

FINAL REPORT

STUDY TITLE

Adsorption/Desorption of ¹⁴C-Metalaxyl

DATA REQUIREMENT

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Company Agricultural Division, CIBA-GEIGY Corporation

Company Agent _____

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Signature

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SPONSOR CERTIFICATION OF GOOD LABORATORY PRACTICE

To the best of my knowledge, the Good Laboratory Practice Statement found on page _____ of this volume, and signed by the study director, is truthful and accurate.

Signature of Agent of Submitter/Sponsor

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TABLE OF CONTENTS

	<u>PAGE</u>
TITLE PAGE.....	1
STATEMENT OF NO CONFIDENTIALITY CLAIMS.....	2
SPONSOR CERTIFICATION OF GOOD LABORATORY PRACTICE.....	3
TABLE OF CONTENTS.....	4
CERTIFICATION OF GOOD LABORATORY PRACTICE.....	7
QUALITY ASSURANCE FINAL REPORT STATEMENT.....	8
ABSTRACT.....	9
INTRODUCTION.....	10
EXPERIMENTAL DESIGN.....	10
Soil.....	10
Test Material.....	10
Test Solutions.....	11
Test System.....	11
Range Finding Study.....	11
Adsorption.....	12
Desorption.....	13
ANALYTICAL METHOD.....	13
Radiocarbon Analysis.....	13
Calculations.....	13
RESULTS AND DISCUSSION.....	14
PROTOCOL DEVIATIONS.....	16
REFERENCES.....	16
TABLE 1: Soil Characterization, Soils Used For Metalaxyl Adsorption/Desorption.....	17
TABLE 2: Average Concentration Of CGA-48988 (Metalaxyl) In Soil And Aqueous Solutions During Range Finding At A Water To Soil Ratio of 20:1. Expressed As ppm CGA-48988 (ug/ml) In Aqueous 0.001 N Calcium Ion Solution.....	18

TABLE OF CONTENTS (CONT'D)

	<u>PAGE</u>
TABLE 3: Mean Estimated K_d Values From Range Finding ($x/m = K_d C_e$).....	19
TABLE 4: Radiocarbon Balance For Range Finding. Soils Combusted After 48 Hours Of Adsorption Shaking. Balance Determined By Summation Of Percent Of Dose On Soil And Percent Of Dose In Solution For Each Replicate Of Each Soil Type.....	20
TABLE 5: Mean Measured Concentration (C_e) Of CGA-48988 In Solution As ug/ml (ppm) And Average For The Duplicate Samples At Each Concentration In The Adsorption Phase Of The Study.....	21
TABLE 6: Calculated Concentration (x/m) Of CGA-48988 In Soil As ug/g (ppm) And Average For The Duplicate Samples At Each Concentration In The Adsorption Phase Of The Study. Concentration Determined Difference.....	22
TABLE 7: Mean Measured Concentration (C_e) Of CGA-48988 In Solution As ug/ml (ppm) And Average For The Duplicate Samples At Each Concentration In The Desorption Phase Of The Study.....	23
TABLE 8: Calculated Concentration (x/m) Of CGA-48988 In Soil As ug/g (ppm) And Average For The Duplicate Samples At Each Concentration In The Desorption Phase Of The Study. Concentration Determined Difference.....	24
TABLE 9: Linear Regression Analysis Of The Adsorption Data Using The Freundlich Isotherm ($\ln x/m = \ln K_d + 1/n \ln C_e$) For CGA-48988 With 4 Soil Types.....	25

TABLE OF CONTENTS (CONT'D)

	<u>PAGE</u>
TABLE 10: Linear Regression Analysis Of The Desorption Data Using The Freundlich Isotherm ($\ln x/m = -\ln K_d + 1/n \ln C_e$) For CGA-48988 With 4 Soil Types.....	26
FIGURE 1: Structure Of Metalaxyl.....	27
FIGURE 2: Metalaxyl Adsorption Isotherms.....	28
FIGURE 3: Metalaxyl Desorption Isotherms.....	30
APPENDIX A: Protocol.....	32
APPENDIX B: Receipt of ^{14}C -Metalaxyl And Correspondence.....	40
APPENDIX C: Data.....	61

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CERTIFICATION OF GOOD LABORATORY PRACTICE

Project No. 1288 "ADSORPTION/DESORPTION OF ¹⁴C-Metalaxyl", has been performed in accordance with current EPA Good Laboratory Practice Standards by Agriseach Incorporated. However, this study was not subject to the GLP requirements specified in 40 CFR 160. Copies of all raw data and final reports are stored in the archives at Agriseach Incorporated.

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QUALITY ASSURANCE
FINAL REPORT STATEMENT

Project No. 1288 was inspected/audited on the following date(s): 6/10/88; 6/13/88; 7/21/88

by Quality Assurance according to Agrisearch Standard Operating Procedures and EPA's Good Laboratory Practice Standards (Ref. 1). All findings were reported to the Study Director and Management on the following date(s): 6/13/88; 7/21/88

Action has been taken in response to all items listed by Quality Assurance. It was concluded that the Final Report accurately reflects the raw data for this project. This study has been conducted in compliance with the above standards.

5.2e Woo

QUALITY ASSURANCE

Date: 7/25/88

ABSTRACT

The rate of dissipation of a pesticide in the environment and in soils is influenced by numerous phenomena. This study was designed (APPENDIX A) according to EPA Guidelines (Ref. 2) to predict the potential for the test material to move to and disperse in aquatic sites. Four soil types varying in organic matter and texture were tested using a batch equilibrium technique (adsorption/desorption).

Analytical grade ^{14}C -labeled Metalaxyl (CGA-48988) was prepared in solution at 0.0, 0.21, 0.52, 1.03, 5.13, and 10.16 ug/ml, mixed with soil and allowed to equilibrate. The phases were separated by centrifugation and the solution concentration determined by liquid scintillation counting (LSC). The soil phases were next desorbed with solution free of metalaxyl and concentrations determined by LSC following centrifugation. Adsorption and desorption isotherms were next graphically determined. Soil characteristics were obtained. All data were evaluated using the Freundlich equation and values for K_{oc} (adsorption coefficient), K_d (adsorption constant) and n were determined.

