Ag. Prod. Div. Activities
April 1971

Biodegradation-Ruabon (Mainprize/Vodden)

Improvement in analytical techniques using capillary column GLC has yielded further results on degradation residues which suggest that MCS 1016 may be a bigger improvement over Aroclor 1242 than we had previously estimated. We have also had access to other workers' results which have enabled better identification of chromatogram peaks to be made. We also have some results of feeding trials which show that degradation of many isomers in animal organs is different from that induced by micro-organism of the types we have so far studied. On the basis of these results we conclude that residues from MCS 1016 would be very small and our present view is that MCS 1016 does provide a very significant improvement over Aroclor 1242 from the environmental viewpoint. Further work is planned to substantiate these views during the next few weeks.

Aroclor Pollution Study-Anniston (I. Ransaw)

Carbon Adsorption Study

PR&D Report No. 2 covering the evaluation of Aroclor removal from waste streams by carbon adsorption was issued under Job #446-514. (copy attached)

Pilot Clarification Study

The pilot clarification unit has been operating since March 15 with minimum mechanical difficulties. Initial test runs were made with optimum coagulant concentrations -- 15 ppm of bentonite clay and 1.5 Betz polyelectrolyte 1170 (determined in lab by jar test) -- at a 5 gpm flow to the clarifier. Results (Table I) indicate that the floc is not consistent in reducing the Aroclor level to 10 ppb, although the expected solids level is realized. Of interest here is the fact that solids in the plant effluent averaged approximately 50 ppm during the test period. These levels are considerably lower than the 100 to 1000 ppm values recorded when this study was initiated. As a result, more bentonite clay is being added to provide more surface area for Aroclor to be adsorbed.

Table II contains the results of the study in which the clay concentration in the feed was increased to 30 ppm without a significant reduction in the Aroclor levels.

At this point it was felt that a close approximation of the optimum clay concentration could be realized in a less time-consuming, batch type adsorption operation in the premix tanks (i.e., whose walls were believed to be saturated with Aroclor from continuous exposure). This effort proved fruitless except there were some indications that clay would reduce the Aroclor level to the desired value.

PENGAD-Bayonne, N. J.
DEPOSITION EXHIBIT
Papageorge
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WATER_PCB-00055478

TABLE I

AROCLOR REMOVAL BY FLOCCULATION CLARIFICATION

Test Conditions:

Clay conc. in feed - 15 ppm
Polymer conc. in feed - 1.5 ppm
Flow through clarifier - 5 gpm

	Avg. Influent Concentration				Avg. Effluent Concentration			
Volume Treated (gal.)	Suspended Solids	A-1221	A-1242	A-1260 or A-1254	Suspended Solids (ppm)	A-1221	A-1242	A-1254
9,600		446	240	70		31	11	6
16,800		22	16	--		15	23	--
25,800		210	60	--		NDA	1	--
		--	--					
		--	--					
41,600	29	100	14	--	18	72	8	--
48,800		196	38	--		100	10	--
52,400	52	146	30	--	2	110	12	--
57,600	40	560	.7	--	11	66	6	--
64,800	14	105	28	--	2	58	9	--

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TABLE II

AROCLOR REMOVAL BY ADSORPTION-FLOCCULATION

Test Conditions:

Avg. flow - 5 gpm
Bentonite clay concentration in feed - 30 ppm
Betz polymer 1170 in feed - 1.5 ppm

	Avg. Influent Concentration				Avg. Effluent Concentration			
Volume Treated (gal.)	Suspended Solids (ppm)	A-1221	A-1242	A-1254	Suspended Solids (ppm)	A-1221	A-1242	A-1254
1,500	24	86	18	--	50	41	7	--
13,200	46	320	40	--	7	64	5	--
20,400	314	236	117	--	8	19	15	--
27,600	65	146	54	--	10	63	7	--
34,800	13	290	160	--	3	88	7	--
42,000	9	154	10	--	5	17	4	--
49,200	38	73	25	--	22	25	4	--

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TABLE III

AROCLOR REMOVAL BY ADSORPTION-FLOCCULATION

Test Conditions:

