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FROM: C. W. DeLong

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ABSTRACT

This report gives the results of a radiochemical analysis of particles collected by electrostatic precipitation from ventilation air of the "B" plant at Hanford Works.

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COLLECTION AND ANALYSIS OF ACTIVE PARTICLES

INTRODUCTION

When it became apparent that particles were emanating from the stacks of the separations plants, it became important that the source, size, activity and composition of the particles be determined in order to evaluate the hazard to persons working in and near the stack areas. The state of the problem was reviewed in 1948 by Parker (1), and since that time there has been some further data published. A physical and chemical analysis was reported by Thorburn (2) with investigation into the source of the particulate matter. This study indicated that the particles were coming from corroded fans, fan breechings, and duct work of the ventilation system. Most of this work concerned individual particles, thus there was some variation in the several chemical analyses. One other report, by Schwendiman and Thorburn (3), gave results of a size distribution study of particles collected in the 200-E Area by electrostatic precipitation.

The present report will give the results of radiochemical analysis of particles collected by electrostatic precipitation from "B" plant canyon ventilation air, not from the off-gas ventilation line. Of importance is the fact the particles analyzed consist not only of particles from the ventilation air but also, unavoidably, of rust from the iron manifold used to conduct the gases to the precipitator. This makes a determination of the activity versus weight ratio impossible, but should not invalidate the radiochemical data.

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Because these analyses were done on large numbers of particles, it is hoped that the data will give a fairly accurate picture of their chemical content.

It is not intended that this report define the radiochemical composition of "Hanford particles". Instead, it purports simply to provide data on the composition of particles collected from air passing through one portion of a separations canyon under the conditions described. Results obtained will be applied to current preliminary animal studies on biological effects caused by active particles. We hope later to have available more complete analyses on all particulate matter suspended in various gaseous effluents from the separations process.

METHODS

Collection

The precipitator is similar to that described by Drinker and Hatch as ~~described~~ ^{modified} by Schwondiman and Thorburn (3), except that 10 collecting tubes, each of which was 36.5 cm. in length by 2.5 cm. in diameter, were placed in parallel in a manifold thus permitting an increased collection rate. The tubes were lined with thin aluminum foil (grounded) which was used as the anode, there being a potential of about 10,000 volts. The incoming air was drawn from ventilating air just prior to its entry into the sand filter, and was passed through the system at a rate of about 10 CFM. There was a simple trap in the line to keep out any large quantity of water or condensate, but no attempt was made to remove fine mist that might have been present. Three aluminum liners were collected for analysis; one was allowed to run about 50 hours and two were allowed to collect about 110 hours to attain sufficient activity and number of particles.

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HW-15802Analysis

For analysis, the particles on the liners were washed off with 2N HNO_3 , the resulting suspension evaporated carefully to dryness, the dried particles weighed, dissolved in 6N HCl , diluted to 100 ml, and made 1N in HCl , from which solution aliquots were taken. The radiochemical analytical methods used were those given by Coryell, et al. (4), Hume, et al. (5), and Project Handbook, Chapter III (6).

The plutonium analysis was a TTA extraction method; the total alpha analysis was done both by ether extraction and by counting evaporated aliquots. In both cases $1\frac{1}{2}$ " stainless steel plates were used, and counting was done in a standard parallel plate alpha counter at 50 per cent geometry.

All beta counting was done on the first shelf of a thin end-window beta counter at a 90 per cent confidence level. Duplicate runs were within the plus or minus values of the values reported. Samples were mounted on $1\frac{1}{2}$ " stainless steel plates of 0.005" thickness and corrections were made for geometry and source-size. No corrections were made for back-scatter, self-scatter, window and air absorption, or self absorption.

RESULTSAlpha and Plutonium Analyses

The sample weights and total alpha activities are listed in Table 1. In this table are given the alpha activity as determined by direct counting and by ether extraction previous to plating, and the plutonium activity as found by TTA analysis. From the table it is seen that about 100 per cent of the alpha activity present is Pu. This figure checks fairly well with analyses previously made (27).

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TABLE 1

ALPHA AND PLUTONIUM ACTIVITY IN PARTICLES

Sample No.	Sample Weight	Total Alpha Activity		Pu Activity* TTA Extract
		Direct Count	Ether Extract	
1 (50 hrs.)	80.0 mg.	0.13 μc^{**}		
2 (110 hrs.)	59.4 mg.	0.16 μc	0.16 μc	0.16 μc

* The figure listed for Pu is corrected for 84% recovery in extraction.

