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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

APRIL, MAY, JUNE, 1958

Prepared by Members of the

Chemical Effluents Technology Operation

Edited by: W. H. Piersenenk

July 10, 1958

CHEMICAL RESEARCH AND DEVELOPMENT OPERATION
HANFORD LABORATORIES OPERATION

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

APRIL, MAY, JUNE, 1958

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS
APRIL, MAY, JUNE, 1958

INTRODUCTION

The Chemical Effluents Technology Operation performs research to investigate the chemical and physical aspects of environmental contamination resulting from plant effluents or from potential process disasters. This report is primarily concerned with plant assistance research in the field of waste disposal during the quarter April-June, 1958.

The ground-water monitoring data utilized in this report were obtained from well-water samples. These samples are collected routinely by the Regional Monitoring Operation and analyzed by the Radiological Chemical Analysis Operation.

I. INTERPRETATION OF GROUND-WATER MONITORING DATA (W. H. Bierschenk)

There have been no significant changes in the pattern or the concentration of ground-water contamination beneath Separations Areas since the quarter January-March, 1958. There are three separate zones of contaminated ground water beneath 200-East Area, and essentially all the ground water beneath 200-West Area is contaminated to some degree.

200-East Area

(1) 216-BY and 241-B cribs. - - Wastes from these cribs contribute the greatest amount of contamination beneath 200-East. During the period covered by this report, the maximum concentration of gross beta activity detected was 3.9×10^{-2} μc/cc, reported 3-17-58, which is down slightly from the 5.1×10^{-2} μc/cc reported last quarter. Co^{60} continues to appear in well-water samples in excess of MPC; the maximum concentration reported being 6.6×10^{-4} μc/cc on 4-14-58. Analysis of a sample collected 5-5-58 indicated a Sr^{90} concentration of 1.9×10^{-7} μc/cc. (The detection limit for Sr^{90} was recently lowered from 2.0×10^{-7} to 7.0×10^{-8} μc/cc).

(2) 216-A cribs. - - Purex cribbed wastes have contaminated the underlying ground water to a maximum concentration for the period of 3.6×10^{-3} μc/cc total beta as of 4-21-58. This concentration occurs beneath the 216-A-8 crib which was inactivated in May 1958. A well monitoring the replacement 216-A-24 crib was probed prior to start up of disposal in order to obtain a background count of gamma activity. Subsequently, several scintillation probings showed that after three weeks detectable gamma activity had percolated to a depth of 100 ft below land surface and after three more weeks activity had reached to 120 ft.

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(3) 216-BC cribs and trenches. -- The intermittent appearance of gross beta concentrations greater than 1.5×10^{-7} μc/cc continues. To date, however, there has been no upward trend in concentration. According to scintillation probes of the monitoring wells, gamma activity has penetrated to a maximum depth of 220 ft (4-18-58), which is approximately 120 ft above the water table. Comparing the results of probings taken during the first quarter of 1957 with those of 4-18-58, it is seen that wastes have moved downward an additional 80-90 ft in the sediments beneath two cribs, and only 10-20 ft additional beneath the other four cribs.

200-West Area

Although at present there appear to be four zones of contaminated ground ground water beneath 200-West Area, essentially all the underlying water may be considered contaminated to some degree. This is due to the changes in the water-table gradient which have shifted contamination back and forth beneath the area. Some wastes continue to percolate to the water table from the inactive T-Plant cribs and trenches but most gross beta activity is being contributed by wastes discharged to the Redox cribs. Beneath the T-Plant facilities a maximum concentration of gross beta activity for the period of 1.3×10^{-4} μc/cc was reported 4-1-58. Beneath the Redox 216-S-1,2 cribs a maximum concentration of 5.8×10^{-3} μc/cc was reported 5-6-58. Radiostrontium continues to appear in the ground water beneath this crib, with a maximum concentration of Sr^{90} of 1.3×10^{-6} μc/cc being reported.

II. PLANT WASTE DISPOSAL PRACTICE

Chemical Processing Department (W. A. Haney)

Disposal to cribs. -- The west section of the Purex 216-A-24 tank farm condensate crib was placed in service and the 216-A-8 condensate crib removed from service on May 2, 1958. At the time the 216-A-8 crib was inactivated, it had received about eight column volumes of waste which is close to the predicted strontium breakthrough volume. Routine well probings, ground-water sample analyses, and waste stream analyses with regard to the new crib, are expected to provide definitive data on the movement of radioisotopes through subsoils at this particular location.

