ASSESSMENT OF THE PERSISTENCE OF POLYCHLORINATED BIPHENYLS IN BIOLOGICAL SYSTEMS

MONS 088223

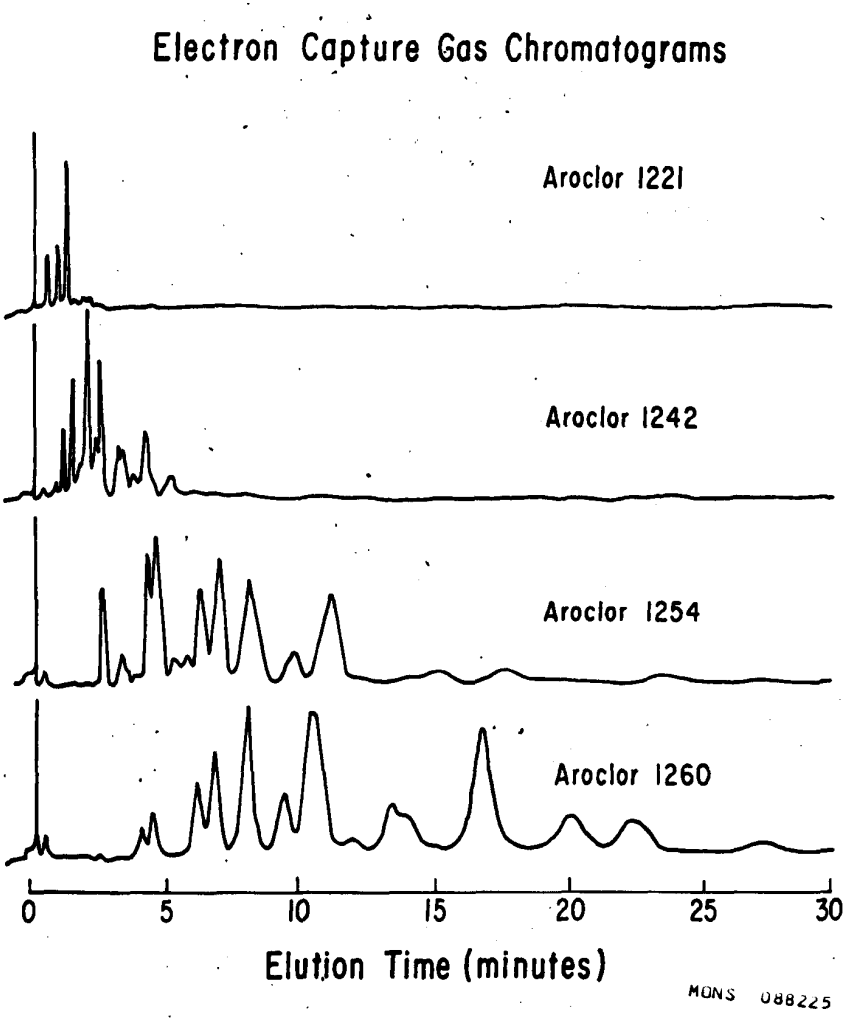
% COMPOSITION OF POLYCHLORINATED BIPHENYL PRODUCTS*

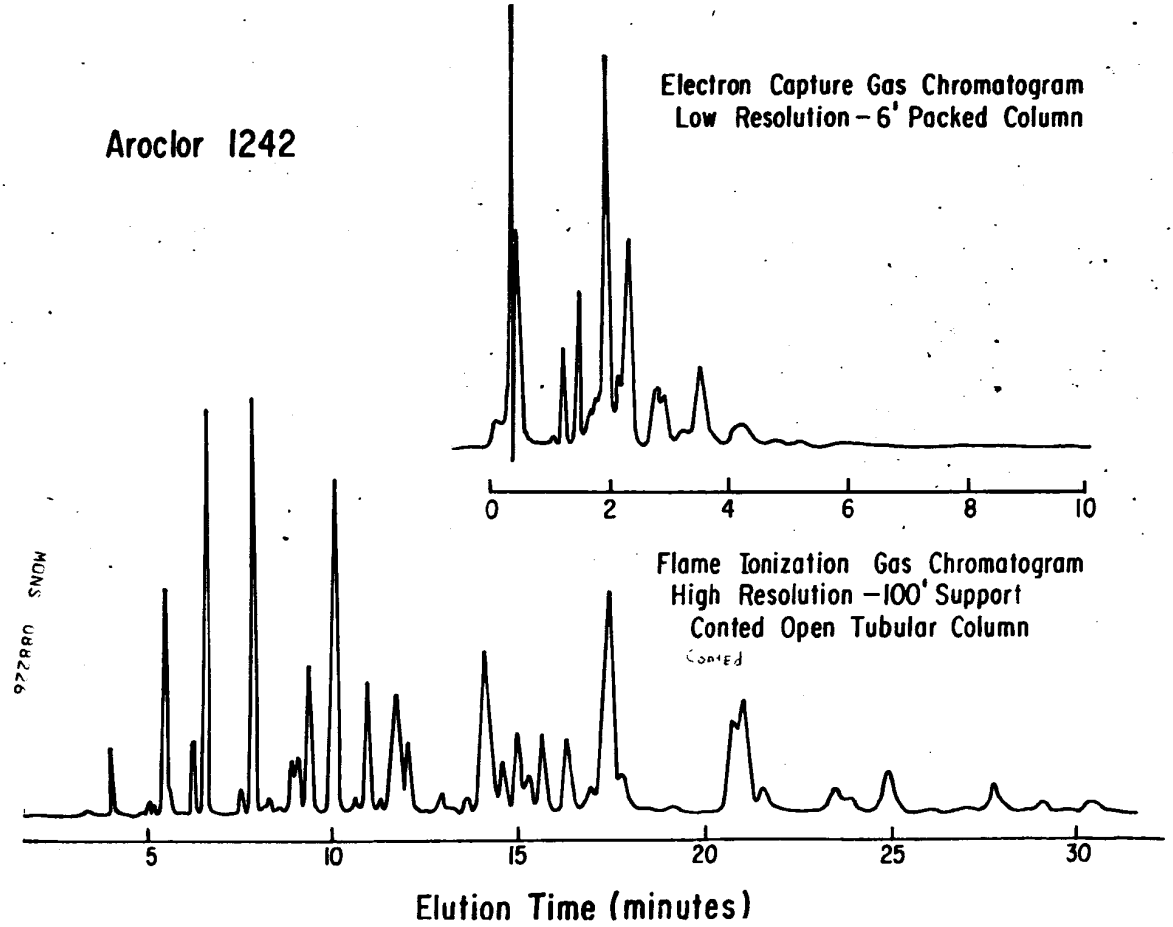
HOMOLOG # Cl/BIPHENYL	AROCLOR 1221	AROCLOR 1016	AROCLOR 1242	AROCLOR 1254
0	10.8	-	-	-
1	51.0	1.0	0.7	-
2	32.0	19.4	15.6	0.2
3	4.2	64.5	54.5	0.6
4	1.6	15.0	22.5	23.0
5+	0.3	0.2	6.7	77.2

*PER CENT (W/W) BY GC/MASS

Should we show A.1260 ?

MUNS 088224


Electron Capture Gas Chromatograms
Aroclor 1221
Aroclor 1242
Aroclor 1254