Clay concentration in feed - 120 ppm
Polymer concentration in feed - 1.5 ppm

Volume Treated (gal.)	Avg. Influent Concentration				Avg. Effluent Concentration			
	Suspended Solids (ppm)	A-1221	A-1242	A-1254	Suspended Solids (ppm)	A-1221	A-1242	A-1254
1,650		480	380	--		80	30	--
8,850		210	13	--		6	2	--
16,050		52	42	--		11	9	--

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WATER_PCB-00055481

RESEARCH AND DEVELOPMENT REPORT
ANNISTON PLANT

Report No.
Job No. 416-514
Date April 15, 1971

OTHER LOCATIONS	GENERAL OFFICE	ANNISTON PLANT
*W. G. Engman - WGK	D. Danna (2)	J. T. Bell
*P. O. deGarmo - So. 2nd	*P. B. Hodges	J. L. Corder
*A. E. Leisy - WGK	*F. J. Holzapfel	J. L. Etheredge
*A. Rasmussen - WGK	R. M. Kountz	V. R. Haupt
*E. S. Tucker - So. 2nd	*W. B. Papageorge	G. L. Jessee
	*W. R. Richard	J. C. Landwehr/W. F. Taffee
	*J. R. Savage	G. W. Miller /E. G. Wright

Title: Aroclor Pollution Study

Personnel: Ishmeal Ransaw and Andrew Nelson (J. L. Brown)

Problem: Evaluate the removal of Aroclor from the Anniston Plant effluent by carbon adsorption

Justification: Pollution Abatement

Summary: In a 107 day pilot run, approximately 287,000 liters of waste water from the Aroclor sump were treated by passing through a series of four (4) packed-bed adsorbers (each adsorber was a five (5) inch diameter tube packed to a bed depth of 5.5 ft. with Pittsburgh's carbon type Filtrasorb 300). Test runs were made at 2 gpm/ft.^{2}, 4 gpm/ft.^{2} and 6 gpm/ft.^{2} flows. During the first 20 days of this study there were periodic indications of breakthroughs[2]. This problem disappeared after backwashing was initiated on a periodic basis regardless of the pressure drop across the columns.

The following conclusions may be drawn from this study:

1. The Aroclor level of waste water containing average concentrations of 4,795 ppb[1] of Aroclor 1221, 1,525 ppb of Aroclor 1242 and 95 ppb of Aroclor 1254 can be reduced to <10 ppb total Aroclor upon passing through the first carbon bed at a 6 gpm/ft.^{2} flow with an expected carbon loading capacity of 25% (based on the first column).

2. Backwashing frequency will have to be based on a factor other than pressure drop alone. This factor is necessary to prevent the migration of small Aroclor-containing particles

[1] ppb = parts per billion

[2] Breakthrough indicated by effluent concentrations >10 ppb Aroclor.

*Appendix sections not included.

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Summary: (cont'd.)

2. through the carbon bed. The backwash water contains an unacceptable Aroclor concentration; hence will have to be treated before disposal.

3. Based on an experimentally determined 25% loading capacity and 6 gpm/ft.^{2} flow, the capital cost for treating a 200 gpm and 600 gpm is \$25,000 ± 30% and \$45,000 ± 30%, respectively. This cost does not include pumps, engineering or other indirects. The total cost becomes \$99,000 ± 30% for 200 gpm flow and \$129,000 ± 30% for 600 gpm with the inclusion of a carbon reactivation system.

Recommendations:

It is recommended that Aroclor be removed from waste streams that contain 60 mg/l or less solids and Aroclor concentrations not exceeding 10,000 ppb by adsorption in a fixed carbon bed.

Future: A study is presently in progress to evaluate the removal of Aroclor by adsorption on a less expensive adsorbent and then removing the adsorbent by flocculation.

