CHAPTER V

DISCUSSION

Wahl and Seaborg[8] reported the half-life of neptunium -237 to be 3×10^6 years. Their results were obtained by using on ionization chamber to detect the alpha particles. Later, Magnusson and La Chapelle[9] found the half life to be $(2.20 \pm 0.10) \times 10^6$ years, closed to the presently accepted value. However, their measurements were made with samples prepared by evaporating aliquots of ^{237}Np solutions. Their samples were therefore not likely to be uniform sources. In addition, the activities were determined by 50 % geometry α-particle counters, and the ultramicro weighings with a precission of 0.02 microgram was used in their measurement of the accurate amount of ^{237}Np. More recently, the value of $(2.14 \pm 0.01) \times 10^6$ years found by Brauer et al.[10] based on ultro-micro weighings of NpO_2 and $2\pi - \alpha$ counting for measuring of the amounts. They measured the activities of their ^{237}Np sources with both a low geometry proportional counter and a

---

[8] A.C. Wahl and G.T. Seaborg, Phys. Rev. 73(1948) 940

[9] L.B. Magnusson and T.J. La Chapelle, J. Am. Chem. Soc. 70(1948) 3534

[10] F.P. Brauer, R.W. Stromatt, J.D. Ludwick, F.P. Roberts and W.L. Lyon, J. Inorg. Nucl. Chem. 12(1960) 234

4π liquid scintillation counter.

If we compare the previous attempts to measure the half-life of neptunium with the present investigation, we see that the preparations of the ^{237}Np sources in the other attempts were as good as our preparation of the source. However, the counters used in the other determinations were not as good as the surface barrier detector used in this work. The counting rates recorded by the surface barrier detector are more accurate than those recorded by the other detectors. This is indicated by our χ^2-test of the distribution of the data points.

The apparently longer half-life $[(2.41 \pm 0.06) \times 10^6 \text{years}]$ determined in this work is likely due either to our mass determination or sample preparation. The latter possibility seems more likely when one compares the spectrums illustrated in Figures 4.1 to 4.5. One clearly sees that the samples prepared for investigation do not produce a spectrum as sharp as that produced by a standard source. Therefore the instruments used for the electrodeposition of the neptunium and americium atoms on the aluminum foil must be improved, i.e, the platinum wire can be controlled to be a straight line in vertical axis at the center of the backing. With the improvement, the radioactive ions could be deposited in a way to give a greater uniformity of the neptunium or americium ions on the backing.

The error could also be reduced if the activities of the americium sources were approximately equal to the activities of the neptunium sources and ^{241}Am sources were not too strong since the too strong sources would cause the error in measuring the activities. Comparing the tail on the spectrum of the α-particles emitted by the ^{237}Np nuclei with the tail on the α-particles spectrum of the ^{241}Am sources, we see that the self-absorption of the α-particles by the ^{237}Np sources are greater than the self-absorption occurring in the ^{241}Am sources. This is due to both the greater thickness of the ^{237}Np sources and the fact that the alpha particles emitted by ^{237}Np are less energetic than those emitted by ^{241}Am. However, all the sources used in this experiment are good enough for the determination of the absolute disintegration rate. The fact that all the experimental points (see Figs. 4.6 and 4.7) did not deviate too much from the straight line was taken as evidence that the self-absorption effect was negligible. It was also assumed that the effect of back-scattering from the aluminum backing was negligible. The reason for this assumption was that the solid angle at the source subtended by the detector was small.

Another cause of the discrepency in the value of the half-life obtained in this work could be due to the fact that solid angles subtended by the detector were not the same for the two sources, ^{237}Np and ^{241}Am of the same pairs. This due to the sizes and positions of the radioactive spots on the aluminum foil. It was not possible to place the backings in

the same position when they were used as the cathode in the electrolysis cell.

Comparing the observed half-lives with the accepted value of the half-life of ^{237}Np, the neptunium sample No. 1 would appear to have been the best source made. The deviations in the half-life determination using the other samples are most likely due to errors in the mass determination by the use of the standard curves. A small variation in the slope of the standard curve could lead to large errors for the larger masses. The mass determination of sample No. 1 is fairly accurate since the error due to the variation of the slope will be very small around the origin. It is, therefore, suggested that the use of the standard curve in the determination of the half-lives by the specific activity method be restricted to sources having only a thin layer of radioactive nuclei.

The excessive large background counts of 7 cpm was probably due to contamination of the chamber. However, the 7 cpm is only 0.01 % of the counts recorded for the ^{241}Am sources. It is therefore thought that the background activity has a negligible effect on the determination of the half-life.