Aroclor 1260
0
5
10
15
20
25
30
Elution Time (minutes)
MONS 088225


Aroclor 1242
Electron Capture Gas Chromatogram
Low Resolution – 6' Packed Column
0
2
4
6
8
10
Flame Ionization Gas Chromatogram
High Resolution – 100' Support
Coated Open Tubular Column
5
10
15
20
25
30
Elution Time (minutes)

PRIMARY BACTERIAL DEGRADATION STUDIES

- SEMI-CONTINUOUS ACTIVATED SLUDGE DEGRADATION

RESIDUE ACCUMULATION STUDIES

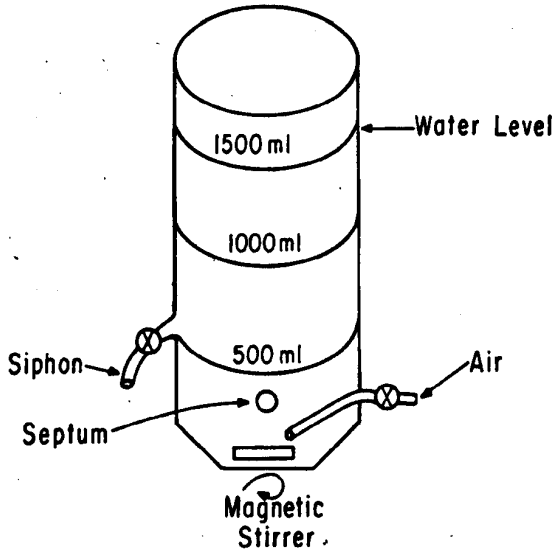
- FISH - CATFISH AND BLUEGILLS
- BIRDS - WHITE LEGHORN CHICKENS
- MAMMALS - ALBINO RATS AND BEAGLE DOGS