The results demonstrated that the Freundlich isotherm was applicable to analysis of the adsorption and desorption phenomena of metalaxyl. Logarithmic plots of data yielded a straight line for all soils tested for both adsorption and desorption. The adsorption constants (K_d) were between 0.1 and 8.0 and the desorption constants (K_d) between 2.0 and 11.3 demonstrating that metalaxyl was not strongly adsorbed onto soil and that was easily desorbed from soil particles. Values for K_d , K_{oc} , and n were determined as follows:

SOIL TYPE	ADSORPTION			DESORPTION		
	K_d	K_{oc}	n	K_d	K_{oc}	n
MD-Clay	8.012	283.8	0.864	11.346	401.9	0.936
MD-Sand	0.157	29.6	1.257	2.482	469.2	1.386
MS-Loam	1.401	199.8	0.766	2.975	421.4	1.070
CA-Sandy Loam	0.400	136.1	1.033	2.064	702.0	1.282

INTRODUCTION

The objective of this study was to predict the potential for movement of metalaxyl to and dispersion in aquatic sites. Four soil types were tested using batch equilibrium techniques (adsorption/desorption).

This study was performed to fulfill the requirements of the "Pesticide Assessment Guidelines, Subdivision N, Chemistry: Environmental Fate" for leaching and adsorption/desorption studies No. 163-1.

EXPERIMENTAL DESIGN

Soil

Four soil types were used in the study. Soils were provided by CIBA-GEIGY Corporation (loam) or obtained by Agrisearch Incorporated (clay, sand, and sandy loam). All soils were air dried and sieved (2 mm mesh screen) prior to use in the study.

Soils were characterized by A & L Eastern Agricultural Laboratories, Incorporated of Richmond, Virginia. Results are summarized in TABLE 1. The Iowa sandy loam soil was the same soil as used for the soil metabolism study of metalaxyl.

Test Material

Analytical standard metalaxyl (100 mg, Code No. 57869) and 5.0 mg of phenyl ring-¹⁴C-CGA-48988 (Code No. GAN-XII-68) at a specific activity of 17.5 uCi/mg were received from CIBA-GEIGY Corporation on 9/25/87 and 8/18/87, respectively. The analytical standard and radioactive chemical were logged into the Agrisearch Incorporated sample log book as numbers 87-086 and 87-075, respectively. Radioactive purity of the CGA-48988 was determined to be 99.1% from one single dimension TLC solvent system. The solvent system was toluene:ethyl acetate:formic acid 50:50:5 v:v:v. The water solubility of metalaxyl is 7100 ppm at 20°C. See APPENDIX B for copies of the shipping forms and labels. FIGURE 1 presents the structure of CGA-48988.

Test Solutions

For the range finding study, the stock solution of the radioactive compound (0.0025 mg/ul) was prepared in methanol. A 500 ul volume of the radioactive stock was diluted to 160 ml using deionized, distilled and boiled water containing 0.01 N calcium ion. Final CGA-48988 nominal concentration was 7.8 ug/ml.

For the definitive test, a 1400 ul volume of the radioactive stock was mixed with 0.2 μ m membrane filter sterilized, deionized, distilled and boiled water containing 0.01 N calcium ion (1.76 g calcium acetate, Baker Chemical #1266-1, per liter of water) in autoclaved glassware. The final CGA-48988 nominal concentration was 10 ug/ml in a total final volume of 350 ml. Aqueous dilutions of this nominal 10 ug/ml solution were prepared in sterile solution containing 0.01 N calcium ion to provide the following concentrations for the study: 10 ug/ml, 5 ug/ml, 1 ug/ml, 0.5 ug/ml, and 0.2 ug/ml. Additional 0.01 N calcium ion solution was used without metalaxyl addition as the 0.00 ug/ml control concentration.

Test System

The test system for this study was each capped centrifuge tube of soil, solution and CGA-48988. All test systems were identified by project number, soil type, replicate, concentration, date, and technician initials. All test systems were shaken in the laboratory at 24 - 25°C.

Range Finding Study

Prior to the definitive testing, each soil type was tested to establish the ratio of soil to stock solution and equilibration time for use in the adsorption and desorption phases of the study. The range finding test was performed in duplicate using a high concentration (7.8 ug/ml) of CGA-48988.

Duplicate 1 g samples of each sieved, air dried soil were placed in 50 ml polypropylene screw cap centrifuge tubes. Twenty ml of CGA-48988 solution at 10 ug/ml was added to each tube. All samples were shaken using a reciprocal Eberbach shaker with a 4 cm throw at approximately 200 rpm. At 2, 4, 8, 24, and 48 hours of shaking, all samples were centrifuged (IEC centrifuge, 1500 rpm - 1000 g) for 15 minutes and 100 ul of the supernatant was removed and analyzed by LSC.

An estimation of the Freundlich adsorption constant was obtained using $x/m = K_d C_e$ (see calculations). The soil to CGA-48988 solution ratio used in the definitive test was selected from the following table based on the estimated K_d :

Estimated K_d	Solution to Soil Ratio
≤ 10	5 ml:1g
$> 10 \leq 50$	20 ml:1g
$> 50 \leq 400$	100 ml:1g
> 400	1000 ml:1g

Adsorption

Based upon the equilibrium shaking time and solution to soil ratios, as determined by the range finding phase, the adsorption phase of the study was performed. Samples of prepared soil (5 g each) were placed in 50 ml polypropylene centrifuge tubes in duplicate for each test solution concentration. Twenty-five ml of CGA-48988 stock solution at 0.00, 0.2, 0.5, 1.0, 5, and 10 ug/ml was transferred to appropriate containers and capped. The entire sample set was shaken for 6 hours using the Eberbach shaker at approximately 200 rpm. Following centrifugation (~ 1000 g for 15 minutes), the equilibrium concentrations (C_e) of CGA-48988 were determined in all solutions. Solutions remaining after adsorption were decanted and supernatant analyzed by LSC to determine the actual equilibrium concentration (C_e).