Ishmeal Ransaw

Ishmeal Ransaw
PR&D Chemist

/dp

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BACKGROUND:

Anniston PR&D Report No. 1 (Job #446-514, 1/15/71) describes a filtration process in which Aroclor is removed from the waste stream by both filtration of neutralization pit solids and by adsorption of any residual Aroclor on the filtration media (carbon). In this study, influent concentrations (100-8,000 ppb) were consistently reduced to <10 ppb upon passing through a four (4) inch diameter column (packed to a bed depth of 5.5 inches with granular carbon) at flows up to 350 cc/min. The presence of 200-1,000 ppm of inert solid particles (size 1.5-250μ) set a maximum limit on the pressure and flow at which the unit could be operated. It was concluded from this study that:

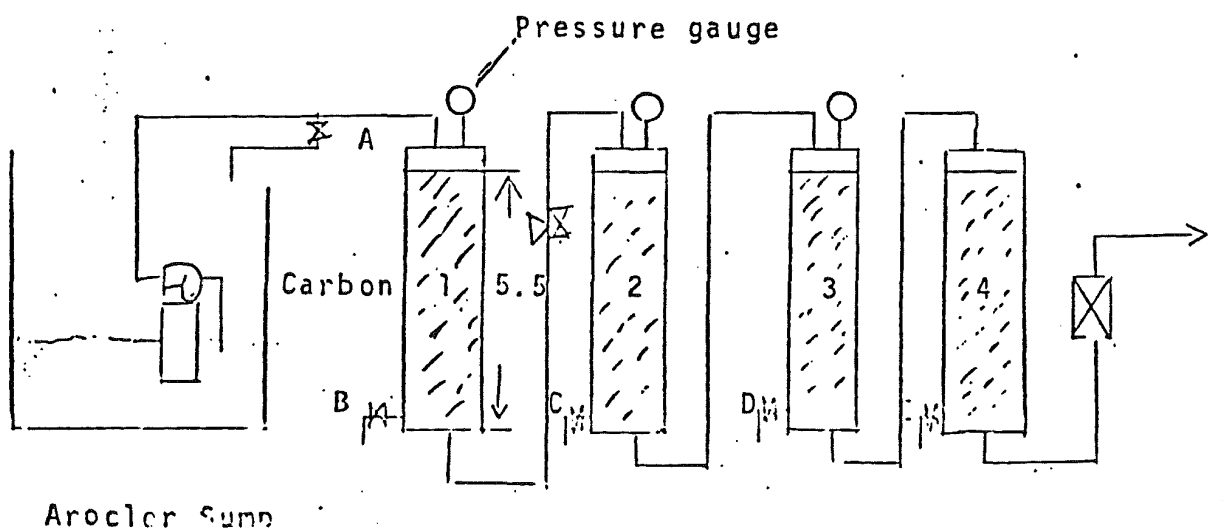
1. An evaluation should be conducted for removing Aroclor in a pilot adsorption unit, and that

2. Such a study should not be conducted on the plant stream without some provision for removing solids.

At that point, it was determined that a solution to the PCB removal problem could be best reached by separating the study into two phases -- solids removal and Aroclor removal. Conventional solutions existed for the solids removal problem so efforts were directed toward the Aroclor removal phase. The Aroclor sump provided the best test conditions for this study as the effluent here contains Aroclor concentrations similar to the total plant effluent, but with less solids. The objective of this study is to define the optimum flow rate and loading capacity for a packed-bed adsorption system for treating the Aroclor waste water. The results of this study are reported herein.

EXPERIMENTAL:

1. Flow Diagram



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EXPERIMENTAL: (cont'd.)

2. Equipment Description

a. Piping -- All piping was done with 1/2 inch PVC tubing and connectors.

b. Columns -- Columns (numbered 1, 2, 3 and 4 in diagram) were all identically constructed of clear, heavy duty plastic. Columns measured 6 ft. X 5 in. I.D. Each was equipped with a 5 in. by 1/2 in. reducing flange at the top and bottom. The bottom flange had two separate outlets; one for sampling and one for transfer to the next column. Each column was packed to bed depth of 5.5 ft. (20 pounds) with Pittsburgh carbon (Filtrasorb 300).

c. Feed Pump -- A Jabsco Model P6116 self-priming pump equipped with a viton head and impeller.