AROCLOR SEMI-CONTINUOUS ACTIVATED SLUDGE PRIMARY DEGRADATION STUDIES

MONS 088228

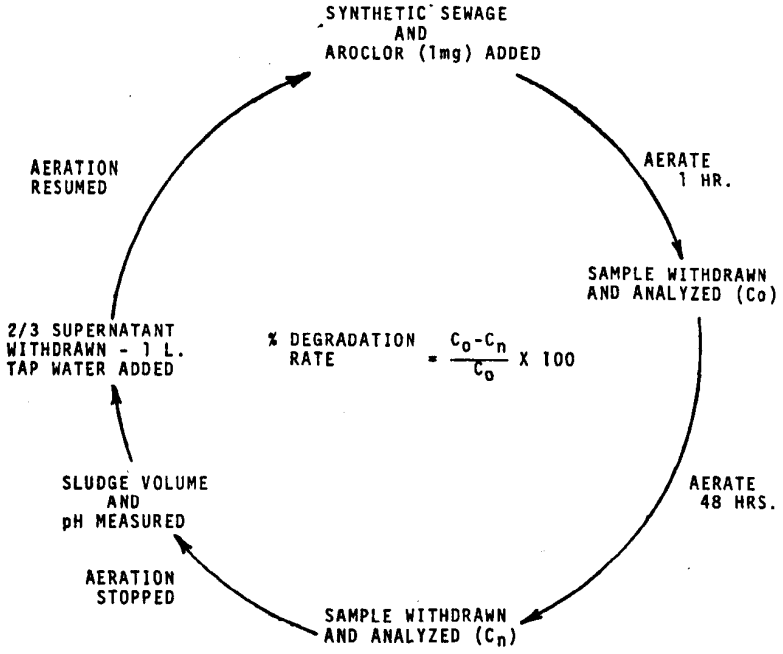
Activated

Semi-Continuous Activited Sludge Test Unit

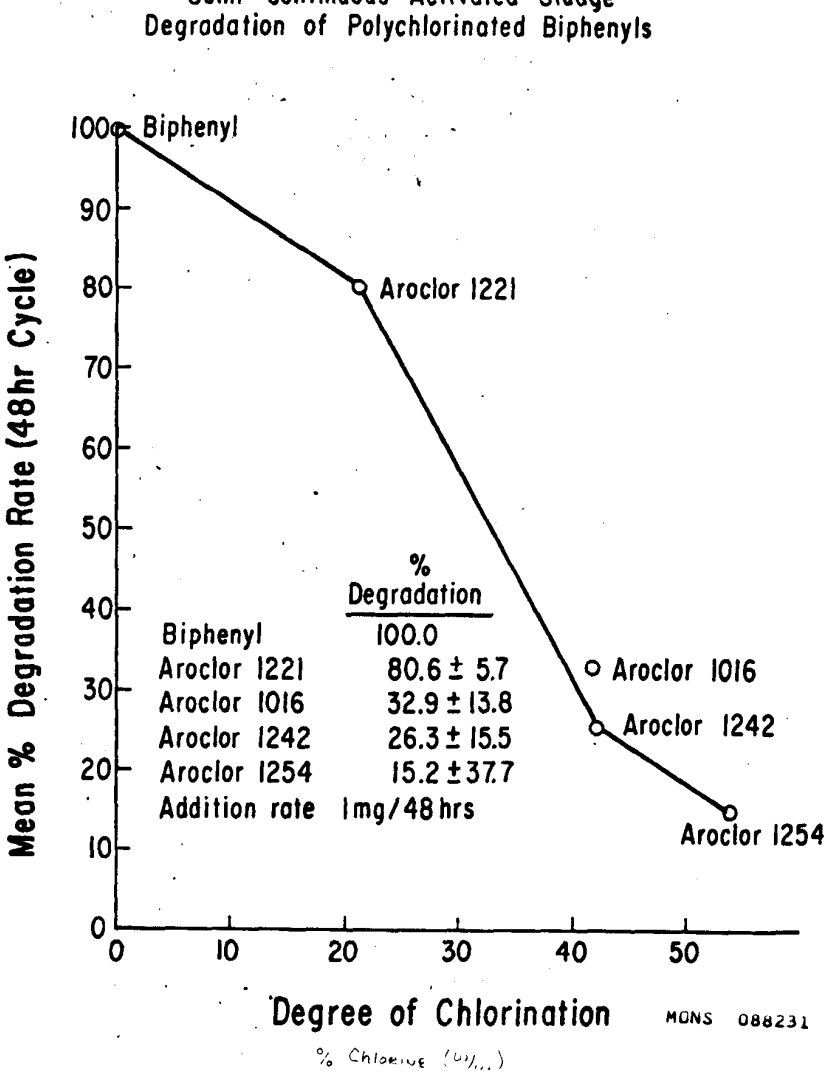


MONS 088229

MECHANICAL CYCLE

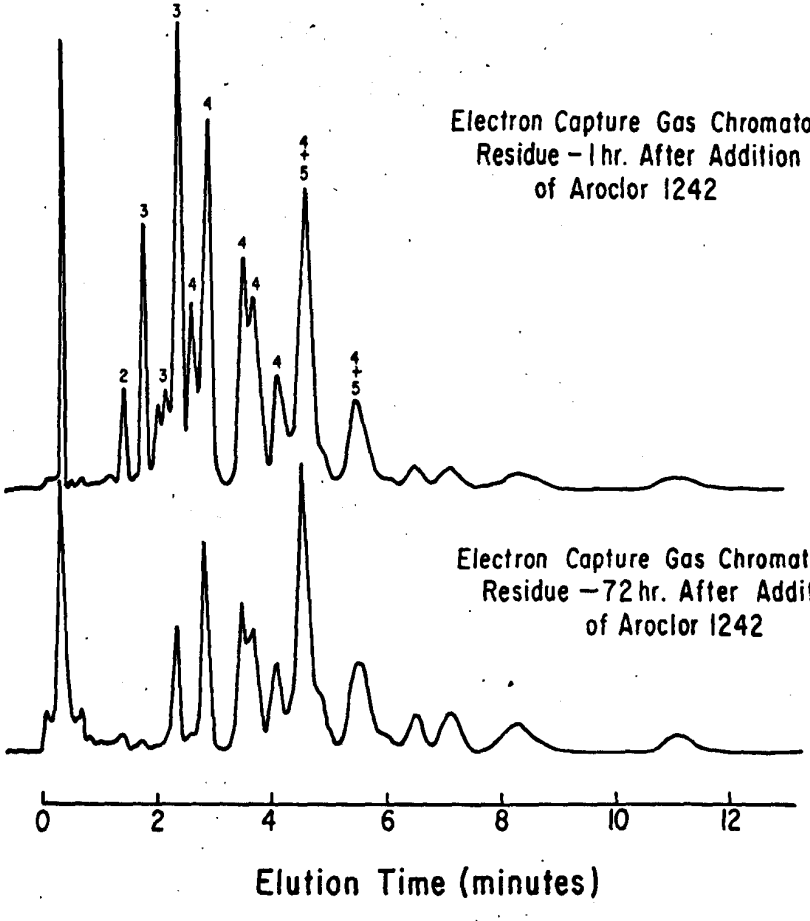


MONS 088230


Semi-Continuous Activated Sludge
Degradation of Polychlorinated Biphenyls
Mean % Degradation Rate (48hr Cycle)
Degree of Chlorination
% Chlorine (Cl)
Biphenyl
Aroclor 1221
Aroclor 1016
Aroclor 1242
Aroclor 1254
% Degradation
Biphenyl 100.0
Aroclor 1221 80.6 ± 5.7
Aroclor 1016 32.9 ± 13.8
Aroclor 1242 26.3 ± 15.5
Aroclor 1254 15.2 ± 37.7
Addition rate 1mg/48 hrs
MONS 088231

Activated

Semi-Continuous Activitated Sludge Degradation of Aroclor 1242



MONS 088232

Conclusions

- BIPHENYL, MONO-, DI-, TRI-, AND TETRACHLORO BIPHENYL HOMOLOGS CAN UNDERGO PRIMARY BACTERIAL DEGRADATION