Desorption

Following adsorption, desorption was performed on the soil samples remaining from adsorption. Twenty-five ml of calcium ion solution at 0.01 N without CGA-48988 was added to the soils. Prior to addition of the calcium ion solution all soils samples (wet) were reweighed to correct for remaining adsorption solution in the final calculations. The entire sample set was shaken for 6 hours using the Eberbach shaker at approximately 200 rpm. All samples were centrifuged (\approx 1000 g for 15 minutes) and the supernatant analyzed by LSC to determine the equilibrium concentration (C_e).

ANALYTICAL METHOD

Radiocarbon Analysis

All solutions were analyzed by direct LSC in Scint-A (Packard Inst. Co.) scintillation cocktail. Soils were oxidized using R.J. Harvey Instruments Corporation Biological Materials Oxidizer (BMO). BMO generated $^{14}\text{CO}_2$ was trapped in R.J. Harvey- CO_2 trapping fluor.

All quantification was performed using 2 channel counting for 5 minutes with a Beckman LS3801 Liquid Scintillation Spectrophotometer. Obtained counts per minute (cpm) were converted to disintegrations per minute (dpm) using the internal standard feature (H#) of the instrument.

Calculations

The Freundlich equation is applicable to the adsorption/desorption of materials at intermediate concentrations and is commonly used to evaluate batch equilibrium data. The equation is an empirical relationship which may be expressed as:

$$x/m = K_d C_e^{1/n} \text{ or } \ln x/m = \ln K_d + 1/n \ln C_e$$

where x/m is the soil equilibrium concentration in $\mu\text{g/g}$, C_e is the aqueous phase equilibrium concentration in $\mu\text{g/ml}$, K_d is the Freundlich adsorption constant and n is a constant.

The values of $\ln C_e$ versus $\ln x/m$ were plotted for adsorption and desorption. The constants K_d and n were determined from the slope ($1/n$) and intercept ($\ln K_d$) of the resultant straight line by linear regression.

The adsorption constant (K_d) was also expressed in terms of the soil organic carbon content using the following equation:

$$K_{oc} = (K_d \times 100) / \% \text{ O.C.}$$

where K_{oc} is the adsorption coefficient based on soil organic carbon content and $\% \text{ O.C.}$ is the organic carbon content of the soil. The organic carbon content of the soil was calculated by dividing the organic matter content by 1.7 per sponsor.

RESULTS AND DISCUSSION

Interferences such as adsorption and absorption of metalaxyl to the test container walls was not expected to occur due to the high solubility of metalaxyl. Therefore the 50 ml polypropylene centrifuge tubes were chosen to conduct the adsorption/desorption study.

The results of the range finding study are presented in TABLES 2-4. Data in TABLE 2 shows that equilibrium in all soil types was reached rapidly. Solution equilibrium was achieved by 4 and 8 hours and all subsequent aqueous samples had reached a plateau. Therefore, the equilibrium shaking time selected for the definitive study was 6 hours. The estimated K_d values from TABLE 3 indicated a K_d of less than 10 for all soils except Maryland clay. Therefore, to provide comparable data for all soils, a solution to soil ratio of 5 ml solution to 1 g soil was used in the definitive study. Radiocarbon balance from the range finding study was 99.4% (TABLE 4). This range finding study was performed to determine: solution to soil ratios, shaking time, and material balance during equilibration. The range finding study showed excellent radioactive balance, therefore, soil concentrations in the definitive test were determined by radioactive difference.

Per sponsor request, the Iowa sandy loam soil used in the range finding phase of the study was replaced by a California sandy loam in the definitive phase of the study. The mean measured concentration and average for the duplicate samples for each chemical concentration in solution and calculated soil equilibrium concentrations for the adsorption phase of the study are presented in TABLES 5 and 6, respectively. The mean measured concentration and average for the duplicate samples for each chemical concentration in solution and the calculated values for the soil concentrations of CGA-48988 at equilibrium for the desorption phase of the study are presented in TABLES 7 and 8, respectively. The ppm values were determined from radioactivity of each sample divided by the specific activity of CGA-48988 used in the study (SA=38850 dpm/ug). The obtained values from adsorption and desorption were analyzed using the empirical Freundlich isotherm. Correlation coefficients calculated using the Freundlich equations were greater than 99% for all soils except desorption sand and sandy loam (97.4%). This showed that adsorption and desorption were studied and that the Freundlich equation was applicable to this compound. Logarithmic plots of x/m (equilibrium soil concentration) versus C_e (equilibrium solution concentrations) yielded a straight line for soils tested for both adsorption and desorption (FIGURES 2 and 3). Calculation of the Freundlich equations by regression analysis are presented in TABLES 9 and 10 for adsorption and desorption, respectively. The adsorption constants (K_d) were found to be between 0.1 and 8.0 and the desorption constants (K_d) between 2.0 and 11.3, demonstrating that CGA-48988 was not strongly adsorbed onto soil particles, and was easily desorbed. The values of n were also determined from the slope of the straight lines graphed. The slopes for adsorption and desorption were not unity. This indicated that the adsorption and desorption process was not equivalent to the distribution law and that adsorption and desorption was not merely a distribution between the organic matter of the soil and the aqueous phase. If the process was merely a distribution, the K_{oc} values would be constant instead of varying from 29.6 to 283.8 for adsorption and 401.9 to 702.0 for desorption.

Following completion of the adsorption and desorption phases of the study, aliquots of the highest solution concentrations were analyzed by thin layer chromatography. That analysis showed only parent CGA-48988 (metalaxyl) in all solutions. No parent degradation was observed.

