2.5 Non-destructive assay of plutonium

Satya Prakash, S.B. Manohar, S.P. Dange and A. Ramaswami

Non-destructive methods of analysis of fissile materials are important from the standpoint of accuracy, rapidity of estimation and applicability to experimental conditions where the material is heterogeneous in character and as a consequence a reliable representative sample is difficult to obtain. Preliminary work on the measurement of the abundances of plutonium isotopes present in solutions of plutonium was undertaken. A 2cc Ge(Li) detector coupled to a 400 channel analyser was used to measure their low energy gamma rays[1-4]. These measurements were carried out to assess the precision and accuracy with which it is possible to estimate total plutonium and the isotopic abundances.

In order to estimate the amount of plutonium and the abundances of various isotopes, the efficiency curves (for fixed geometry and volumes) for different gamma ray energies were constructed in the energy range 0-400 KeV. Using the extensive compilation of gamma ray energies and abundances of ^{238}, ^{239}, ^{240}, ^{241}Pu and ^{241}Am by Gunnink and Morrow, photo peaks suitable for use in the gamma ray counting of plutonium samples with the present set-up were selected. The peaks at 129 KeV, 208 KeV and 60 KeV for ^{239}Pu, ^{241}Pu and ^{241}Am respectively were found to be free from interference of other gamma rays. No suitable photo-peaks could be fixed for ^{240}Pu because of the limited resolution of the present set-up.

The results obtained from the preliminary experiments are summarised in Table 21. The isotopic composition of the sample by mass spectrometric analysis is also listed for comparison. Further work is in progress to ascertain the accuracy of the results. The possibility of using a NaI(Tl) crystal for these determinations will also be investigated.

References

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TABLE 21

Analysis of plutonium by Gamma Spectrometry

Isotope	^{239}Pu	^{241}Pu	^{240}Pu* (by balance)	Total amount of Pu as estimated by potentiometry	^{241}Am
Amount in mg	6.940	0.018	0.310	7.268	0.006
+Atom% abundance (present method)	95.490	0.241	4.270		0.070
+Atom% abundance (Mass spectrometry	94.170	0.351	5.479		

* Values quoted in this column include small contributions from ^{238}Pu and ^{242}Pu and do not include contribution from ^{241}Am.

\+ Contribution of ^{241}Am is not taken into account and the quoted atom % abundances are relative to total plutonium only. Atom % abundance of ^{241}Am is also relative to total plutonium content.

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2.6.1 Mass spectrometric analysis

H.C. Jain, S.A. Chitamber, V.D. Kavimandan, G. Periaswamy, P.M.Shah, P.A. Ramasubramanian and C.K. Mathews

During the year under report, five hundred mass spectrometric analyses were carried out. Eighty samples of uranium, plutonium and lithium from vario