3. General Procedure

Effluent from the Aroclor sump was pumped downflow through the series of packed carbon beds at an initial flow of 2 gpm/ft.^{2} (1,000 cc/min.). The columns were not backwashed during the initial phase of testing because it was not warranted by the pressure drop across the columns. Upon observing periodic breakthroughs, however, it was determined that backwashing could alleviate or eliminate this problem by exposing new carbon surface and preventing channeling. This problem disappeared after backwashing was done periodically for the remainder of the test period regardless of pressure drop. Flow was increased first to 4 gpm/ft.^{2} (2,000 cc/min.) and then to 6 gpm/ft.^{2} (3,000 cc/min.) when there was no indication of a breakthrough of Aroclor. Results are tabulated in Appendix A. Design and cost estimates based on the experimental results are reported in Appendix B.

4. Sampling

A 24 hour composite sample (300 ml.) was taken by catching a 100 ml. sample every eight (8) hours at points A, B, C, D and E. Point A is the influent to Column 1. Points B, C, D and E are respectively the effluents from Columns 1, 2, 3 and 4. Considerable care had to be taken to avoid contamination since the quantity of contaminants was so small. Care was especially taken to prevent the sample from coming into contact with the plastic bottle caps which are known to adsorb Aroclor.

5. Pressure Drop

The unit was never operated at a pressure greater than 10 psig on the head column. A pressure drop of 10 psi was used as a signal to backwash; however, this was not the only signal used for this purpose

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EXPERIMENTAL: (cont'd.)

6. Analytical Analysis

The Aroclor was extracted from the aqueous sample into a hexane solvent. Once extracted, the hexane solution was then dried and analyzed on a EC/GC. The concentration of Aroclors 1221, 1242 and 1254 was determined by comparing the main peak height of the unknown with the height of the same peak in the chromatographs of known Aroclor solutions of pure 1221, 1242 and 1254. Not all samples were analyzed. Generally, composites caught every other day were analyzed unless some other factor necessitated running samples in between the said period. Samples not analyzed were stored for future reference. The analytical results are tabulated in Appendix A.

7. Backwashing Frequency and Rate

Each column was generally backwashed every 48 hours except during the first 20 days of operation. This operation was carried out by pumping upflow through each column at an approximate 6 gpm/ft.^{2} flow. This was enough flow to easily expand the compacted carbon beds by 10%. However, this was not always enough flow to expend the carbon bed in the first column. The difficulty experienced in expanding the first column was caused by the agglomeration of Aroclor, Biphenyl, foreign solids and carbon granules at the top of the column. Most of the backwashing time was spent trying to break up this apparent solid mass. The backwash water from the first adsorber was saturated with unadsorbed Aroclor and other organics. The condition of the backwash water indicates that Aroclor is being removed by filtration and adsorption. Backwash water will have to be properly disposed of due to its Aroclor content.

DISCUSSION:

1. Test Results

The results of the 107 day pilot run with respect to the removal of Aroclor is tabulated in Appendix A. These results represent the analysis of 52 sets of samples taken during the test period. Since the analysis time required to complete an analysis is quite lengthy, only the samples considered necessary to define the problem solution were analyzed. With the exception of the brief period in October, results show that the Aroclor was reduced to <10 ppb in the first column. For this reason all calculations are based on the results of the first column.

2. Process Parameters

a. Influent Water Quality -- During the test period approximately 287,000 liters of water was treated with average Aroclor

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DISCUSSION: (cont'd.)

2. Process Parameters (cont'd.)

a. concentrations of 4,795 ppb of Aroclor 1221, 1,525 ppb of Aroclor 1242 and 95 ppb of Aroclor 1254. Aroclor concentrations fluctuated from no detectable amount (NDA) to 90,000 ppb with certain components without any apparent effect on the effluent water quality.

b. Loading Capacity -- Based on the average influent concentrations and volume treated, a minimum of four (4) pounds of Aroclor was removed by 20 pounds of carbon. This represents a 25% loading factor based on Aroclor alone. This does not take into consideration the removal of other organics in the stream, such as Biphenyl. This loading factor could be higher at complete exhaustion since a considerable quantity of Aroclor is actually filtered out.

c. Flow Rate -- The operation of the pilot unit over the flow profile, 2, 4 and 6 gpm/ft.^{2}, seems to have little if any effect on the product water quality. A 6 gpm/ft.^{2} flow was essentially all that could be realized in this unit. This flow does not necessarily represent the optimum flow. This variable probably should be evaluated further where the equipment permits.