Information on the life expectancy of the Redox 216-S-7 process condensate crib was communicated to the Chemical Processing Department. Laboratory findings revealed an appreciable remaining life for this disposal facility; accordingly, plans for construction of a replacement crib were cancelled. Since there is a definite need for better sampling of this waste stream, the proportional sampler which was included in the scope document for the replacement crib will probably be provided on a work-order basis.

Underground tank storage. -- A sampling, analytical, and soil adsorption evaluation program has been proposed for investigating the radiological and chemical characteristics of waste stored in 200 Areas underground tanks. The results of such an investigation should have practical application in underground leak detection, future waste processing, and possibly radioisotope recovery programs. The opinions of other interested groups in Hanford Laboratories Operation and Chemical Processing Department on the desirability and requirements of an evaluation of this type are being solicited.

A comprehensive list of possible research studies to evaluate the consequences of a leak in an underground storage tank was submitted to members of Chemical Processing Department's Research and Engineering Operations for comments. Specific initial studies and actions are to be based on mutual agreement of the urgency and need of the data. The study as outlined would begin with the characterization of stored wastes and investigations of waste soil reactions. Results of these and subsequent evaluation of dispersal patterns of other variables would be utilized to define the consequences of loss of waste through failure of a tank.

Gelling of wastes. -- The test disposal gel bed and underlying soil were excavated to a depth of 15 feet to determine the depth of moisture penetration into the soil beneath the gel. The wetted soil pattern could not be defined by visual observation since all of the soil surrounding the gel had been moistened by infiltration of rainwater. Soil samples taken at various depths immediately below the gel bed were analyzed for moisture content and alpha-particle activity. The following table presents the results of these analyses.

SAMPLE DEPTH (Feet below bottom of gel bed)	MOISTURE CONTENT (% wet basis)	ALPHA-PARTICLE ACTIVITY (10^{-7} μc/ U/gm)
3	8.6	8.1
4	6.9	12.0
7	5.3	10.0
9	5.9	4.4) background
12	6.4	4.2)

While only slight variations in moisture content between various samples were evident, more pronounced variations in the alpha activity of the samples were observed. Based on these analyses, loss-of-moisture wetted the soil to a depth that was 2 - 3 times the gel depth.

Irradiation Processing Department

Navigation channel (C. E. Linderoth, W. N. Koop)

Chemical Effluents Technology cooperated with the Irradiation Processing Department in a study of the effects of a navigation channel on the Hanford operations. Technical aid and opinions from other interested components of Hanford Laboratories were solicited and coordinated. This contribution was included in document HW-55950, "Effects of a Columbia River Navigation Channel on Hanford Operations."

As^{76} and P^{32} in reactor effluents (W. N. Koop)

Concentrations of As^{76} and P^{32} in Columbia River Water, resulting from disposal of reactor coolant, continue to be a subject for study. Samples and operating data have been collected routinely since January 1958 from B reactor with the objective of determining the relationships that may exist between the seasonal operating conditions and the effluent concentrations of these two radioisotopes. However, attempts to correlate information by graphical methods have not been successful. The collecting of samples and operating data will be continued until at least January, 1959.

Analyses of the effluent from the six 105-KE experimental tubes indicate that the concentration of As^{76} increases by about 80% if the pH of the cooling water is lowered from 7 to 6 by increasing the sulfuric acid concentration. This further substantiates previous data which indicate that sulfuric acid is one of the main sources of the parent isotope. This estimate is based on only four sets of samples and consequently is preliminary in nature. Additional sampling is scheduled in order to further substantiate this finding.

A third study was started at the end of this quarter at 100-F. The objective of this study is to determine whether or not the effluent concentrations of As^{76} and P^{32} can be significantly decreased by avoiding the impurities associated with the use of commercial grade H_2SO_4 for treating coolant. Reagent grade sulfuric acid is being added to the water cooling one-half the reactor, while commercial grade acid is used to treat the other half. Isotopic analyses of effluent samples from each half of the reactor will be made and compared. Samples are also being taken of influent water to both sides. Activation analyses will be performed on the samples to determine if the concentrations of parent isotopes are significantly different in the water cooling each half of the reactor. It is expected that the analytical work and evaluation will be completed within the six weeks following the four-day addition of reagent grade acid. The isotope Zn^{65}, a leading contributor of external irradiation of workers in reactor discharge areas, was included in this test at the request of Irradiation Processing Department.

