## CHAPTER IV.

## EXPERIMENTAL RESULT AND DISCUSSION

### Results

Test for the goodness of $G_{th}$ and $G_r$ (gold). If the values of $G_{th}$ and $G_r$ used are correct, the whole columns 2 of table 1 and 2 should each contain equal numbers.

Table 1

| $mg/cm^2$ | $\left(\frac{A_{th}}{mg}\right)\left(\frac{1}{G_{th}}\right)$ |
|---|---|
| 10.7 | 16300 |
| 16.2 | 15700 |
| 33.3 | 15700 |
| 36.0 | 15800 |
| 36.3 | 16000 |
| 36.4 | 15800 |
| 47.4 | 15900 |
| 52.8 | 15800 |
| 70.3 | 15100 |
| 112.8 | 15100 |

Table 2

| $mg/cm^2$ | $\left(\frac{Acd}{mg}\right)\left(\frac{1}{G_r}\right)$ |
|---|---|
| 11.0 | 5210 |
| 16.7 | 5400 |
| 33.8 | 5330 |
| 36.1 | 5250 |
| 37.0 | 5360 |
| 47.9 | 5410 |
| 53.7 | 5290 |
| 70.5 | 5330 |
| 113.7 | 5150 |

$A_{th}$ was obtained by subtracting the cadmium-covered saturated activity from the bare one. $A_{cd}$ was obtained from the cadmium-covered activity. For the G value, see Annex 2.

$r\sqrt{\frac{T}{T_o}}$ at the pneumatic position. Results of different analyses of the cadmium ratio of gold are shown in Table 3.

Table 3

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| $mg/cm^2$ gold | CdR | $CdR_o$ | $r\sqrt{\frac{T}{T_o}}$ eq.9 | $r\sqrt{\frac{T}{T_o}}$ eq.10 | $r\sqrt{\frac{T}{T_o}}$ see below |
| 11 | 10.99 | 7.26 | .00897 | .00910 | .00905 |
| 16.7 | 11.81 | 6.82 | .00960 | .00980 | .00973 |
| 33.8 | 15.37 | 6.92 | .00932 | .00965 | .00956 |
| 36.1 | 15.97 | 7.02 | .00914 | .00948 | .00941 |
| 37.0 | 16.32 | 7.08 | .00904 | .00938 | .00931 |
| 47.9 | 17.58 | 6.85 | .00931 | .00974 | .00968 |
| 53.7 | 18.68 | 6.99 | .00908 | .00952 | .00945 |
| 70.5 | 19.57 | 6.68 | .00951 | .01006 | .00997 |
| 113.7 | 23.61 | 6.88 | .00907 | .00973 | .00963 |
| | | | .00923±1% | .00961±1% | .00953±1% |

$CdR_o$ was calculated using

$$(CdR_o - 1) = \frac{G_r}{G_{th}} (CdR-1)$$

Column 6 was obtained by using $CdR_o$ and either eq.9 or 10 but deleting $G_{th}$ and $G_r$

For gold

$S_o$ = 17.3

$\frac{1}{K}$ = .477 (cadmium thickness=0.055 cm)

$W$ = .09

$g$ = 1.005

$F$ = .995

By using indium, the average cadmium ratio from 4 irradiations is $7.33 \pm .04$. Either eq.9 or 10 give the value of $r\sqrt{\frac{T}{T_o}} = .00940 \pm .5\%$

For indium
$s_o = 18.8$
$W = .335$
$g = 1.021$
$G_{th} = 1$ (0.2 mg/cm$^2$ In)
$G_r = .96$
$F = .95$

From 21 measurements for manganese, the average cadmium ratio is $102.42 \pm .20$. Using $r\sqrt{\frac{T}{T_o}} = .00953$, $s_o$ was determined to be 0.662 (by eq.9) which is very close to the value given by Westcott.

For manganese
$G_r = .787$ (Mn-Ni alloy with 80 mg/cm$^2$ Mn)
$G_{th} = .97$
$F = 1$
$W = 0$
$g = 1$

Table 4 summarizes the results of $r\sqrt{\frac{T}{T_o}}$

Table 4

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | gold eq.9 | gold eq.10 | gold $CdR_o$ | indium eq.9 |
| $r\sqrt{\frac{T}{T_o}}$ | .0092 | .0096 | .0095 | .0094 |

Use of β and eq.7. From the cadmium ratio, it is possible to utilize eq.7 to obtain β The first difficulty to be encountered is the wide variations of $\sigma_r$ for indium and manganese. Next is the modification of eq.7 to be applicable to thick foils.

For gold, if one uses $\frac{98.8}{1.128}$ and 1558 barns as σ and $\sigma_r$ respectively together with the average $CdR_o$ of 6.94, β can be calculated as follows:

$$\beta = \frac{98.8}{1.128 \times 1558 \times (6.94-1)}$$

$$= .00948$$

F and g are considered as unity

For indium, activated σ and $\sigma_r$ for In 115 have been recently available (14).

$$\beta = \frac{150 \times 1.02}{1.128 \times 2500(.95 \times 7.08-1)}$$

$$= .00950$$

Discussion

Upon applying eq.9 and 10 to the same experimental data, the difference could easily be identified especially in case of thick foil. It is felt that $G_r$ obtained directly from the Roe's report should be the correction factor for the total epithermal self-shielding in case of gold. This means that eq.10 is the proper one to be used (although still approximate to a lesser extent). However, if foils are not very thick where $G_r$ is closed to unity, eq.9 and 10 give almost identical results.

With regard to $S_o$ and $\sigma_r$, it may briefly be mentioned that for gold the parameters are well established. For indium, there still exists wide variations. Manganese is even worse. There has been a tendency that each experimenter himself measured $S_o$ of maganese by comparison with gold and used the measured value for further purpose. However, different measurements rather disagreed with one another.

From the summarized results of $r\sqrt{\frac{T}{T_o}}$ (Table 4), it will be seen that the difference in case of gold between eq.9 and 10 is very significant. The better agreement between column 3 and 4 is due to the common assumption that $G_r$ has to be applied to the total epithermal neutron self-shielding. In case of indium, there exists some doubt with regard to the factor F. The overall accuracy is expected to be poorer than gold.

It should be noted that the calculation of $\beta$ is not as rigorous as that of $r\sqrt{\frac{T}{T_o}}$, since it neglects the factor W and also the variation due to cadmium cut off. However, in case of gold and indium, these corrections are small. The cadmium cutoff is expected to be serious in case of manganese.