SNO-STR-92-006

Leaching: situation report 6.12.91

This report follows those made earlier this year (18/2 and 18/6/91). The equipment has already been described and only minor modifications have been made to it.

Since June, measurements have continued on the thoriated glass samples and in parallel with these, leaching measurements have been made with samples of ABS. At present, an attempt is being made to assay the ^{232}Tb content of salt samples.

1. Thoriated glass measurements

Details as in note of 18th June. Repeat run with discs spiked with ^{232}Th to 456 ppm. Temperature increased to 55°C. Mass loss 7 mg. Solubility consistent with previous value for Schott glass (.05μg/cm^2/cl at 10°C). Water spiked with 2.4 Bq of ^{226}Ra. Ge diode measurement gave

$$K = 1470 \pm 9 \text{ ppm}, \; U = 0.62 \pm .02 \text{ ppm}, \; Th = 0.05 \pm .05 \text{ ppm}.$$

This is consistent with Runs 2 and 3. Expected presence of Th should have been 0.11 ppm.

The statistics are too poor to come to any firm conclusion regarding the Thorium leaching. The Uranium figure is consistent with the rate to be expected as a result of the ^{226}Ra spiking, and the potassium concentration is presumably the result of some residue from the $KMnO_4$ used in the production of the Seakem granules.

The next runs (5 and 6) were made using the second glass series, which had been thoriated to a concentration of 5680 ppm. 35 gm of glass were ground and then sieved to be $> 850\mu$ and < 1 mm in size. Assuming roughly cubic shape, this would give an exposed area of some 800 cm^2. Mass loss measurements are not reliable with glass in this form, but assuming the Schott 8246 figure for solution, we would expect to lose 8 mg during the first run, and 6 mg during the second. These amounts would give approximately 280 and 210 ppb for the Thorium content of the MnO_2 in runs 5 and 6. In fact, the Ge diode readings for runs 5 and 6, approximately 60 counts per day for the 238 keV line, indicate a concentration much less than this, nearer to 85 ppb.

It does therefore seem a reasonable conclusion that Millipore water extracts some Thorium from Schott type glass, but at a rate much less than its extraction of other constituents of the glass.

At the end of Run 6, a sample was taken from the water in the leaching tank and its Thorium concentration was measured using the Sellafield ICPMS. The value obtained for this measurement was approximately 3 pg/mil, supporting the observations above.

Alternative explanations to consider are either that the Thorium was extracted from the glass but then plated out on the walls of the leaching container and its associated piping, or perhaps the Seakem MnO_2/acrylic was grossly inefficient in extracting Thorium. Whilst these explanations cannot be totally excluded, they appear improbable since the water in the tanks was in all cases acidified with Analar nitric acid to a pH lower than 3.5 whilst it was circulated several times through the piping and tanks in the day before extraction. The acidified water was then pumped out through the Seakem container and previous experiments by Andy Ferraris have established that this procedure should ensure that only a very small proportion of the Thorium would remain plated out on the container and piping. Other experiments have established that the efficiency of extraction of Thorium from acid solutions of pH less than 4 is better than 80%.

2. Measurements on ABS

1.9 kg of ABS sheet, provided as 16 pieces 14 × 28 cm in size were oven dried at 65°C for 2 days, then cooled in the laboratory for 2 hours, weighted and then immersed for four ten day periods in the leaching plant at a temperature of 40°C. In the intervals between the immersion periods the samples were dried, cooled and weighed.

No systematic weight loss was observed, though variations of less than 1 part in 10^4 were observed, apparently dependent on the local humidity when cooling prior to weighing.

Measurements on the effect of these samples on the optical transmission of the Millipore are planned.

The radioactive content of a 300 gm sample of the ABS was measured, using the Holborn Ge diode. It was found to be:

$$\text{K} - 60 \pm 30 \text{ ppm} \qquad \text{U} - .006 \pm .015 \text{ ppm} \qquad \text{Th} - .035 \pm .044 \text{ ppm}$$

Consequently, ABS appears not to present any radioactive hazard to the screening water.

3. Purity of NaCl

Commercially available salt contains several impurities, including sodium hexacyanoferrate, metallic iron, calcium, potassium, magnesium, copper, arsenic, lead, cadmium and mercury. In the high purity specifications, these are mostly present at concentrations of less than 1 ppm and so presumably should not present problems, with the possible exception of iron.

In order to check for the presence of Thorium, two samples of high purity salt have been obtained and are being measured. The best specification, vacuum dried, obtained from ICI has been measured with the Holborn γ-spectrometer. At a level of 10 ppb. neither Th nor U were detected, but the sample did contain potassium at a level of 16 ± 8 ppm.

To carry the Thorium and Uranium measurements further, 14 kg of ICI salt have been dissolved in 850 litres of Millipore water in the leaching plant. The solution has been acidified and pumped out through the Seakem MnO_2 assay unit. The result of this measurement will be available shortly.

P.T.T.
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P.S. The result of the salt measurement (3) indicates a purity better than 1 part per billion for contamination by ^{226}Ra or its daughter products. It is harder to be as definite with ^{232}Th contamination, since some plating out in the tanks and piping of the assay plant. If we ignore this possibility, the ^{232}Th concentration is also less than 1 p.p.b.