PROTOCOL DEVIATIONS

The definitive was performed at a uniform soil to solution ratio of 1 to 5 and not 1 to 20 for clay and 1 to 5 for the other soils as the protocol would indicate. The 8 hour sampling for the range finding was actually at 9 hours of shaking time. Actual dose levels used for testing metalaxyl in this study were nominally 0.0, 0.2, 0.5, 1.0, 5.0, and 10.0 ppm and not the protocol stated 1.0, 2.5, 5.0, and 10 ppm. These deviations were not expected to adversely impact the study.

REFERENCES

- 1) U.S. Environmental Protection Agency, 1983. Pesticide Programs; Good Laboratory Practice Standards; Final Rule (40 CFR 160). Federal Register, Vol. 48, No. 230: 53946-53969.
- 2) "Pesticide Assessment Guidelines, Subdivision N Chemistry: Environmental Fate", U.S. Environmental Protection Agency, Office Of Pesticide And Toxic Substances, Washington, D.C. 20460; EPA 540/9-82-021, October 18, 1982. NTIS PB83-153973.

TABLE 1: SOIL CHARACTERIZATION. SOILS USED FOR METALAXYL ADSORPTION AND DESORPTION.

SOURCE	MARYLAND	MARYLAND	MISSISSIPPI	IOWA	CALIFORNIA
Texture	Clay	Sand	Loam	Sandy Loam	Sandy Loam
% Sand	25.2	95.6	49.6	53.2	74.0
% Silt	32.8	2.2	39.2	37.6	19.6
% Clay	42.0	2.2	11.2	9.2	6.4
Organic Matter %	4.8	0.9	1.2	5.0	0.5
pH	5.9	6.5	7.6	5.9	6.5
Field Capacity %	35.9	3.8	13.3	23.9	6.1
Cation Exchange Capacity (meq/100g)	24.3	1.8	8.0	13.6	4.7
Bulk Density* (g/ml)	1.21	1.64	1.23	1.18	1.51

* Determined at Agrisearch Incorporated.

TABLE 2: AVERAGE CONCENTRATION OF CGA-48988 (METALAXYL) IN SOIL AND AQUEOUS SOLUTIONS DURING RANGE FINDING AT A WATER TO SOIL RATIO OF 20:1. EXPRESSED AS ppm CGA-48988 (ug/ml) IN AQUEOUS 0.001 N CALCIUM ION SOLUTION.

		SOIL TYPE			
Equilibrium Shaking Time	Rep.	Maryland Sand	Maryland Clay	Mississippi Loam	Iowa Sandy Loam
Solution					
2 Hours	1	8.85	4.95	7.58	8.08
	2	<u>8.91</u>	<u>5.01</u>	<u>7.23</u>	<u>8.08</u>
	X	8.88	4.98	7.40	8.08
4 Hours	1	8.84	5.13	7.72	8.09
	2	<u>9.03</u>	<u>5.20</u>	<u>7.39</u>	<u>8.08</u>
	X	8.94	5.16	7.56	8.08
8 Hours	1	8.88	5.22	7.59	8.20
	2	<u>9.01</u>	<u>5.25</u>	<u>7.14</u>	<u>8.17</u>
	X	8.94	5.24	7.36	8.18
24 Hours	1	8.83	5.08	7.47	8.04
	2	<u>9.00</u>	<u>5.04</u>	<u>7.17</u>	<u>7.95</u>
	X	8.92	5.06	7.32	8.00
48 Hours	1	8.83	5.31	7.52	8.08
	2	<u>8.93</u>	<u>5.23</u>	<u>7.17</u>	<u>8.00</u>
	X	8.88	5.27	7.34	8.04
Soil					
48 Hours	1	0.313	71.77	17.59	14.98
	2	<u>0.000</u>	<u>65.12</u>	<u>18.13</u>	<u>14.23</u>
	X	0.156	68.44	17.86	14.60

TABLE 3: MEAN ESTIMATED K_d VALUES FROM RANGE FINDING ($x/m = K_d C_e$)*

Equilibrium Shaking Time	SOIL TYPE			
	Maryland Sand	Maryland Clay	Iowa Sandy Loam	Mississippi Loam
2 Hours	0.02	13.76	1.80	2.42
4 Hours	0.02	13.25	1.80	2.36
8 Hours	0.02	13.08	1.78	2.43
24 Hours	0.02	13.52	1.82	2.44
48 Hours	0.02	12.98	1.82	2.44

* Assumes $1/n = 1$ in the Freundlich adsorption isotherm. Soil concentration (x/m) determined by oxidation of soils at 48 hours.

TABLE 4: RADIOCARBON BALANCE FOR RANGE FINDING. SOILS COMBUSTED AFTER 48 HOURS OF ADSORPTION SHAKING. BALANCE DETERMINED BY SUMMATION OF PERCENT OF DOSE* ON SOIL AND PERCENT OF DOSE IN SOLUTION FOR EACH REPLICATE OF EACH SOIL TYPE.

Soil Type	Rep.	TOTAL dpm**		PERCENT OF DOSE		
		Soil ($\times 10^5$)	Solution ($\times 10^6$)	Soil	Solution	Total
Maryland Sand	1	0.13	6.86	0.19	100.01	100.20
	2	0.00	6.94	0.00	101.13	101.13
Maryland Clay	1	30.3	4.12	44.08	60.09	104.17
	2	26.4	4.07	38.41	59.23	97.64
Mississippi Loam	1	7.34	6.28	10.74	85.16	95.90
	2	10.5	6.21	15.30	81.16	96.46
Iowa Sandy Loam	1	6.18	5.84	9.00	91.52	100.52
	2	5.93	5.57	8.64	90.53	99.17
						x 99.40

* Dose - 6.863×10^6 dpm per replicate

** Determined by direct liquid scintillation counting of solutions and combustion by BMO of soils

TABLE 5: MEAN MEASURED CONCENTRATION (C_e) OF CGA-48988, IN SOLUTION AS $\mu\text{g}/\text{ml}$ (ppm) AND AVERAGE FOR THE DUPLICATE SAMPLES AT EACH CONCENTRATION IN THE ADSORPTION PHASE OF THE STUDY.

