MITSUBISHI MONSANTO CHEMICAL COMPANY

FROM LOCATION : Tokyo

DATE : December 6, 1971

SUBJECT : GASCHROMATOGRAPHY ANALYTICAL PROCEDURE FOR AROCHLOR AT MMK

REFERENCE :

TO : Dr. R. S. Tucker
St. Louis

cc Messrs.
R. E. Keller-St. Louis
W. B. Papageorge "
E. P. Wheeler- "
CC: Ralph Muench

During our recent stay in St. Louis Mr. Katayama and I had discussions with you on details of your research subjects. Your comments given us were very informative and useful to us.

Enclosed is a report prepared by Mr. Uragami, Yokkaichi R & D, on details of MMK's gaschromatography analytical procedure for Arochlor according to your request made at the time of our discussions.

We are also forwarding you, as requested, by air a sample of low chlorine content biphenyl test-produced at Yokkaichi (temporarily called "Arochlor-2000) together with a sample of Kaneka's KC-400 (tetrachlorobiphenyl) for your study to find out whether or not tetrachlorodioxane or chloro-dibenzofurane is contained in it.

Please review of the above-materials as well as our analytical procedure and let us have your comments.

Best regards.

S. Uneno

S. Uneno
Product Director
Division C

MM:ri

Date : November 29, 1971

Subject: ON ANALYTICAL METHOD FOR AROCLOR

cc: Messrs.
*R. E. Keller-St. Louis
W. B. Papageorge "
E. P. Wheeler- "

To : Dr. R. S. Tucker*
St. Louis

We hear that when Messrs. Ueno and Katayama discussed with you the components of Aroclor during their stay in the States, you found some differences between MC and MMK in the identification of GLC peaks. Therefore I would like to explain to you our method of determining component names of GLC peaks.

Messrs. Arasaki and Yamamoto were trained at Mr. G. W. Miller's Lab. in Anniston four years ago. At that time, they received a set of information as attached("Information 1"). And Dr. R. H. Munch sent us a letter describing GLC analytical method for Aroclor(attached information 2). It does not appear that there is any inconsistency in these two methods. So, we are using these two pieces of information as basic data for identification of our GLC peaks.

In our GLC diagram, however, we find peaks which do not appear in Mr. Miller's and Dr. Munch's diagrams. For instance, the peaks 10, 14, 16 and 22 appear in our GLC diagram, but not in MC's diagram. Attached "Information 3" shows MMK peak numbers that correspond respectively to MC peak numbers. I do not think the difference is so important. Attached "Information 4" shows the physical and electrical properties and chemical composition of our test product named temporarily "Aroclor 2000 " .

SIGNED

M. Uragami

* Encl.