Uranium Oxidation and Fission Product Volatilization Experiments (R. K. Hilliard)

Oxidation of uranium in air was studied. Time, temperature, air flow rate, and specimen size were the variables investigated. Results were reproducible within about a 5% standard deviation. Comparison of the results with literature data was made difficult by the many variables influencing the reaction and the lack of information concerning these variables given in the literature. At 300° C the results agreed closely with three other investigations. No literature information is available at temperatures above 500° C.

At temperatures up to 1120° C, the rate increased exponentially with temperature, and other variables remaining constant. The curve will be extended to 1400° C before these tests are terminated.

The rate was found to be a complex function of the time in an air atmosphere. At a temperature of 780° C and with the other variables held constant, the amount of metal oxidized increased parabolically during the first 20 minutes. After 20 minutes the oxidation rate tended to become linear. However, several points of inflection were definitely detectable. Although the rate was found to be dependent upon original surface area, it was noted that with both sizes of test specimens employed, an increase in rate occurred near the end of the test and this higher rate was maintained until the metal was completely converted to oxide.

The data also show that the rate is roughly proportional to the logarithm of the air flow rate past the specimen, an effect which remains to be explained.

A topical report will be issued when the oxidation investigation with air is completed.

III. LABORATORY EVALUATION OF WASTES (H. L. Brandt)

Neutralization of Radioactive Wastes with Limestone ($CaCO_3$)

The use of limestone to neutralize acidic radioactive wastes can suppress the uptake of strontium by the soil. As a consequence, the cribs receiving wastes treated in this manner may show a severe decrease in capacity if Sr^{90} is the critical isotope in the waste. This information was gleaned from experiments with the Purex 216-A-5 condensate. The limestone treatment is used in accordance with the practice of disposing to the ground only those aqueous wastes whose pH is greater than 7 and preferably in the range of 8 to 10. Results of investigations now being completed indicate that

the preponderant concentration of calcium ions dissolved out of the limestone by the acid waste furnishes strong competition for the Sr^{90} for occupation of the soil exchange sites. Sodium hydroxide neutralization, on the other hand, can effect the desired pH range without the introduction of formidable competition for the exchange sites.

Purex condensates (216-A-5). -- Soil column capacities for Purex process condensate wastes treated by three different methods are given in Table 1.

TABLE 1

Purex A-5 Crib Capacity for Three Different Prediposal Treatment of 216-A-5 Condensate

Treatment	Soil Capacity (Column Volumes)
Limestone Neutralization	4.2
None	11.4
Sodium Hydroxide Neutralization	> 86.

The A-5 crib had received 184 million gallons (36 soil column volumes) of waste by the end of June 1958. Total quantity disposed was erroneously reported as 89 column volumes in the January-March 1958 quarterly report. Only the Sr^{90} is of high enough concentration in the 216-A-5 waste to limit crib capacity. The average concentration was found to be about 8×10^{-7} μc/cc or just at the MPC. Radiation Protection Standards prescribe that "disposal of a waste to a particular disposal facility shall cease when certain long-lived radioisotopes (includes Sr^{90}) are detected in concentrations of 1/10 or greater of the MPC in the ground water below the facility." It is upon this limitation that the capacities listed in Table 1 are based. The technical details of the neutralization experiments will be published soon in HW-56562.

U-Plant condensates (216-WR-1,2 and 3). -- Both the 221-U concentrator and the 224-U concentrator contributed to a composite condensate to the U-Plant waste starting in July 1952. In April 1957, when 221-U ceased operation, this condensate had an average Sr^{90} concentration of 1×10^{-3} μc/cc. After April 1957, the 224-U concentrator has made the only contribution to the condensate. It has a Sr^{90} concentration of about 1×10^{-6} μc/cc. The condensates are acidic and for the reasons cited above have been allowed to percolate through limestone for neutralization before disposal to the ground. Laboratory soil columns show that a limestone-neutralized waste with 1×10^{-3} μc/cc concentration of Sr^{90} has practically no Sr^{90} removed by the soil. Although the data indicate the possibility of Sr^{90} entering the local ground water beneath the crib, this conclusion is subject to question as a result

of uncertain waste compositions and effective soil volumes beneath the crib. It is noted however, that samples of ground water taken from the well monitoring the crib have never shown a detectable concentration of Sr^{90}. After the 221-U concentrator went off stream, the crib continued to receive the low level 224-U condensate. The latter acts as a leaching solution for the Sr^{90} stored in the soil column.

Redox waste evaporator condensates (216-S-7). -- The 216-S-7 crib, according to computations based on results from laboratory soil columns, has a very large capacity for Redox D-2 condensate. The prudence of the 1956 recommendation to neutralize the condensate before disposal to the crib is again confirmed. One of two laboratory soil columns yields a capacity of 35 column volumes. The second experimental column has not yet broken through. At the present rate of disposal, according to these results, the crib may be used for many years.

