Successive Hydrogen Isotope Separation/Enrichment by Pressure Swing Adsorption Using SZ-13X Column

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Focusing on the behaviour of hydrogen isotopes adsorbed onto synthetic zeolites at cryogenic temperatures such as 77.4 K of liquefied nitrogen, we have been developing a system of pressure swing adsorption (PSA) process for hydrogen isotope separation applicable to fusion fuel processing, environmental safety tritium confinement or recovery of tritium from a heavy water reactor. The PSA process system consists of plural packed-bed columns cooperating in sequential operation procedure and alternative combination among adsorption, desorption and other preparative processes. In a previous work, we conducted an experimental series of 5-cycle PSA operations with a single column packed with 2mmφ particles of synthetic zeolite SZ-5A, where tracer D_2 could be enriched in a processing volume of H_2-D_2 gas mixture more and more with increase in cycle times. The result has been reported at the 9th Int. Symp. Fusion Nucl. Technol., 2009.

In this work, the series of 5-cycle PSA operations with a single column employing zeolite SZ-13X was carried out to examine the successive enrichment of tracer D_2 in a given volume of H_2-D_2 gas mixture, where the experimental method and procedure were improved in order to evaluate the accurate mass balance in the PSA process system. This improvement was effective because of an error within a few percents in comprehensive mass balance in this experimental system. The experiment was performed exhibiting the successive enrichment of D_2 in the volume of a gas mixture in the cyclical repetition of adsorption and desorption, that was promoted by the difference in isotherms for hydrogen isotopes onto the zeolite adsorbent. In addition to this static isotope effect, the kinetic isotope effect also occurs in the evacuating desorption process. The last effect produces the concentrating of D_2 in the residual adsorbed phase. From the adsorption isotherm, we had predicted that SZ-13X would have an advantage in hydrogen isotope separation, and it was verified in this work. The experimental results show that the SZ-13X column demonstrated more than twice the efficiency of D_2 enrichment in comparison with the SZ-5A column.

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