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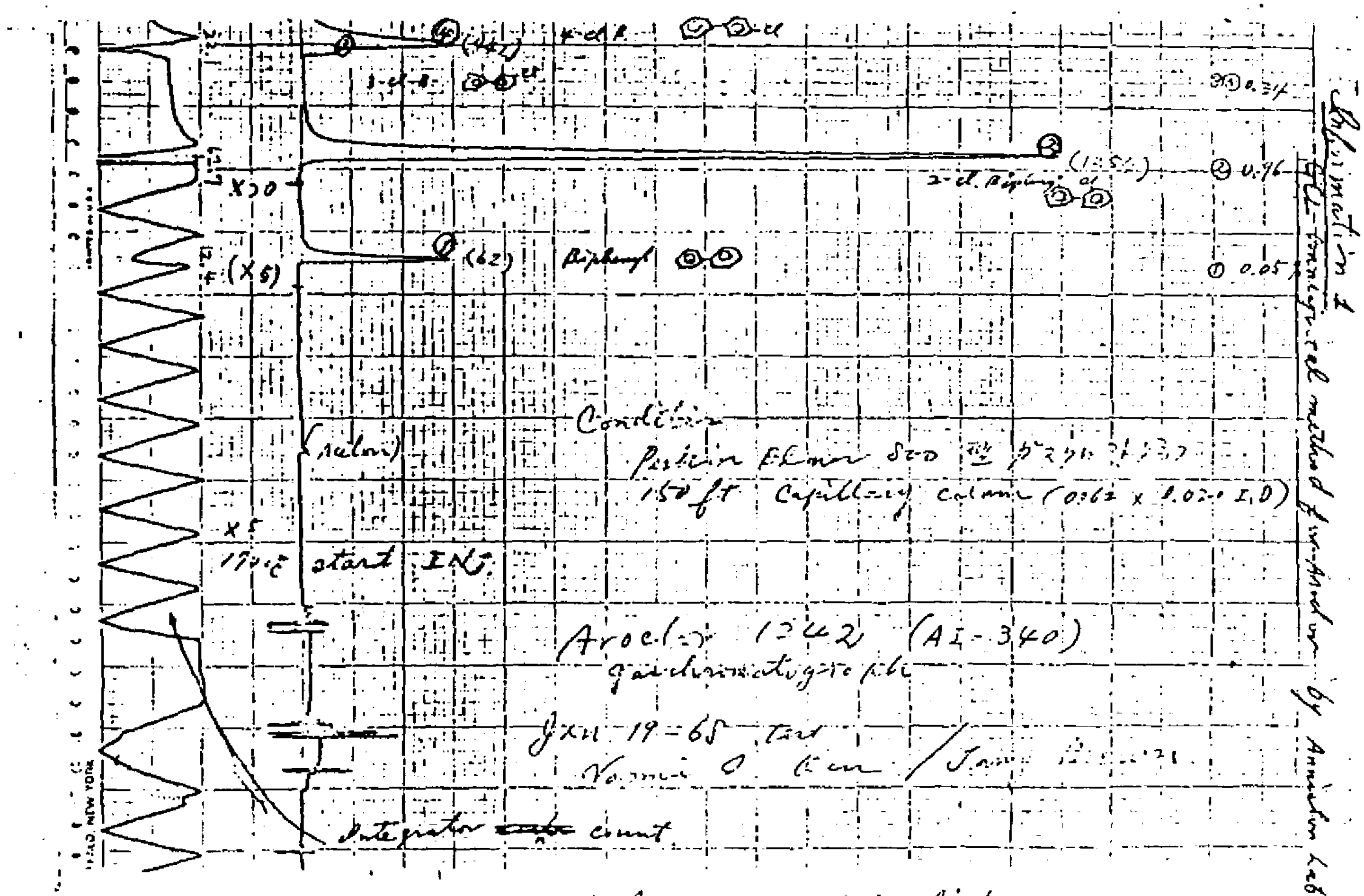
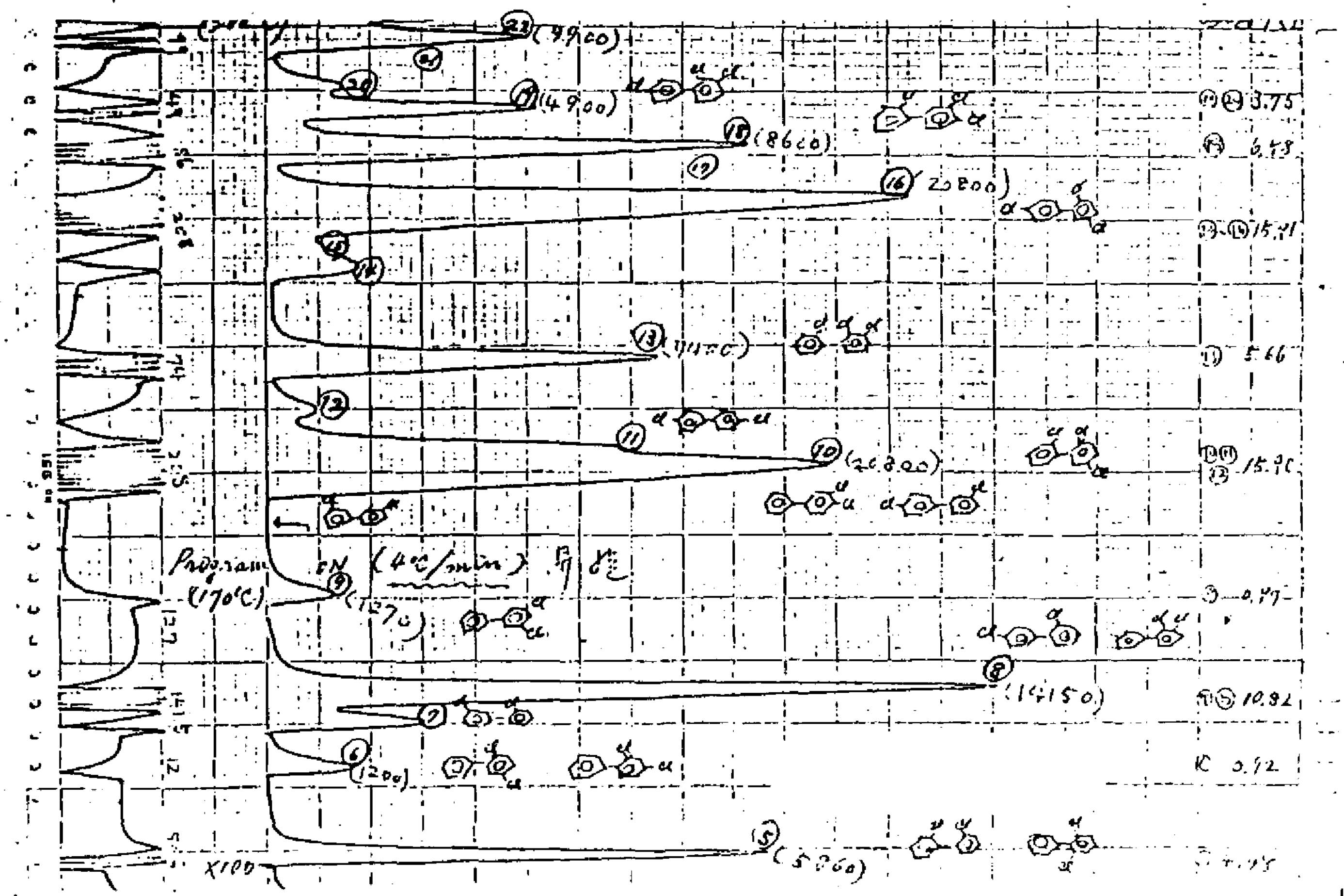