TEST SOL. CONC.	REP	SOIL TYPE			
		MARYLAND CLAY	MARYLAND SAND	MISSISSIPPI LOAM	CALIFORNIA SANDY LOAM
0 $\mu\text{g}/\text{ml}$		0.0	0.0	0.0	0.0
0.21	1	0.092	0.201	0.175	0.193
	2	<u>0.092</u>	<u>0.203</u>	<u>0.174</u>	<u>0.188</u>
	x	0.092	0.202	0.174	0.190
0.52	1	0.232	0.499	0.425	0.485
	2	<u>0.236</u>	<u>0.493</u>	<u>0.431</u>	<u>0.486</u>
	x	0.234	0.496	0.428	0.486
1.03	1	0.463	0.996	0.851	0.948
	2	<u>0.459</u>	<u>0.993</u>	<u>0.847</u>	<u>0.943</u>
	x	0.461	0.994	0.849	0.946
5.13	1	1.93	5.02	3.57	4.74
	2	<u>1.89</u>	<u>4.99</u>	<u>3.72</u>	<u>4.79</u>
	x	1.91	5.00	3.64	4.76
10.16	1	3.04	10.01	6.52	9.44
	2	<u>3.06</u>	<u>9.98</u>	<u>6.33</u>	<u>9.41</u>
	x	3.05	10.00	6.42	9.42

TABLE 6: CALCULATED CONCENTRATION (x/m) OF CGA-48988 IN SOIL, AS ug/g (ppm) AND AVERAGE FOR THE DUPLICATE SAMPLES AT EACH CONCENTRATION IN THE ADSORPTION PHASE OF THE STUDY. CONCENTRATION DETERMINED BY DIFFERENCE.

ORIGINAL TEST SOL. CONC.	REP	SOIL TYPE			
		MARYLAND CLAY	MARYLAND SAND	MISSISSIPPI LOAM	CALIFORNIA SANDY LOAM
0 ug/ml		0.0	0.0	0.0	0.0
0.21	1	0.584	0.040	0.172	0.082
	2	<u>0.581</u>	<u>0.031</u>	<u>0.173</u>	<u>0.102</u>
	x	0.582	0.036	0.172	0.092
0.52	1	1.42	0.086	0.450	0.158
	2	<u>1.42</u>	<u>0.116</u>	<u>0.426</u>	<u>0.149</u>
	x	1.42	0.101	0.438	0.154
1.03	1	2.82	0.177	0.899	0.405
	2	<u>2.67</u>	<u>0.194</u>	<u>0.914</u>	<u>0.432</u>
	x	2.74	0.186	0.906	0.418
5.13	1	15.99	0.568	7.80	1.96
	2	<u>16.01</u>	<u>0.700</u>	<u>7.00</u>	<u>1.68</u>
	x	16.00	0.643	7.40	1.82
10.16	1	33.64	0.734	18.20	3.49
	2	<u>35.44</u>	<u>0.865</u>	<u>18.78</u>	<u>3.67</u>
	x	34.54	0.800	18.49	3.58

TABLE 7: MEAN MEASURED CONCENTRATION (C_e) OF CGA-48988 IN SOLUTION AS $\mu\text{g/ml}$ (ppm) AND AVERAGE FOR THE DUPLICATE SAMPLES AT EACH CONCENTRATION IN THE DESORPTION PHASE OF THE STUDY.

		SOIL TYPE			
ORIGINAL ADSORPTION TEST SOL. CONC.	REP	MARYLAND CLAY	MARYLAND SAND	MISSISSIPPI LOAM	CALIFORNIA SANDY LOAM
0 $\mu\text{g/ml}$		0.0	0.0	0.0	0.0
0.21	1	0.0389	0.0024	0.0194	0.0080
	2	0.0385	0.0022	0.0203	0.0078
	x	0.0387	0.0023	0.0198	0.0079
0.52	1	0.0957	0.0063	0.0519	0.0170
	2	0.1010	0.0057	0.0518	0.0204
	x	0.0984	0.0060	0.0519	0.0186
1.03	1	0.206	0.0130	0.104	0.0392
	2	0.190	0.0117	0.102	0.0428
	x	0.198	0.0123	0.103	0.0410
5.13	1	1.02	0.0540	0.920	0.215
	2	1.04	0.0497	0.943	0.199
	x	1.03	0.0518	0.932	0.207
10.16	1	1.88	0.0944	2.44	0.503
	2	1.90	0.0959	2.35	0.550
	x	1.89	0.0952	2.40	0.526

TABLE 8: CALCULATED CONCENTRATION (x/m) OF CGA-48988 IN SOIL AS $\mu\text{g/g}$ (ppm) AND AVERAGE FOR THE DUPLICATE SAMPLES AT EACH CONCENTRATION IN THE DESCRIPTION PHASE OF THE STUDY. CONCENTRATION DETERMINED BY DIFFERENCE.

ORIGINAL ADSORPTION TEST SOL. CONC.	REP	SOIL TYPE			
		MARYLAND CLAY	MARYLAND SAND	MISSISSIPPI LOAM	CALIFORNIA SANDY LOAM
0 $\mu\text{g/ml}$		0.0	0.0	0.0	0.0
0.21	1	0.389	0.0279	0.0755	0.0428
	2	0.391	0.0208	0.0720	0.0637
	x	0.390	0.0244	0.0738	0.0532
0.52	1	0.941	0.546	0.193	0.0730
	2	0.907	0.879	0.168	0.0489
	x	0.924	0.712	0.180	0.0609
1.03	1	1.80	0.112	0.380	0.215
	2	1.78	0.135	0.412	0.223
	x	1.79	0.124	0.396	0.219
5.13	1	10.90	0.299	3.20	0.892
	2	10.85	0.451	2.32	0.710
	x	10.88	0.375	2.76	0.801
10.16	1	24.73	0.269	5.95	1.017
	2	25.95	0.393	7.23	0.971
	x	25.34	0.331	6.59	0.994

TABLE 9: LINEAR REGRESSION ANALYSIS OF THE ADSORPTION DATA USING THE FREUNDLICH ISOHERM ($\ln x/m = \ln K_d + 1/n \ln C_e$) FOR CGA-48988 WITH 4 SOIL TYPES.

