Corrosion of Aluminum Irradiated in Atomic Reactor

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For preliminary test of radiation corrosion of aluminum in atomic reactor, we measured the induced activities of aluminum specimens, and compared the corrosion resistance of these pile-irradiated specimens in high purity water at elevated temperatures with those of unirradiated ones.

The experiment was performed with three kinds of Al specimens containing 99.0, 99.9 and 99.99 weight percent Al respectively, and they were intermittently exposed in the thermal neutron flux of 2×10^{11} n/cm² sec. for one or two weeks until the total amount of thermal neutron became 2 or 4×10^{16} n/cm².

After removal from pile, the induced activities of these specimens were measured everyday by G-M counter (Fig. 1), and sometimes by a Gamma-ray spectrometer (Fig. 2). We unexpectedly found that pure aluminum specimens of 99.9 and 99.99% had higher residual activities than the other one, and it was caused mainly by Sb* which also proved its existence by Kraus' ion exchange method⁽¹⁾ later.

Fig. 1 Decay curves of impurities in pile-irradiated Al samples.

Fig. 2 γ -ray spectrogram of irradiated Samples after 2 days from removal.

The difference of corrosion behavior between irradiated and unirradiated specimens was observed in high purity water which had above 400 kilo-ohm specific resistance, at 80, 100 and 200°C. for 25, 20 and 9 hours respectively.

The results of the corrosion test are shown in Table. 1, 2 and 3 in which the degree of corrosion is indicated by weight gain per initial weight of sample because all specimens have the same thickness of 1mm. and therefore the initial weight of sample corresponds to its surface area.

From these results, we can see the effect of irradiation on corrosion is negligible or very little. We also studied the corrosion properties of irradiated and unirradiated specimens with and without surface treatment of abrasion by emery paper.

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Table 1 Corrosion of Aluminum at 80°C, 25 hrs.

Sample	A	B	A	B
Condition of irradiation	455.5 kWh ($^{c22}\times10^{16}n/cm^2$)		—	
Weight gain (mg/g)	1.29	1.78	1.16	1.95
pH	7.55	7.75	7.45	7.5
Specific resistance (kΩ)	71.00	98.00	105.00	100.00

Original water: pH 6.0 specific resistance 420 k Ω.

Table 2 Corrosion of Aluminum at 100°C, 20 hrs.

Sample	A	B	C	A	B	C
Condition of irradiation	425.6 kWh ($^{c22}\times10^{16}n/cm^2$)			—		
Weight gain (mg/g)	1.34	1.90	3.58	1.68	2.06	5.26
pH	7.88	8.05	7.85	7.15	7.68	7.60
Specific resistance (kΩ)	34.00	36.00	37.00	37.00	37.00	39.00

Original water: pH 6.5 Specific resistance 500 kΩ.

Table 3 Corrosion of Aluminum at 200°C, 9 hrs.

Sample	A	B	C	A	B	C
Condition of irradiation	455.5 kWh ($^{c22}\times10^{16}n/cm^2$)			—		
Weight gain (mg/g)	3.81	6.99	185.5	3.10	6.92	180.4
pH	7.33	7.38	7.80	7.16	7.30	7.33
Specific resistance (kΩ)	29.5	30.0	36.0	29.0	30.0	34.0

Sample	A	B	C	A	B	C
Condition of irradiation	927.4 kWh ($^{c24}\times10^{16}n/cm^2$)			—		
Weight gain (mg/g)	2.50	7.00	178.1	2.34	7.77	176.2
pH	7.00	7.25	7.45	6.95	7.15	7.65
Specific resistance (kΩ)	27.0	27.0	33.0	25.0	30.0	31.0

Original water: pH 7.0 Specific resistance 450 k Ω.

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Literature :

- (1) K.A. Kraus and F. Nelson: International Conference on the Peaceful Use of Atomic Energy VII p. 113 (1955)