1968年1月19日 [illegible] Anniston plant [illegible]
Instructor [illegible] Mr. G.W. Miller

MONS 205939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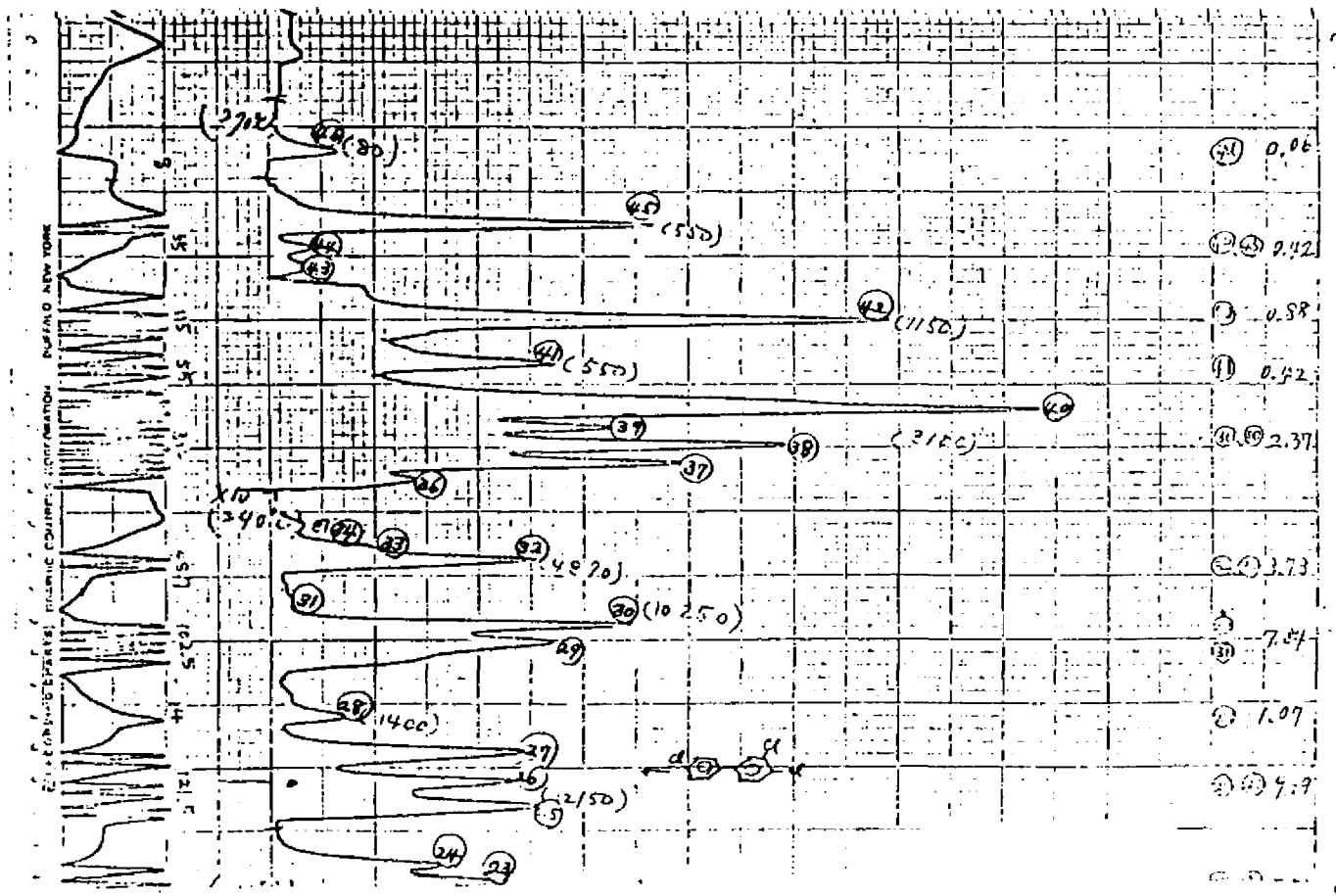
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X10
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0.06
0.42
0.88
0.52
2.37
3.73
7.54
1.07
4.9

