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CESIUM-137 INDEX FOR NUCLEAR MATERIALS
CONTENT OF COATING WASTE.

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by

R. A. Schneider
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February 1, 1962

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CESIUM-137 INDEX FOR NUCLEAR MATERIALS
CONTENT OF COATING WASTE

INTRODUCTION

For some time it has been thought that coating waste measurements for nuclear materials may be grossly understated. This conclusion stems from the two-phase nature of the caustic coating solution in which uranium and plutonium are present, predominantly in the solid phase. Samples of the coating waste solution are not representative of this mixture, being biased high in the liquid phase and, consequently, biased low in uranium and plutonium.

Cesium-137 was chosen as a possible index of the plutonium and uranium in coating waste since a) it is representative of the nuclear materials, b) it is caustic soluble, and c) it is long-lived. The validity of Cs-137 as an index has been verified.⁽¹⁾

The cesium-137 index will be stated in terms of a ratio of total plutonium to cesium. This ratio is dependent on the formation rate of plutonium in the uranium irradiated. For this reason Redox and Purex will have different Cs-137 indexes. The uranium content of the coating waste will be calculated from the monthly Pu/U ratio, already being circulated.

SUMMARY AND CONCLUSIONS

The cesium-137 index is a stable ratio as long as the plutonium formation rate (Pu/MWD) is stable. No significant change in the index need normally be contemplated, except when the degree of enrichment in the uranium processed changes by greater than one-half per cent.

In routine operation, the coating solution is not flushed from the dissolver after transfer. Tests have indicated that less than five per cent of the associated solids remain in the dissolver after transfer so that the cesium-137 index calculation of uranium and plutonium losses can be biased high by this factor. For this reason a five per cent correction is calculated into the cesium-137 index.

The cesium-137 index is calculated as follows:

$$\mu\text{c Cs-137/MWD} = \frac{6.3 \times 10^{11} \mu\text{c Cs-137}}{2175 \text{ MW} \times 81 \text{ d}} = 3.576 \times 10^6 \quad (2)$$

$$1961 \text{ Purex Avg. Pu/MWD} = \frac{0.287813 \text{ g Pu/\#U} \times 2000 \text{ \#/Ton}}{693 \text{ MWD/Ton U}}$$

$$= 0.83063 \frac{\text{g Pu}}{\text{MWD}}$$

$$1961 \text{ Redox Avg. Pu/MWD} = \frac{0.277651 \text{ g Pu/\#U} \times 2000 \text{ \#/Ton}}{773 \text{ MWD/Ton U}}$$

$$= 0.71836 \frac{\text{g Pu}}{\text{MWD}}$$

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$$\text{Purex Cs-137 index} = \frac{0.83063 \text{ g Pu/MWD} \times 0.95^*}{3.57598 \times 10^6 \text{ uc Cs-137/MWD}} = 2.207 \times 10^{-7} \frac{\text{g Pu}}{\text{uc Cs-137}}$$

$$\text{Redox Cs-137 index} = \frac{0.71836 \text{ g Pu/MWD} \times 0.95^*}{3.57598 \times 10^6 \text{ uc Cs-137/MWD}} = 1.908 \times 10^{-7} \frac{\text{g Pu}}{\text{uc Cs-137}}$$

* Five per cent adjustment for possible coating waste solids left in the dissolver.

The coating waste solution would be analyzed for uc Cs¹³⁷/gal. Pu loss is calculated by multiplying the uc Cs¹³⁷/gal times the Cs-137 index (g Pu/uc Cs¹³⁷), resulting in g Pu/gal. Uranium loss is calculated by either of two methods:

$$a) \text{ uc Cs}^{137}/\text{gal} \times \frac{\text{Cs-137 index (g Pu/uc Cs}^{137})}{(\text{g Pu/\#U})} = \text{\#U/gal}$$

$$b) \frac{\text{g Pu/gal}}{\text{g Pu/\#U}} = \text{\#U/gal}$$

RECOMMENDATIONS

It is recommended that the cesium-137 index method for determining nuclear materials content in coating waste be used at both Purex and Redox. Once in use, it is further recommended that the Pu to U ratio used in calculating uranium losses in each batch of coating waste be a projected Pu to U ratio, to be corrected on a monthly basis for BPID adjustment. The corrected Pu to U ratio would be the monthly average Pu to U ratio. The cesium-137 index should be reviewed by the CPD, R&E, Process Chemistry sub-section when the uranium enrichment factor changes by one-half of one per cent in the material processed, or annually, if no such change occurs.

Use of this method will result in higher but more accurate statements of plutonium and uranium losses in coating waste. Its use should help to improve and stabilize the Chemical Processing Department's BPID.

- (1) HW-71321, Cesium-137 as an Index of the Nuclear Materials Content of Coating Waste, Secret, October 11, 1961. R. A. Schneider.
- (2) Private conversation with Roy Nilson, January 29, 1962.

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