- RATE OF PRIMARY DEGRADATION DECREASES AS THE DEGREE OF CHLORINATION OF THE AROCLOR PRODUCT IS INCREASED

BIPHENYL>AROCLOR 1221>>AROCLOR 1016>AROCLOR 1242>AROCLOR 1254

AROCLOR RESIDUE STUDIES

MUNS 088234

RESIDUE STUDIES* - CATFISH AND BLUEGILL FINGERLINGS

	21 DAY DYNAMIC
PRODUCTS STUDIED	AROCLOR 1016 AROCLOR 1242
NUMBER OF FISH	270
NUMBER OF SAMPLES WHOLE FISH	24
NUMBER OF SAMPLES ANALYZED WHOLE FISH	24

*BIONOMICS, INC.
WAREHAM, MASSACHUSETTS

MONS 088235

RESIDUE STUDIES* - BEAGLE DOGS

#SAMPLES.

PRODUCTS STUDIED		2 YEAR CHRONIC ORAL AROCLOR 1242 AROCLOR 1254 AROCLOR 1260	90 DAY SUBACUTE ORAL AROCLOR 1221
NUMBER OF DOGS)	FEMALE	40	14
	MALE	40	14
NUMBER OF SAMPLES)	MUSCLE	54	7
	LIVER	54	7
	FAT	54	7
TOTAL SAMPLES COLLECTED		242	21
NUMBER OF SAMPLES ANALYZED)	MUSCLE	42	7
	LIVER	40	7
	FAT	43	7
TOTAL ANALYZED		125	21

*INDUSTRIAL BIO-TEST LABORATORIES, INC.
NORTHBROOK, ILLINOIS

FEED LEVELS : 1, 10, 100 ppm.

MONS 088236

RESIDUE STUDIES* - ALBINO RATS

SAMPLES.