MONS 205941

7 1968年9月5日付 Munch書簡より 4

(1968年1月来日/[illegible]がアメリカで[illegible]した分析法に一致する)

Monsanto *Information*

FROM (NAME & LOCATION): R. H. Munch - St. Louis Organic Research - South Second Street

DATE	September 5, 1968	cc	W. R. Richard	WRICH
SUBJECT	ANALYTICAL METHODS FOR AROCLORS		P. G. Benignus	PBENI
REFERENCE			J. R. Durland	Tokyo
			S. Satoh	Tokyo

TO : T. Katayama
Tokyo (MMK)

[illegible]

COMPANY CONFIDENTIAL

When you were here last February, we agreed to furnish details of the gas chromatographic method we use for determining the amounts of the various individual isomers and homologs present in Aroclor 1242, chlorobenzenes and chlorinated naphthalene. Our Analytical Group has now completed the work of testing the method on all these materials.

Attached is a copy of the basic method for "Gas Chromatographic Determination of the Distribution of Isomers in Aroclor 1242, Chlorinated Benzene, Chlorinated Naphthalene and Mixtures of the Three." In addition, there are copies of pages from one of our reports describing the procedure for preparing the silicone gum rubber coated capillary columns used in the analysis and an article entitled, "Application of On-Column Injection to Open Tubular Columns: Instrument Modifications for On-Column Injection."

We are sending you separately a freshly prepared silicone gum rubber capillary column of the type used in the method. Along with it are four small samples of materials which we have analyzed by the method. These are trichlorobenzene, Halowax 1000, Aroclor 1242 and a mixture of all three of these. Analyses of these samples are given in the method.

Along with the method we are also sending an original record of the gas chromatogram of the trichlorobenzene, Halowax, Aroclor 1242 mixture run using the capillary column being sent to you.

With the information and the column we are sending you along with a suitable gas chromatograph, you should be able to analyze the samples we are sending and check your results against those given in our method.

We trust that this will fill all your needs for the analysis of mixtures of halogenated aromatic materials for use in electrical applications.

Please note that this method should not be given to anyone outside Monsanto without our permission.

R. H. Munch

R. H. Munch

jp

Attachments

MONS 205942

GAS CHROMATOGRAPHIC DETERMINATION OF THE DISTRIBUTION OF ISOMERS IN AROCLOR 1242, CHLORINATED BENZENE, CHLORINATED NAPHTHALENE AND MIXTURES OF THE THREE

PURPOSE OF ANALYSIS

To determine the isomer distribution in samples of Aroclor 1242, chlorinated benzene and chlorinated naphthalene. Mixtures of the three can also be chromatographed, but some of the peaks overlap one another.

