§8. Methane Decomposition on Nonvolatile Getter Materials of ZrNi (2)

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In our previous reports (1997 and 1998), a new type of tritium cleanup system, which was installed a decomposition process vessel of various tritiated compounds, was introduced. And, to develop a practical decomposition technique, ZrNi alloy was taken up and its methane decomposition properties were experimentally investigated under various process conditions. As a result, the methane and hydrogen concentrations after undergoing decomposition process showed qualitatively similar four-stage-time change profiles for all independently of experimental conditions. However, the definite dependence of decomposition properties on the decomposition conditions was quantitatively recognized.

In the present studies, to investigate the decomposition properties quantitatively, following three physical values were defined: a duration time, a volume of processed methane and a volume of generated hydrogen accumulated for a period when more than 70 % decomposition rate of methane continued.

Table 1 summarizes the results of thus obtained values. As found in Table 1, decomposition properties generally became better as gas flow rate is low, temperature is high, and granular size is fine. Moreover, the other results could be derived from Table 1 by using two values, M/D and H/M, derived by the calculations of (Decomposed **M**ethane Volume / **D**uration Time) and (Generated **H**ydrogen Volume / Decomposed **M**ethane Volume). In Table 1, the values of M/D and H/M are shown in parentheses following the values of "Decomposed Methane Volume" and "Generated Hydrogen Volume," respectively. The M/D values mean methane volume decomposed using 1 kg ZrNi alloy per unit time, and vary in large depending on gas flow rate. However, it is noticeable that the normalized values of M/D by the gas flow rate of 35 cc/min are about 4 for the four gas flow rates. This means the gas flow rate has no significant effect on the normalized M/D but on the duration time. The normalized values are shown right side in the same parentheses (marked by superscript of three stars). As for granular size and temperature dependencies, M/Ds are also all around a constant value of 4. It is suggested the effect of granular size and temperature for decomposition properties primarily appears on the duration time of the briskest reaction, which brings about great differences of the volume of decomposed methane. In the case of H/M, an interesting fact was derived, that is, all the values of H/M were around 2. As a methane molecule: CH_4 contains four hydrogens and a hydrogen molecule: H_2, two hydrogens, the decomposition of one methane molecule: CH_4 results in generation of two hydrogen molecules: $2H_2$. Thus, the value 2 of H/Ms must give the evidence that a methane was decomposed and perfectly converted into two hydrogen molecules, and released without the hydrogen molecules combining with Zr or Ni in ZrNi alloy.

Table 1 Experimental results for methane decomposition testing

Process Condition	Use with a decomposition rate more than 70%		
	Duration Time (hr)	Decomposed Methane Volume; ℓ /kg-ZrNi	Generated Hydrogen Volume; ℓ /kg-ZrNi
Gas Flow Rate Dependence (873K, 70-200 mesh)			
20 cc/min	92	205 (2.2*,3.9***)	385 (1.9**)
35 cc/min	44	173 (3.9*,3.9***)	335 (1.9**)
70 cc/min	11	75 (6.8*,3.4***)	157 (2.1**)
100 cc/min	3	28 (9.3*,3.3***)	55 (1.9**)
Granular Size Dependence (873K, 35 cc/min)			
70-200 mesh	44	173 (3.9*)	335 (1.9**)
200-400 mesh	66	258 (3.9*)	504 (1.9**)
<400 mesh	81	304 (3.7*)	612 (2.0**)
Temperature Dependence (35 cc/min 、 70-200 mesh)			
873 K	44	173 (3.9*)	335 (1.9**)
848 K	16	50 (3.2*)	96 (1.9**)
823 K	---	---	---

* : Decomposed Methane Volume per 1 kg-ZrNi/Duration Time (M/D)
** : Generated Hydrogen Volume/Processed methane Volume (H/M)
*** : Normalized values of M/D by the gas flow rate of 35 cc/min
--- : Time range with decomposition rate of more than 70 % was not observed