§64. Study on Tritium Transfer through Porous Concrete and Film Coating to Restrain Tritium Permeation

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If a large amount of radioactive tritium is accidentally released in fusion-related facilities, an emergency clean-up system is launched operation, and tritium in air is recovered by a catalytic adsorption method. However, concrete walls constituting the tertiary enclosure system have pores that can include structural water as shown in Fig. 1. Usually, surfaces of concrete are coated with a hydrophilic paint. However, tritium transfer in paint coating has been less studied. In order to make clear the advantage of paint coating to control the tritium transfer into concrete walls, several kinds of cement or mortar disks with or without two kinds of paint coatings are tested in the present study. Three kinds of the HTO concentrations are tested in the three RI laboratories in JAEA-TPL, Toyama University and Kyushu University. Consistent results are obtained among any laboratories.

Experiment is performed using six kinds of samples as follows; (1) cement without any coating, (2) mortar without any coating, (3) cement with epoxy paint coating, (4) mortar with it, (5) cement with silicon paint coating and (6) mortar with it. The cement and mortar have compositions of 0.6/1 in water/cement ratio and of 0.6/1/2 in water/cement/sand ratio. The disk has a form of 35mm in diameter and 7.8mm in thickness. Two kinds of paints used in the present study are popular ones including epoxy polymer or acrylic silicon polymer.

After around two months of curing time, the cement and mortar has a porous structure shown in Fig. 1. The six kinds of samples are exposed to HTO vapor for a specified period, and an amount of tritium sorbed in samples are determined by a technique of water dissolution. On the other hand, the dissolution time is also varied after a specified period of HTO exposure.

Fig. 2 shows typical results of the sorption experiment for the six kinds of samples. The results are correlated in two ways; (1) a model based on the one-dimensional HTO diffusion through pores of cement paste or paint film and (2) the linear sorption model. The lines in Fig. 1 are calculated by the model (1) and the chain lines are by model (2).

The results obtained here are summarized as follows: (1) HTO penetration in porous concrete can be correlated in terms of the effective diffusivity. (2) Its value in porous cement without coating is 1.2×10^{-11} m^2/s at 25 ºC. (3) HTO penetrates only through pores in cement, and there is no path for HTO transfer in non-porous sand. (4) Rates of sorption and dissolution of HTO in disks of cement and mortar coated with the epoxy resin paint are correlated in terms of the effective diffusivity through the paint film which value is D_T = 1.0×10^{-16} m^2/s. The rate-determining

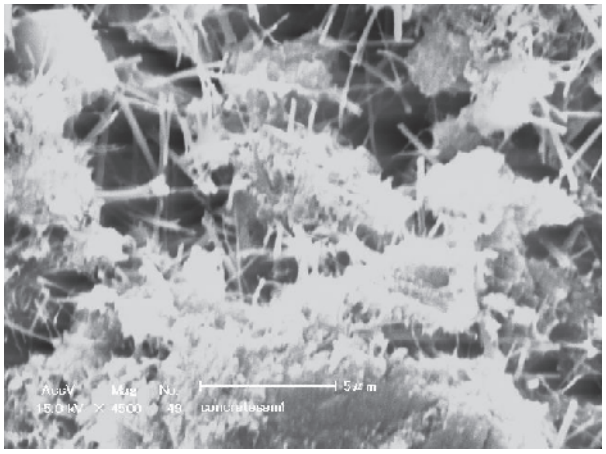

Fig. 1 Porous dendrite structure in cement paste[1)]

step is diffusion through the paint. (5) The epoxy resin paint works more effectively as an anti-HTO diffusion coating. (6) Another acrylic-silicon resin paint does not work well as anti-HTO diffusion coating. This may be because the hydrophobic property of the silicon resin paint is deteriorated with elongating the contact time with H_2O vapor or liquid. (7) The HTO uptake inside the epoxy paint is greater than that of the silicon one. (8) The permeation reduction factor (*PRF*) of HTO for the epoxy paint at steady state is expected large, if HTO vapor only contributes to diffusion. However, when concrete surfaces coated with the epoxy paint are under wet conditions, the *PRF* value becomes smaller.

1) Fukada S. *et al*.: Proc. 9th IAEA-TM on Fusion Power Plant Safety (2009).
2) Fukada, S. *et al*.: Proc. Inter. Conf. on Tritium Sci. and Technol. in Nara, (2010) in printing.
3) Fukada, S. *et al*.: Fus. Eng. Des., (2011) in printing.

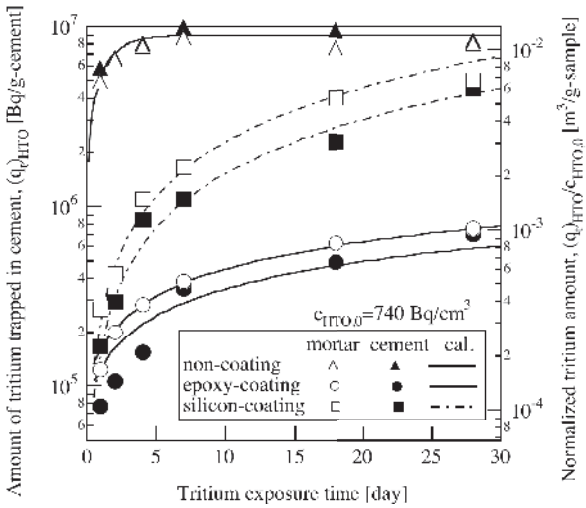

Fig. 2 Variations of tritium sorption in cement or mortar with or without hydrophobic paints with time[2)]