ORIGINAL TEST SOL. CONC.	SOIL TYPE							
	MARYLAND CLAY		MARYLAND SAND		MISSISSIPPI LOAM		CALIFORNIA SANDY LOAM	
	$\ln C_e$	$\ln x/m$	$\ln C_e$	$\ln x/m$	$\ln C_e$	$\ln x/m$	$\ln C_e$	$\ln x/m$
0.21 ug/ml	-2.385	-0.541	-1.599	-3.352	-1.745	-1.757	-1.658	-2.384
0.52	-1.454	0.349	-0.701	-2.302	-0.848	-0.825	-0.723	-1.873
1.03	-0.774	1.010	-0.005	-1.686	-0.163	-0.097	-0.056	-0.871
5.13	0.646	2.772	1.611	-0.442	1.294	2.001	1.561	0.598
10.16	1.114	3.513	2.302	-0.223	1.861	2.917	2.243	1.274
Correlation	0.9967		0.9895		0.9964		0.9951	
Slope (1/n)	1.157		0.795		1.306		0.968	
Intercept	2.081		-1.853		0.344		-0.916	
n	0.8642		1.257		0.766		1.033	
K_d	8.012		0.157		1.410		0.400	
K_{oc}	283.8		29.6		199.8		136.1	
% O.C.	2.823		0.529		0.706		0.294	

% O.C. = % Organic Carbon = % Organic Matter / 1.7

$K_{oc} = (K_d \times 100) / \% \text{ O.C.}$

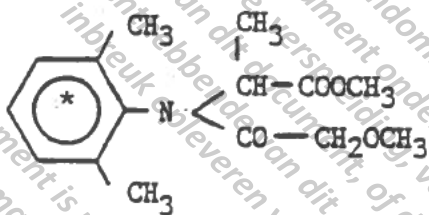
TABLE 10: LINEAR REGRESSION ANALYSIS OF THE DESORPTION DATA USING THE FREUNDLICH ISOTHERM ($\ln x/m = \ln K_d + 1/n \ln C_e$) FOR CGA-48988 WITH 4 SOIL TYPES.

ORIGINAL TEST SOL. CONC.	SOIL TYPE							
	MARYLAND CLAY		MARYLAND SAND		MISSISSIPPI LOAM		CALIFORNIA SANDY LOAM	
	$\ln C_e$	$\ln x/m$	$\ln C_e$	$\ln x/m$	$\ln C_e$	$\ln x/m$	$\ln C_e$	$\ln x/m$
0.21 ug/ml	-3.251	-0.9441	-6.083	-3.716	-3.917	-2.607	-4.841	-2.933
0.52	-2.319	-0.0790	-5.119	-2.641	-2.960	-1.713	-3.982	-2.798
1.03	-1.617	0.5824	-4.393	-2.091	-2.272	-0.927	-3.194	-1.517
5.13	0.0320	2.3870	-2.960	-0.979	-0.070	1.015	-1.575	-0.222
10.16	0.6328	3.232	-2.352	-1.106	0.8748	1.885	-0.642	-0.006
Correlation	0.9981		0.9737		0.9994		0.9745	
Slope (1/n)	1.068		0.721		0.934		0.780	
Intercept	2.429		0.909		1.090		0.724	
n	0.936		1.386		1.070		1.282	
K_d	11.346		2.482		2.975		2.064	
K_{oc}	401.9		469.2		421.4		702.0	
% O.C.	2.823		0.529		0.706		0.294	

% O.C. = % Organic Carbon = % Organic Matter / 1.7

$K_{oc} = (K_d \times 100) / \% O.C.$

FIGURE 1: STRUCTURE OF METALAXYL



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FIGURE 2: GRAPHIC PLOTS OF THE ADSORPTION FREUNDLICH ISOTHERMS FOR CALIFORNIA SANDY LOAM AND MARYLAND CLAY