CHROMATOGRAPHIC CONDITIONS

Instrument: F&M Model 5756B with Infotronics CRS-100U Integrator

Type Detector: Flame Ionization

Column: 0.02" I.D. X 200' SE-52 Silicone Rubber Gum Stainless Steel Capillary

Column Temperature: 225°C

Detector Block Temperature: 350°C

Injection Port Temperature: 290°C

Sample Volume Injected: 0.05 ul onto an "On Column" Insert (Ref. J. of GC, Aug. 1967, p.435)

Flow Rates

Helium: 12.5 ml/min.

Auxiliary Helium: 37.5 ml/min.

Hydrogen: 40 ml/min.

Air: 500 ml/min.

COMMENTS: To achieve better resolution of components in chlorinated benzenes and chlorinated naphthalenes, the column can be operated at 175°C isothermally. This temperature (175°C) is too low for Aroclor 1242 or mixtures containing Aroclor 1242.

Integration of the area under the peaks was carried out by using an Infotronics CRS-100U integrator. The settings are below.

Digital Filtering - 20 cts.

Output - Auto., X1

Baseline Tracking - 60 μv/min. UP, 200 μv/min. DOWN

Threshold Level - 100 μv.

Input Noise Rejection - 4

Peak Rate - 10 sec/peak

Slope Sensitivity - 2

RETENTION TIMES (UNCORRECTED) FOR COMPOUNDS SEPARATED (CHROMATOGRAMS ATTACHED)

See Table I - attached.

CALCULATION TECHNIQUE

Normalization with no calibration factors applies. Results reported in area per cent.

ACCURACY

No estimation of accuracy was made. The variability of a single GC analysis at the 95% confidence limits is usually ±1.5 to 2% of the amount present. An electronic integrator reduces the variability by about a factor of two.

W. M. Mees 8/68

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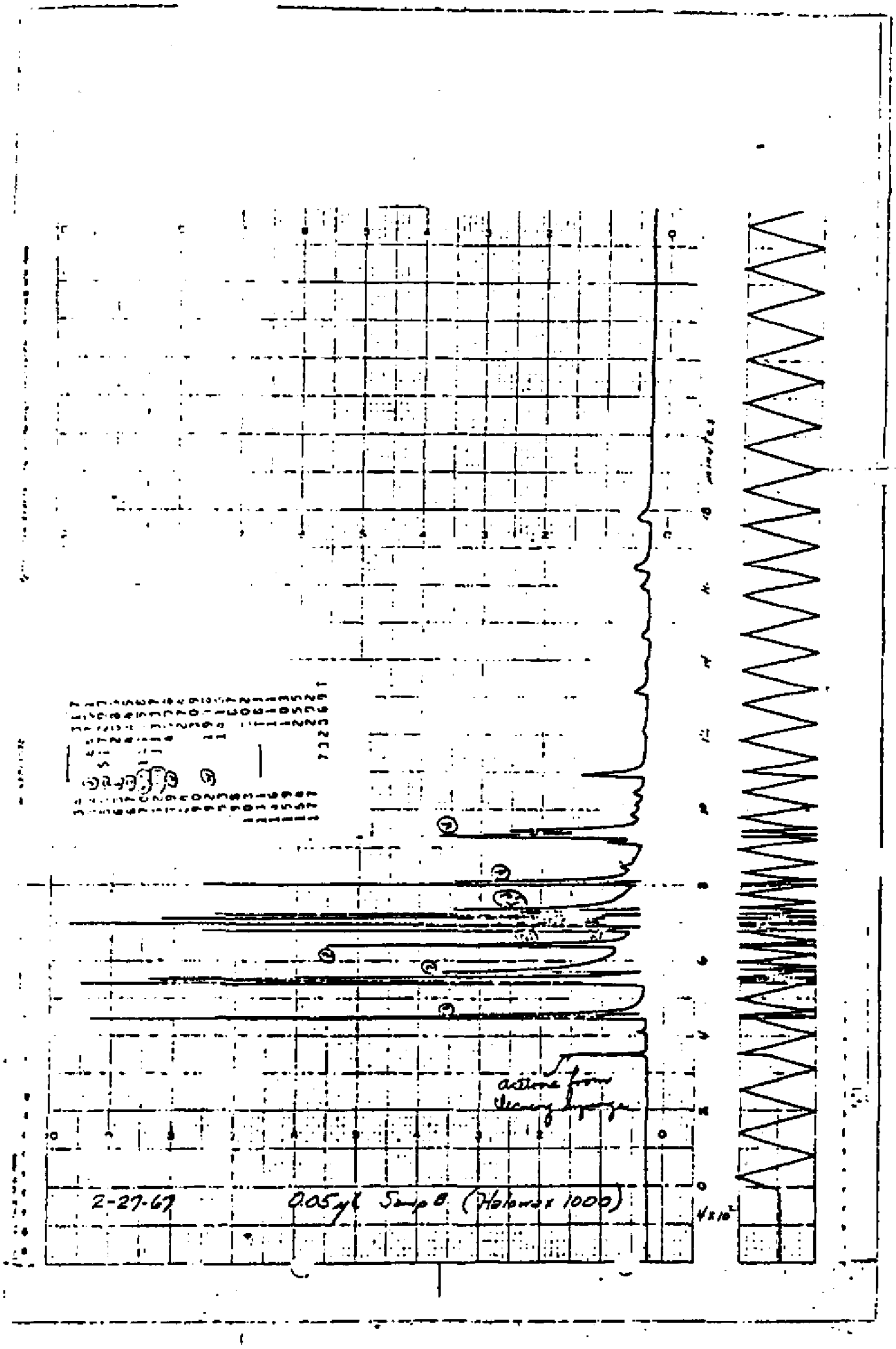
TABLE I