PRODUCTS STUDIED		30 DAY ORAL AROCLOR 1242 AROCLOR 1254 AROCLOR 1260	2 YEAR CHRONIC ORAL AROCLOR 1242 AROCLOR 1254 AROCLOR 1260	3 GENERATION RAT REPRODUCTION AROCLOR 1242 AROCLOR 1254 AROCLOR 1260	90 DAY SUBACUTE ORAL AROCLOR 1221
NUMBER OF RATS	FEMALE	115	500	~20	60
	MALE	115	500	~20	60
NUMBER OF SAMPLES	MUSCLE	18	33	-	7
	KIDNEY	18	-	-	-
	LIVER	18	33	-	7
	FAT	18	33	-	7
	PUPS	-	-	10	-
NUMBER OF SAMPLES ANALYZED	MUSCLE	18	33	-	7
	KIDNEY	18	-	-	-
	LIVER	18	33	-	7
	FAT	18	33	-	7
	PUPS	-	-	10	-
TOTAL SAMPLES COLLECTED		144	198	20	42
TOTAL ANALYZED		72	99	10	21

FEED LEVELS : 1, 10, 100 ppm.

*INDUSTRIAL BIO-TEST LABORATORIES, INC.
NORTHBROOK, ILLINOIS

RESIDUE STUDIES* - WHITE LEGHORN CHICKENS

Samples.

PRODUCTS STUDIED		CHICKENS REPRODUCTION RESIDUE AROCLOR 1242 AROCLOR 1254 AROCLOR 1260	AROCLOR 1242
NUMBER OF CHICKENS	FEMALE	200	80
	MALE	40	16
NUMBER OF SAMPLES	MUSCLE	40	8
	LIVER	40	8
	FAT	40	8
	EGGS	~250	~60
	CHICKS	30	10
NUMBER OF SAMPLES ANALYZED	MUSCLE	14	5
	LIVER	12	4
	FAT	18	5
	EGGS	25	8
	CHICKS	11	10
TOTAL SAMPLES COLLECTED		400	121
TOTAL ANALYZED		80	32

*INDUSTRIAL BIO-TEST LABORATORIES, INC.
NORTHBROOK, ILLINOIS

TWO YEAR CHRONIC ORAL EXPOSURE RESIDUE STUDY OF AROCLOR 1242, AROCLOR 1254, AND AROCLOR 1260 IN BEAGLE DOGS

MONS 088239

RESIDUE STUDY OF AROCLOR 1242 IN BEAGLE DOGS

TWO YEAR CHRONIC ORAL EXPOSURE

MDNS 088240

	PPM PCBs			HOMOLOG DISTRIBUTION									
				1	2	3	4	5	6	7	8	9	10
ORAL EXPOSURE LEVEL	1	10	100										
*RESIDUE, IF TOTAL FED RETAINED	519	5186	51865	-	(2)	(3)	(4)	(5)	6	-	-	-	-
*RESIDUE, 2 YEAR EXPOSURE	2	6	12	-	-	(3)	(4)	5	6	(7)	(8)	-	-
*RESIDUE, 30 DAY RECOVERY	1	4	10	-	-	-	-	5	(6)	(7)	(8)	-	-
*RESIDUE, 60 DAY RECOVERY	0.8	3	6	-	-	-	-	5	6	(7)	(8)	-	-

explanation? Conc^n. effect?

*AVERAGE PPM IN LIPID - ALL TISSUES

( )ELECTRON CAPTURE PEAKS GREATER THAN 5% OF TOTAL

RESIDUE STUDY OF AROCLOR 1254 IN BEAGLE DOGS

TWO YEAR CHRONIC ORAL EXPOSURE

ORAL EXPOSURE LEVEL	PPM PCBs 1	10	100	HOMOLOG DISTRIBUTION 1	2	3	4	5	6	7	8	9	10
*RESIDUE, IF TOTAL FED RETAINED	519	5186	51865	-	-	3	(4)	(5)	(6)	7	-	-	-
*RESIDUE, 2 YEAR EXPOSURE	7	30	132	-	-	-	-	(5)	(6)	(7)	8	-	-
*RESIDUE, 30 DAY RECOVERY	5	24	109	-	-	-	-	5	(6)	(7)	8	-	-
*RESIDUE, 60 DAY RECOVERY	4	20	88	-	-	-	-	5	(6)	(7)	(8)	-	-

*AVERAGE PPM IN LIPID - ALL TISSUES

( )ELECTRON CAPTURE PEAKS GREATER THAN 5% OF TOTAL

MONS 0882+1

RESIDUE STUDY OF AROCLOR 1260 IN BEAGLE DOGS

TWO YEAR CHRONIC ORAL EXPOSURE

	PPM PCBs			HOMOLOG DISTRIBUTION									
				1	2	3	4	5	6	7	8	9	10
ORAL EXPOSURE LEVEL	1	10	100										
*RESIDUE, IF TOTAL FED RETAINED	519	5186	51865	-	-	-	-	(5)	(6)	(7)	8	-	-
*RESIDUE, 2 YEAR EXPOSURE	8	63	388	-	-	-	-	-	(6)	7	(8)	-	-
*RESIDUE, 30 DAY RECOVERY	7	60	363	-	-	-	-	-	(6)	(7)	(8)	-	-
*RESIDUE, 60 DAY RECOVERY	7	55	337	-	-	-	-	-	6	(7)	(8)	-	-

