Conductance Characteristics of Hydrogen Isotopes between Viscous and Molecular Flow Regions in Spherical Pellet Packed-beds at 77.4 K

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We have been studying the dynamic behaviour of hydrogen isotopes flowing in an adsorbent packed-bed column between viscous and molecular regions, aiming at developing a pressure swing adsorption (PSA) system for hydrogen isotope separation needed in the fusion fuel cycle or/and tritium environmental safety systems. The PSA system is considered consisting of several columns to operate the cycles of adsorption, evacuating desorption and replenishing processes in these alternative combination. In its design and operation problems, the kinetics in adsorption process has been becoming to be predictable in the theoretical simulation based on experimental results, but the dynamic behaviours of hydrogen isotopes in evacuating and replenishing processes are difficult as yet to be estimated as transient phenomena because of the complicated geometry of passages in a packed-bed and the change between viscous and molecular regions depending on not only the pressure but also the dimension of passages. In the dynamics, the most important factor, should be known, is the mass flow conductance in an adsorbent packed-bed.

In a previous work, the conductance of hydrogen and deuterium with a packed-bed of 2 mmφ ceramic particles was experimentally examined under the conditions of pressure from around 30 Pa up to 3,000 Pa at 77.4 K, where the isotope effect was observed in the difference of conductance between hydrogen and deuterium appearing at a square root ratio of molecular weights. A conductance coefficient was defined there as a measure per units of packed-bed height and cross-section. The result has been reported at the 9th Int. Symp. Fusion Nucl. Technol., 2009. In the present work, we carried out the experiment to examine the dependence of the conductance on the diameter of particles in a packed-bed, since the geometrical and dimensional conditions of passages are affected by the size of the packing pellets. So, several sizes in addition to 2 mmφ were chosen for individual packed-beds. The conductance was measured under the same conditions as in the previous examination. From the experimental result and its analysis, we could clarify the pressure and particle-size dependences of the conductance coefficients of hydrogen isotopes in the packed-beds.

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