Purex boiling-tank condensates (216-A-24). -- The Purex A-24 crib has a calculated capacity of 4.5 soil column volumes. This value is an average of two laboratory soil columns run by Chemical Effluents Technology and the Redox Analytical Laboratory in Chemical Processing Department. Excellent agreement of results is noted for the two laboratories in the 4 column runs reported. They are recorded in Table 2.

TABLE 2

Soil Capacity for Purex 216-A-24 Condensate

Column run by	Capacity (Soil Column Volumes)
Chemical Processing Department	4.7
" " " " " "	4.0
Chemical Effluents Technology	4.7
" " " " " "	4.8

IV. GROUND-WATER HYDROLOGY (W. H. Bierschenk)

Field tests

Hydraulic field tests were completed on five wells. The analyses of drawdown-recovery data are summarized in the following table:

Well No.	Aquifer tested	Transmissibility gpd/ft	Average Permeability gpd/ft^2
699-14-27	Glacio-fluviatile	230,000	15,600
699-58-19	Ringold Conglomerate	80,000	500
699- 1-18	" " " "	70,000	430
699- 8-17	" " " "	67,000	450
699- 8-33	" " " "	4,200	105

These data aid in delimiting the zone of very highly permeable glacio-fluviatile sands and gravels. Thus, this zone which extends southwesterly of the Separations areas to the Columbia River is now known to be north of about plant coordinate N 10,000.

Step-drawdown tests were performed on all of these wells excepting 699-8-32. The purpose of such tests is to determine the efficiency of the casing perforations for transmitting water. In general, the well-loss constant (resistance of the casing perforations to water flow) determined for recently perforated observation wells averages about 4.5×10^{-5}. In its original condition, well 699-88-19 had a loss constant of 2.2×10^{-3}, but after additional perforations were jetted by the shape-charged technique, the constant was reduced to 6.2×10^{-5}. The constants determined for the other three wells so tested were obtained after jet perforating so that the original constants are not known. However, preliminary pumping data prior to re-perforation suggested that the well efficiency was then much less. The value of some of the older Hanford Observation wells for monitoring purposes thus appears subject to some doubt inasmuch as the original perforations may be seriously constricted through corrosion and encrustation.

Laboratory tests

The centrifuge technique for determining the specific retention capacities of Hanford sediments continues to be tested and evaluated. According to theoretical soil moisture concepts, $t = N^2 t$ where t is the time required to establish by simple gravity a certain degree of drainage (ratio between the amount of water that has been expelled at the end of the test to the total amount that can be expelled by drainage); N is a multiplication factor of centrifugal force, and t is the period of centrifuging. According to this theory, the drainage experienced by soil under 1000 gravities for one hour is approximately equivalent to that of soil subjected to one gravity for 100 years. A study is in progress to determine the applicability of this theory to the evaluation of Hanford specific retention situations.

V. WELL DRILLING SUMMARY (D. J. Brown)

Artesian Well & Pump Company

Well	Ft. Drilled	Finished	Total ft.	To Water?
299-E26-5	293	4/22/58	293	Yes
399- 4-3a	27	4/11/58	27	No
399- 4-3b	100	4/18/57	100	Yes
699-31-53	487	5/23/58	487	"
699-28-52	715	6/24/58	715	"
	1622		1622	

The Artesian Well & Pump Company of Boise, Idaho, [illegible] contract AT(45-1)-1655, started drilling [illegible] April 21, 1958. This contract calls for a total of nine wells to be drilled under two separate projects. Five wells are to be drilled on Project CA-793, "Wells, Interim Waste Crib," and four wells on Project CA-794, "Additional Test Wells for 216-BC Crib Area." These nine wells represent approximately 3,600 feet of drilling. The completion date for this work is July 15, 1958.

During the second quarter of 1958 the Artesian Well & Pump Company completed three wells on the AT(45-1)-1655 drilling contract with a total footage of 1,495 feet. An additional 1,000 feet of drilling was completed in four wells still under construction. This makes a total of approximately 2,500 feet of drilling or about two-thirds of that scheduled to be drilled in four-fifths of the allotted time.

The Bach Drilling Company of Coulee City, Washington, was the low bidder on Contract CA-794. This contract calls for 11 wells with a total footage of 3,800 feet. The low bid was $32,270. This is approximately $8.50 per foot for drilling, casing, and sampling.