*AVERAGE PPM IN LIPID - ALL TISSUES

( )ELECTRON CAPTURE PEAKS GREATER THAN 5% OF TOTAL

MUNS 088242

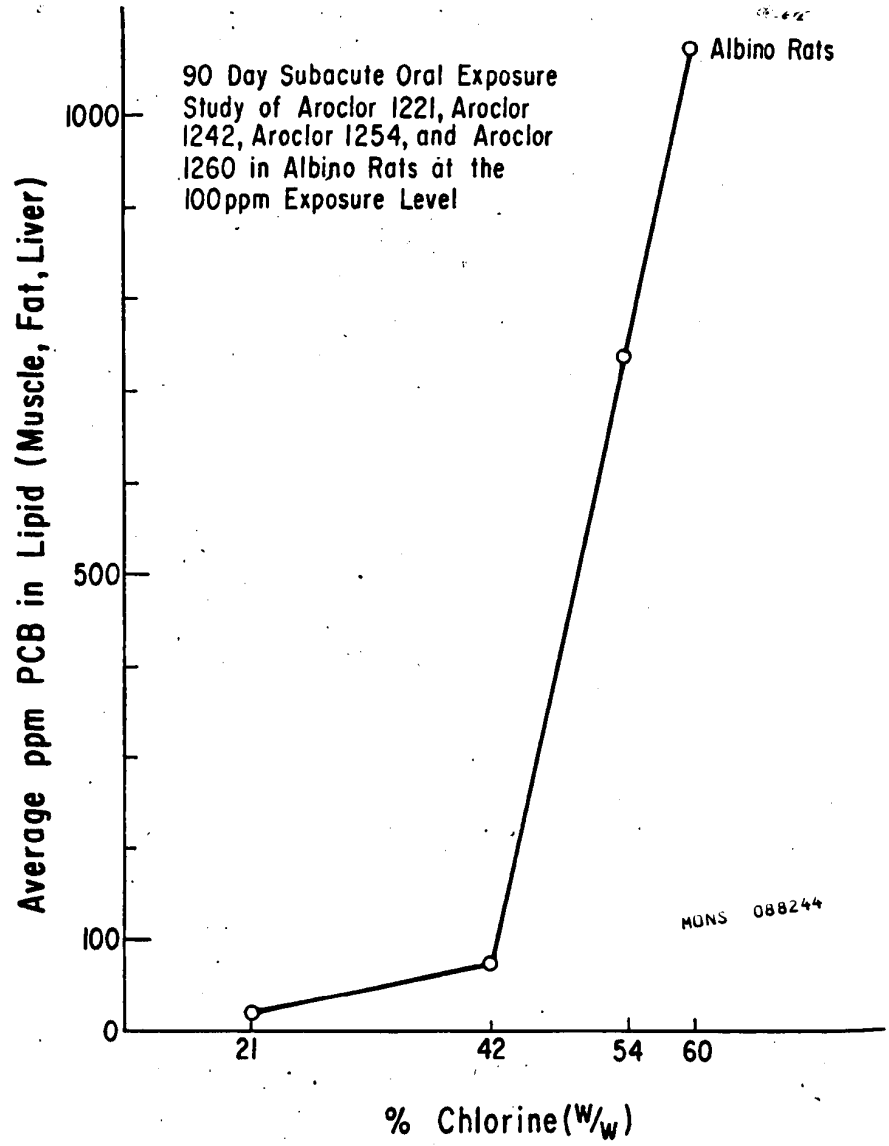
GENERAL CONCLUSIONS

I. RESIDUE BUILDUP RATE

- INCREASED AS THE EXPOSURE LEVEL INCREASED
- INCREASED AS THE EXPOSURE PERIOD INCREASED
- DECREASED EXPONENTIALLY AS THE DEGREE OF CHLORINATION OF THE PRODUCT FED DECREASED
- AROCLOR 1260>AROCLOR 1254>>AROCLOR 1242 >AROCLOR 1221
- FISH>>>>>>CHICKENS>RATS>DOGS
- CHICKENS (LIPID): FAT = MUSCLE>LIVER