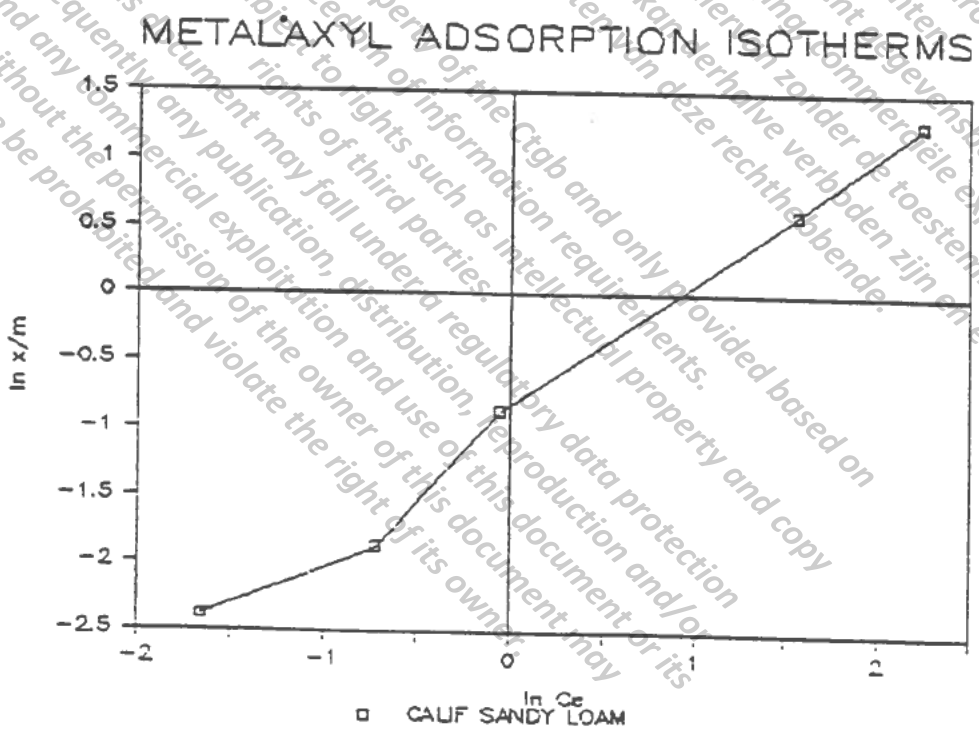
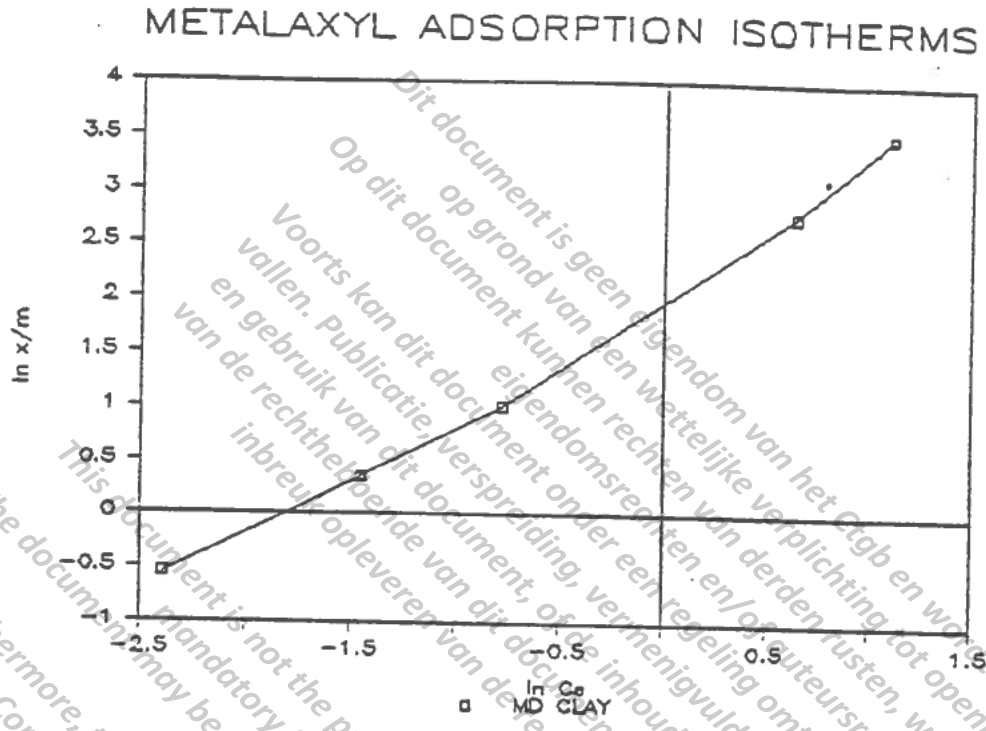
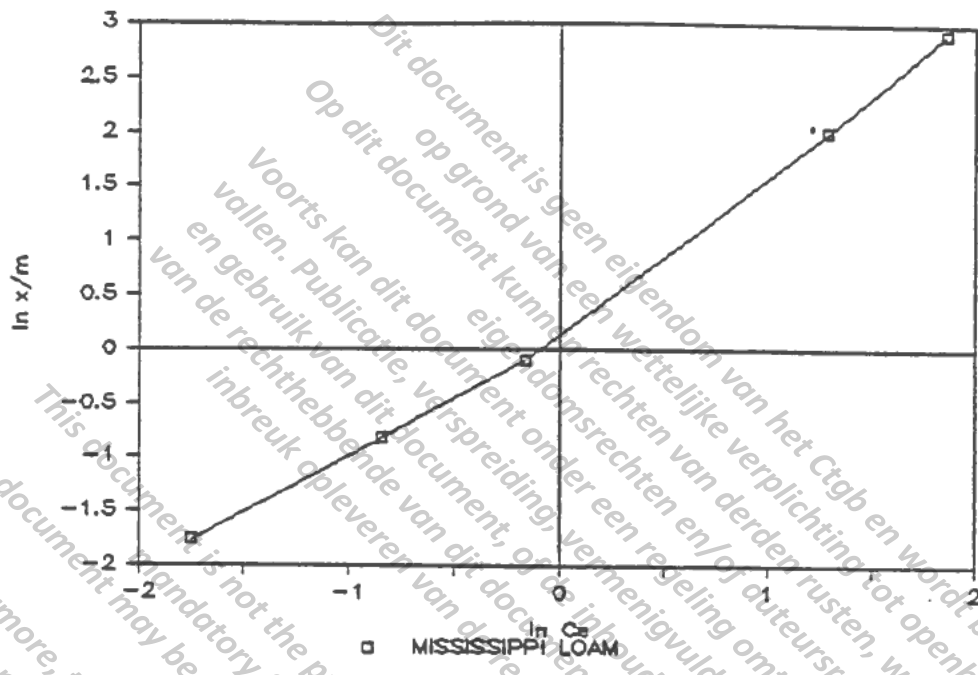


