstration.

Catalyst development for isotope-exchange and recombination applications have continued over the last decade. As a result, significant improvements in catalyst performance have been achieved for these applications. This presentation outlines the uniqueness of AECL's specialized catalysts and process designs for these applications with examples from laboratory and industrial case studies.