  RATS (LIPID): LIVER>FAT = MUSCLE>KIDNEY

  DOGS (LIPID): LIVER>FAT = MUSCLE


90 Day Subacute Oral Exposure Study of Aroclor 1221, Aroclor 1242, Aroclor 1254, and Aroclor 1260 in Albino Rats at the 100ppm Exposure Level
Albino Rats
Average ppm PCB in Lipid (Muscle, Fat, Liver)
1000
500
100
0
21
42
54
60
% Chlorine (W/W)
MONS 088244

GENERAL CONCLUSIONS

I. RESIDUE BUILDUP RATE

- INCREASED AS THE EXPOSURE LEVEL INCREASED
- INCREASED AS THE EXPOSURE PERIOD INCREASED
- DECREASED EXPONENTIALLY AS THE DEGREE OF CHLORINATION OF THE PRODUCT FED DECREASED
- AROCLOR 1260>AROCLOR 1254>>AROCLOR 1242 >AROCLOR 1221
- FISH>>>>>>CHICKENS>RATS>DOGS
- CHICKENS (LIPID): FAT = MUSCLE>LIVER

  RATS (LIPID): LIVER>FAT = MUSCLE>KIDNEY

  DOGS (LIPID): LIVER>FAT = MUSCLE

	EXPOSURE LEVEL (PPM)	EXPOSURE PERIOD	CONCENTRATION FACTOR*
BLUEGILLS	0.1 (WATER)	21 DAYS	400,000
CATFISH	0.1 (WATER)	21 DAYS	320,000
WHITE LEGHORN CHICKENS	1.0 (FEED)	12 WEEKS	20
ALBINO RATS	1.0 (FEED)	2 YEARS	9
BEAGLE DOGS	1.0 (FEED)	2 YEARS	2

*CONCENTRATION FACTORS DO NOT TAKE INTO ACCOUNT EXPOSURE PERIODS

MONS 088246

GENERAL CONCLUSIONS

I. RESIDUE BUILDUP RATE

- INCREASED AS THE EXPOSURE LEVEL INCREASED
- INCREASED AS THE EXPOSURE PERIOD INCREASED
- DECREASED EXPONENTIALLY AS THE DEGREE OF CHLORINATION OF THE PRODUCT FED DECREASED
- AROCLOR 1260>AROCLOR 1254>>AROCLOR 1242 >AROCLOR 1221
- FISH>>>>>>CHICKENS>RATS>DOGS
- CHICKENS (LIPID): FAT = MUSCLE>LIVER

