§9. Methane Decomposition Reaction on ZrNi Alloy

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A method of decomposing hydrogen compounds was developed by employing a zirconium nickel (ZrNi) alloy. This method enables all tritium compounds (HTO, CH_3T, C_2H_5T, etc.) in an exhaust gas to be decomposed into their respective elements, and the tritium itself to be removed in the form of hydrogen gas (HT). The method was developed through a series of experiments using methane. To ascertain the mechanism of methane decomposition on a ZrNi alloy, alloy samples were examined based on X-ray diffraction spectra before, during, and after the experiments (Fig.1.).

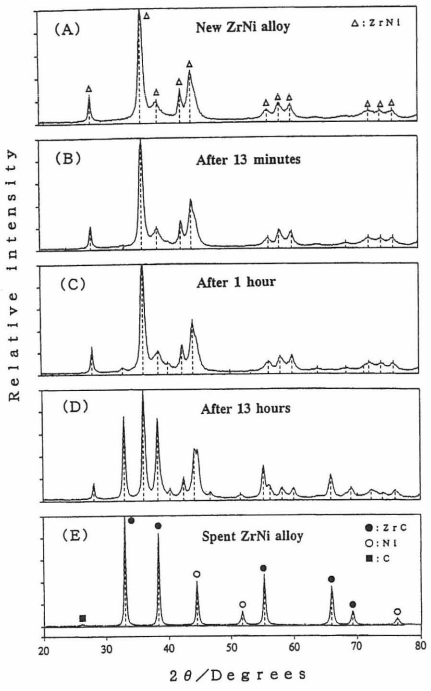

Fig. 1. Typical X-ray diffraction spectra.

As a result, the chemical reaction equation (1) explaining methane decomposition on a ZrNi alloy was proposed and discussed.

$$ZrNi + (1+\alpha)CH_4 \rightarrow ZrC + Ni + \alpha C + 2(1+\alpha)H_2. \quad (1)$$

The equation (1) shows that one molecule of ZrNi can decompose $(1+\alpha)$ molecules of methane and generate $2(1+\alpha)$ molecules of hydrogen. The value of α can be determined by using the weight of the ZrNi used and the decomposed methane volume derived from the experiment. The α-value thus obtained was bigger when a larger decomposed methane volume was obtained. Therefore, if the decomposition condition is considered to be better when the total methane volume decomposed is larger, the α-value can be used as an index to identify a good condition or not.

Under a practical good condition for us, though, the decomposition rate of more than a certain value should continue for a sufficient time length, and a larger volume of methane should be decomposed within the limited time span. It is important that a larger methane volume decomposes in a limited time span to maintain a good decomposition rate. However, the α-value is derived based on the entire time range and is not directly connected with the limited time span. So we have to derive and examine the α-value directly related to the limited time span. However, it is impossible to determine the α-value of the limited time span because the weight of ZrNi consumed within that time cannot be determined from a practical decomposition experiment. Thus, we investigated whether the α-value based on the entire time range can be used to evaluate the practical good decomposition condition in which a large volume of methane is decomposed within the limited time span. In the actual investigation, different decomposition rates of 10, 20, 30, 50, and 70% were studied and the methane volume decomposed in a partial range limited by the rates was examined. The relationship between the methane volume thus obtained and the value of α derived from the entire range was investigated.

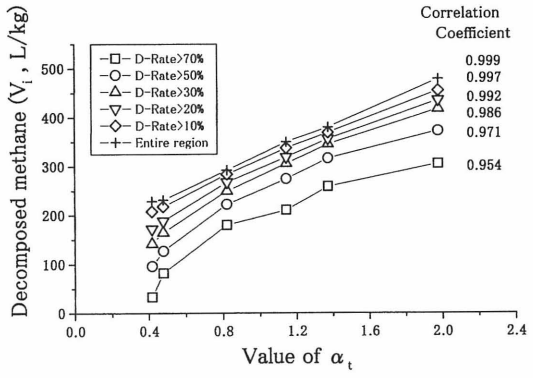

Fig. 2. Correlation between value of α_t and decomposed methane volume of V_i.

A result is shown in Fig.2. In Fig.2, the value of α was found to be strongly correlated to the methane volume decomposed within the limited time span. We thus conclude that the α-value based on the entire time range can be used as an index to estimate whether a decomposition condition is better or not from the view point of actual processing work.