ACKNOWLEDGEMENT

I wish to thank Mr. Don Turner, Analytical Lab Technician, who conducted all the Aroclor analyses for this study. Further, I wish to extend gratitude to all the personnel of the analytical lab who helped to monitor pilot operation during off-shift.

Ishmeal Ransaw

Ishmeal Ransaw

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Att.

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Aroclor 5432, Aroclor 5442, Aroclor 5460, Arobrom 5465, and Hexabromobiphenyl (E. S. Tucker)

Development work on the analytical methods for monitoring these materials continues. Sampling of these units will be started as soon as the analytical methods have been demonstrated. The Aroclor 5460 SCAS unit is showing possible toxic effects from the test compound as witnessed by a decreasing sludge volume and an observable decrease in LAS degradation. Feeding of this unit has been stopped to determine if it will recover.

A review of the progress to date toward developing biodegradation testing methods was held 5/11/71.

Polychlorinated Terphenyls (PCTs) (E. S. Tucker)

Attempts to measure PCTs by EC/GC have not been successful. The 300°C upper temperature limit of the EC detector did not allow the column temperature to be held high enough to completely elute the PCTs. Fractions of each of the materials were eluted but the relative responses indicated that only small percentages of the higher boiling materials were eluted. This approach has been dropped and an attempt will be made to monitor total organic halogen microcoulometrically.

Aroclor Removal from Waste Water by Adsorption-Flocculation (I. Ransaw - Anniston)

With the exception of the last two test runs, results show that effluent with an average 61 ppb Aroclor was produced from influent water with average Aroclor level of 288 ppb by varying the clay concentration and flow. The result of tests carried out at clay concentrations of 240 and 480 ppb Aroclor and a 2.5 gpm flow show effluent quality less than 50 ppb. (See Tables I and II.) However, there is still considerable fluctuation in the Aroclor level of the effluent. There is reason to believe that some residual Aroclor is being carried out on the solids in the overflow since essentially the same effluent quality is realized regardless of test conditions. This possibility is being checked out.

At clay concentrations of 480 ppm, the economics of using bentonite clay as an adsorbent becomes questionable. Therefore, in an effort to realize the desired effluent quality (20 ppm solids and 10 ppb Aroclor) with a clarification type process, powdered carbon will be evaluated. Cheaper sources of clay are also being evaluated. The extent of these efforts are reported in the work plan issued 5/11/71.

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WATER_PCB-00055488

TABLE I

AROCLOR REMOVAL BY ADSORPTION-FLOCCULATION

Test Conditions:

Flow to clarifier - 2.5 gpm

Clay concentration in feed - 240 ppm

Polymer concentration in feed - 1.5 ppm

Volume Throughput (Gal.)	Avg. Influent Concentration					Avg. Effluent Concentration				
	SS*	1221	1242	1254	1260	SS*	1221	1242	1254	1260
3,600		42	75	--	--		17	5	--	--
7,200		490	590				64	15		
10,800		80	37	--	--		46	3	--	--
11,000		33	23				8	NDA	--	--

*SS -- Suspended solids concentration in ppm's

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WATER_PCB-00055489

TABLE II

AROCLOR REMOVAL FROM WASTE WATER
BY ADSORPTION-CLARIFICATION

Test Conditions:

Flow to clarifier - 2.5 gpm

Clay conc. in feed - 480 ppm

Polymer conc. in feed - 1.5 ppm

Volume Throughput (Gal.)	Avg. Influent Conc.				Avg. Effluent Conc.			
	1221	1242	1254	1260	1221	1242	1254	1260
2,250	180	68	--	--	24	NDA	--	--
5,850	470	63	--	--	57	3	--	--
9,450	163	114	--	--	43	5	--	--
13,050	960	760	--	--	57	4	--	--
16,650	94	60	--	--	26	NDA	--	--
20,250	68	11			14	1		

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