1-23 Evaluation of Hydrogen Production from Waste Zeolite Adsorbents
— γ-Radiolysis of Mixtures of Zeolites and Seawater —

Fig.1-48 Photograph of the zeolite adsorbents used in this study
Three types of zeolite adsorbents (from left zeolite H, zeolite EH, and natural mordenite) were used in this study.

Table 1-6 Evaluated hydrogen production and assumed condition of the waste zeolites
Hydrogen production was evaluated assuming that the radiation from the adsorbed Cs was fully absorbed.

Zeolite adsorbents	1 t
Seawater	1 t
Adsorbed Cs / zeolite adsorbents	0.1wt%
Radiation-chemical yield of hydrogen	3.5×10^{-8} mol/J
Absotbed fraction of the radiations	100%
Hydrogen production rate	1.5 ℓ/h

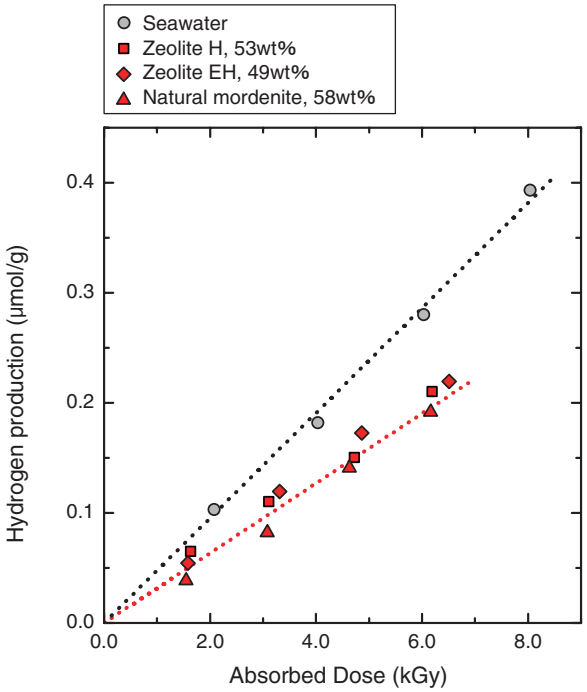

Fig.1-49 Hydrogen from mixtures of zeolites and seawater
The mixtures of zeolites and seawater were irradiated with γ-rays from ^{60}Co, and the produced quantities of hydrogen were measured.

Safe storage of waste zeolites is important for stable water treatment operations at the TEPCO's Fukushima Daiichi NPS (1F). Because the treatment uses zeolite adsorbents for removal of radioactive materials from contaminated water, highly radioactive waste zeolites are generated. A similar water treatment method was applied after the accident at Three Mile Island (TMI), and the obtained experience serves as a useful reference. However, the water in 1F contains salts from seawater, which makes the situation different from that of TMI.

Hydrogen (H_2) control is necessary for the safe storage of the wastes, because the radiolysis of residual water in the wastes produces H_2. However, the prediction of H_2 production is difficult, because porous ceramics such as zeolites are considered to affect water radiolysis. The reaction scheme for H_2 production in the presence of ceramics has not been established. Hence, further studies are required for evaluating the effect of zeolites on the radiolysis of water containing salts.

Mixtures of zeolites and seawater were irradiated with γ-rays, and the quantity of generated H_2 was measured. Three types of zeolites (Fig.1-48) were used. Zeolites H and EH were supplied by KURION. Zeolite H has actually been used at 1F. Natural mordenite was supplied by SHIN TOHOKU Chemical Industry.

Fig.1-49 presents the results. The produced quantities of H_2 were comparable for the three zeolites. Based on the results, the H_2 production from the waste zeolites was estimated assuming the conditions shown in Table 1-6. The radiation-chemical yield of H_2 indicates the H_2 production per unit energy deposition by the γ-rays. The highest value of the yield in the experiment, 3.5×10^{-8} mol/J, was used, and the H_2 production was determined to be 1.5 ℓ/h at standard temperature and pressure.

A more conservative evaluation can be obtained using the H_2 yield of the radiolysis of seawater. As shown in Fig.1-49, seawater in the absence of the zeolites produces more H_2 than the mixtures with zeolites.

In future studies, we are planning to investigate H_2 production under various conditions in order to provide more precise evaluation of the H_2 production from the waste zeolites.

Reference

Kumagai, Y. et al., Measurement and Evaluation of Hydrogen Production from Mixtures of Seawater and Zeolite in Decontamination of Radioactive Water, Nippon Genshiryoku Gakkai Wabun Ronbunshi, vol.10, no.4, 2011, p.235-239 (in Japanese).