FIGURE 2 (CONT): GRAPHIC PLOTS OF THE ADSORPTION FREUNDLICH ISOTHERMS FOR MISSISSIPPI LOAM AND MARYLAND SAND

METALAXYL ADSORPTION ISOTHERMS



METALAXYL ADSORPTION ISOTHERMS

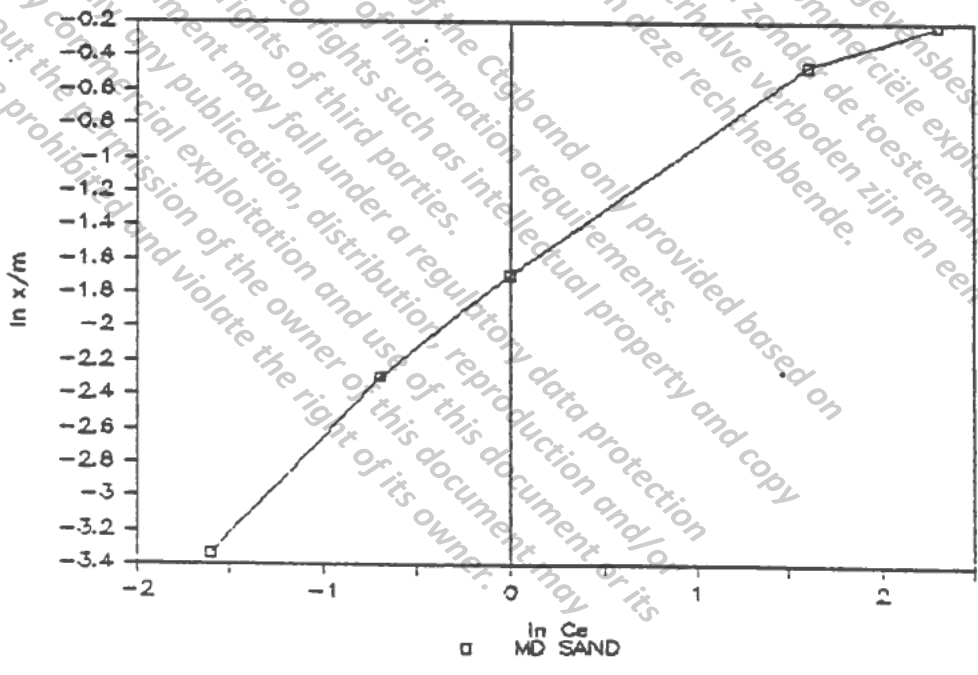


FIGURE 3: GRAPHIC PLOTS OF THE DESORPTION FREUNDLICH ISOTHERMS FOR CALIFORNIA SANDY LOAM AND MARYLAND CLAY

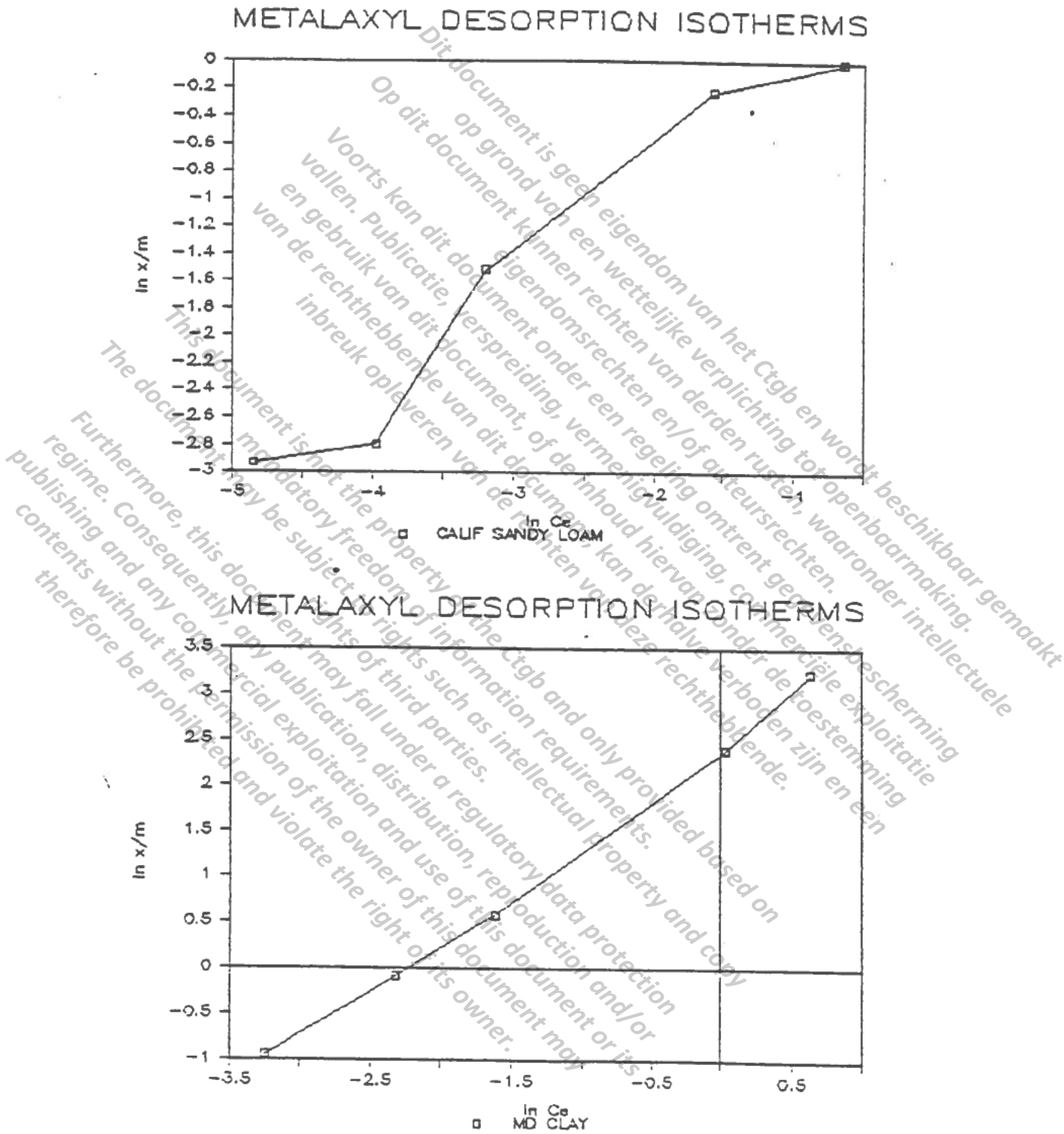


FIGURE 3 (CONT): GRAPHIC PLOTS OF THE DESORPTION FREUNDLICH ISOTHERMS FOR MISSISSIPPI LOAM AND MARYLAND SAND