** One microcurie as used here is taken to be 3.700×10^4 disintegrations per second.

TABLE 2

BETA ACTIVITY OF PARTICLES

Sample No.	Sample Weight	Total Beta Activity	
		per sample	per gram of particles
1 (50 hrs.)	80.0 mg.	48 μc	600 μc
2 (110 hrs.)	59.4 mg.	57 μc	950 μc
3 (110 hrs.)	161.0 mg.	50 μc	310 μc

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Beta Activity Analysis

Table 2 presents the beta activity of the three samples.

An absorption curve was run on Sample #1 to determine the beta spectrum (see Figure 1). The only conclusion to be reached is that there are several beta energies present, the higher ones being 2.2 ± 0.2 M.E.V., 1.9 ± 0.2 M.E.V., and 1.5 ± 0.2 M.E.V.

Decay curves for all three samples are shown in Figure 2. The curve for Sample #1 is for the period from 66 days to 273 days; the curve for Sample #2 is for 3 days to 68 days; the curve for Sample #3 is for 4 days to 64 days; in each case zero time is the time collected, not the actual age. From these curves it may be concluded that the decay in each case is approximately the same, although the slope of the curve for Sample #2 is slightly less than those of the other curves. Actual age determination was made on Sample #1 by an isotopic ratio determination of $\text{Sr}^{89}/\text{Sr}^{90}$ from the $\text{Sr}^{90} \rightarrow \text{Y}^{90}$ build-up. Knowing this isotopic ratio at zero time, or "push time", the ratio may easily be calculated for any later time, thus determining the age of the sample. Employing a curve prepared by RC Thorburn (7), the age of Sample #1 was found to be 280 ± 100 days, on September 27, 1949. Using this figure, admittedly not a precise one, we may say that the age of the particles at the time of collection (April 14, 1949) was from 100 to 200 days.

Radiochemical Analysis

The results of radiochemical separation and analysis presented in Table 3 were obtained from duplicate analyses. Because the three samples presumably were quite similar in content, Samples #2 and #3 were analyzed only for shorter-lived elements such as Ba, Cd, Sr, Cb and others with half-lives of from 12.5 to 90 days. The rare earth determinations were checked by

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FIGURE 1. ABSORPTION CURVE FOR SAMPLE 1

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FIGURE 2. DECAY CURVES FOR PARTICLES

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TABLE 3

RADIOCHEMICAL ANALYSIS OF PARTICLES

Element	Sample #1 (2457 d/m)		Sample #2 (9828 d/m)		Sample #3 (8736)	
	d/m	% of Total d/m	d/m	% of Total d/m	d/m	% of Total d/m
Sr	199.8	8.1	753.5	7.7	—	—
Ru*	491.4	20.0	—	—	—	—
Tc	0.0	0.0	—	—	—	—
Cb	0.0	0.0	145.2	1.5	263.7	3.0
Te	49.7	2.0	618.1	6.3	570.6	6.5
Cs	124.5	5.1	—	—	—	—
Co*	618.1	25.2	—	—	—	—
Rare earth	539.4	21.9	667.2	6.8	526.3	6.0
Y*	272.4	11.1	1088.7	11.1	940.8	10.8
Zr	401.3	16.3	—	—	—	—
Ba	—	—	7.6	0.1	29.5	0.3
Cd	—	—	0.0	0.0	7.6	0.1
Totals	2696.6	109.7%**	3280.3	33.5%	2338.5	26.7%

* Ru¹⁰⁶ and Ce¹⁴⁴ were counted with their daughters Rh¹⁰⁶ and Pr¹⁴⁴, whereas Sr⁹⁰ was not counted with its daughter Y⁹⁰.

** This high yield, about 2700 d/m recovered from a total of about 2500 d/m, is explained by the fact that the carriers used in separating individual elements tend to maintain an even spread of the sample on the plate, whereas the plate which was used to obtain a total beta count had no carrier, thus the sample was not spread too evenly (8).

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decay analysis to assure that only the long-lived elements were present. Over a period of 60 days, there was no appreciable decay in any of the rare earth samples.

Spectrochemical Analysis

Spectrochemical analysis was attempted but results were inconclusive.

SUMMARY

Presented here are observations on the radioactive particles collected from ventilation air from the "B" plant in Hanford Works. Alpha and beta activities, decay analysis, absorption analysis, and age of the particles are given.

The alpha activity, while not very great, was found to consist almost exclusively of plutonium. Most of the beta activity was contributed by cerium, rare earths, ruthenium, zirconium, yttrium, and strontium. Analysis of the absorption curve gave three main energies in the higher energy portion of the spectrum, these being 2.2, 1.9, and 1.5 M.E.V. which values correspond respectively with Pr^{144} , Y^{91} , and Sr^{89} .

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