  RATS (LIPID): LIVER>FAT = MUSCLE>KIDNEY

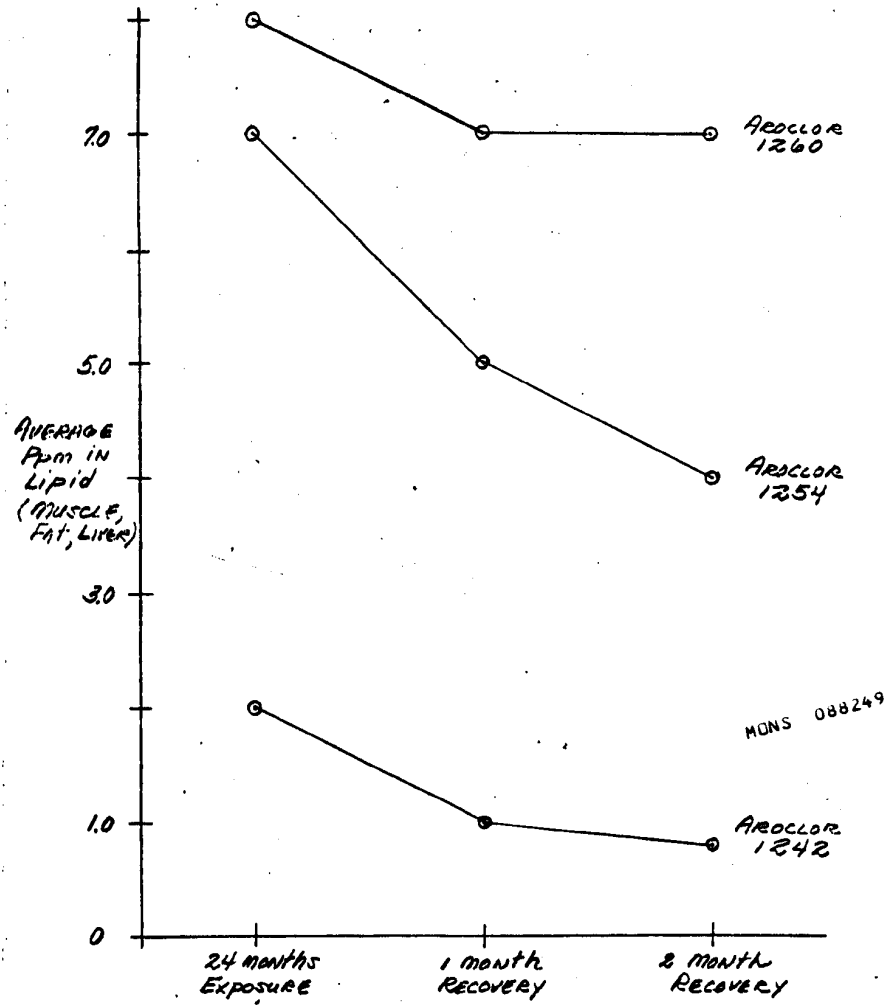
  DOGS (LIPID): LIVER>FAT = MUSCLE

GENERAL CONCLUSIONS

II. RESIDUE FALL OFF RATE .

- INCREASED AS THE EXPOSURE LEVEL DECREASED
- INCREASED AS THE DEGREE OF CHLORINATION OF THE PRODUCT FED DECREASED
- AROCLOR 1242>AROCLOR 1254>AROCLOR 1260
- INCREASED AS RECOVERY PERIOD INCREASED
- DOGS>CHICKENS

Two Year Chronic Oral Exposure in Beagle Dogs at the 1 Ppm Level



MONS 088249

GENERAL CONCLUSIONS

II. RESIDUE FALL OFF RATE

- INCREASED AS THE EXPOSURE LEVEL DECREASED
- INCREASED AS THE DEGREE OF CHLORINATION OF THE PRODUCT FED DECREASED
- AROCLOR 1242>AROCLOR 1254>AROCLOR 1260
- INCREASED AS RECOVERY PERIOD INCREASED
- DOGS>CHICKENS

GENERAL CONCLUSIONS

III. ALTERATION OF THE HOMOLOG DISTRIBUTION OF PRODUCTS FED

- INDEPENDENT OF EXPOSURE LEVEL
- INDEPENDENT OF EXPOSURE PERIOD
- HIGHER CHLORINATED HOMOLOGS DOMINANTLY RETAINED (PENTA-, HEXA-, HEPTA-, OCTA-CHLORO BIPHENYLS)
- DOGS>RATS>CHICKENS>>>>>FISH*
- INCREASED AS DEGREE OF CHLORINATION OF PRODUCT FED DECREASED

  AROCLOR 1221>AROCLOR 1242>AROCLOR 1254 >AROCLOR 1260

*DISTRIBUTION UNALTERED BY FISH

RESIDUE STUDY OF AROCLOR 1242 IN WHITE LEGHORN CHICKENS

MONS 088252

	PPM PCBs*			HOMOLOG DISTRIBUTION									
				1	2	3	4	5	6	7	8	9	10
ORAL EXPOSURE LEVEL	1	10	100										
RESIDUE, IF TOTAL FED RETAINED	126	1260	12602	-	(2)	(3)	(4)	(5)	6	-	-	-	-
RESIDUE, 12 WEEK EXPOSURE	14	136	1312	-	-	(3)	(4)	(5)	6	-	-	-	-
RESIDUE, 30 DAY RECOVERY	9	77	749	-	-	(3)	(4)	(5)	(6)	-	-	-	-

*AVERAGE PPM IN LIPID - ALL TISSUES

( )ELECTRON CAPTURE PEAKS GREATER THAN 5% OF TOTAL

MONS 088253

RESIDUE STUDY OF AROCLOR 1254 IN WHITE LEGHORN CHICKENS

	PPM PCBs*			HOMOLOG DISTRIBUTION									
				1	2	3	4	5	6	7	8	9	10
ORAL EXPOSURE LEVEL	1	10	100										
RESIDUE, IF TOTAL FED RETAINED	126	1260	12602	-	-	3	(4)	(5)	(6)	7	-	-	-
RESIDUE, 12 WEEK EXPOSURE	38	362	3506	-	-	-	4	(5)	(6)	7	-	-	-
RESIDUE, 30 DAY RECOVERY	17	164	1580	-	-	-	-	5	(6)	7	-	-	-

*AVERAGE PPM IN LIPID - ALL TISSUES

( )ELECTRON CAPTURE PEAKS GREATER THAN 5% OF TOTAL

RESIDUE STUDY OF AROCLOR 1260 IN WHITE LEGHORN CHICKENS

MUNS 088254

	PPM PCBs*			HOMOLOG DISTRIBUTION									
				1	2	3	4	5	6	7	8	9	10
ORAL EXPOSURE LEVEL	1	10	100										
RESIDUE, IF TOTAL FED RETAINED	126	1260	12602	-	-	-	-	(5)	(6)	(7)	8	-	-
RESIDUE, 12 WEEK EXPOSURE	65	607	5909	-	-	-	-	5	(6)	(7)	8	-	-
RESIDUE, 30 DAY RECOVERY	26	232	2363	-	-	-	-	5	(6)	(7)	8	-	-

*AVERAGE PPM IN LIPID - ALL TISSUES

( )ELECTRON CAPTURE PEAKS GREATER THAN 5% OF TOTAL