Compounds Separated (See Attached Chromatograms)

	Sample	#6	#2	#8
A	benzene	—	0.2	
B	chloro benzene	—	0.3	
C	p-dichloro benzene	0.2	0.8	
D	m-dichloro benzene	}0.3	}1.1	
E	o-dichloro benzene			
F	not used	—		
G	not used	—		
H	1,3,5 trichlorobenzene	0.1	0.1	
I	1,2,4 Trichlorobenzene	11.3	72.0	
J	naphthalene	2.5		6.2
K	1,2,3 trichlorobenzene	4.1	23.7	
L	1,2,4,5 tetrachlorobenzene	0.2	0.8	
M	1,2,3,4 tetrachlorobenzene	}23.4	0.9	
	not used			
#1	biphenyl			
O	α, β chloronaphthalene			71.4
#2	o-chlorobiphenyl	0.1		
P		0.2		0.3
#3	m-chlorobiphenyl	—		
#4	p-chlorobiphenyl	—		
Q		0.2		0.6
R		}7.4		15.2
S				1.9
T		}0.5		1.9
U				1.4
#5	2,2' or 2,6 dichloro biphenyl	1.5		
V		0.2		0.5
#6	2,5 & 2,4 dichloro biphenyl	0.2		
#7	2,3' dichloro biphenyl	0.5		
	2,4' & 2,3 dichloro biphenyl	3.1		
#8		0.5		
W		0.2		0.2
X	not used	—		
Y	not used	—		
Z	not used	—		
#10	3,4; 3,4' dichlorobiphenyl	5.2		
11	4,4' dichlorobiphenyl	2.0		
12		0.4		
13	2,3,2' trichloro biphenyl	3.0		
14		0.7		
15		0.2		
16	2,5,4' trichloro biphenyl	4.1		
17		3.1		
18	3,4,2' trichloro biphenyl	3.5		
19	2,3,4 trichloro biphenyl	1.6		
20		0.4		
21		—		
22		1.4		

	Sample	#[illegible]
23		[illegible]
24		[illegible]
25		[illegible]
26	3,4,4' trichlorobiphenyl	[illegible]
27		[illegible]
28	↓ mixed with [illegible]	}[illegible]
29	[illegible]	
30		—
31		[illegible]
32		[illegible]
33		[illegible]
34		—
35		}[illegible]
36		
37		—
38		—
39		—
40		0.1
41		[illegible]
42		—
43		[illegible]
44		—
45		—
46		—
47		—
48		0.1
49		—
50		—
51		—
52		—

Peak identification and the amounts present on enclosed chromatograms.



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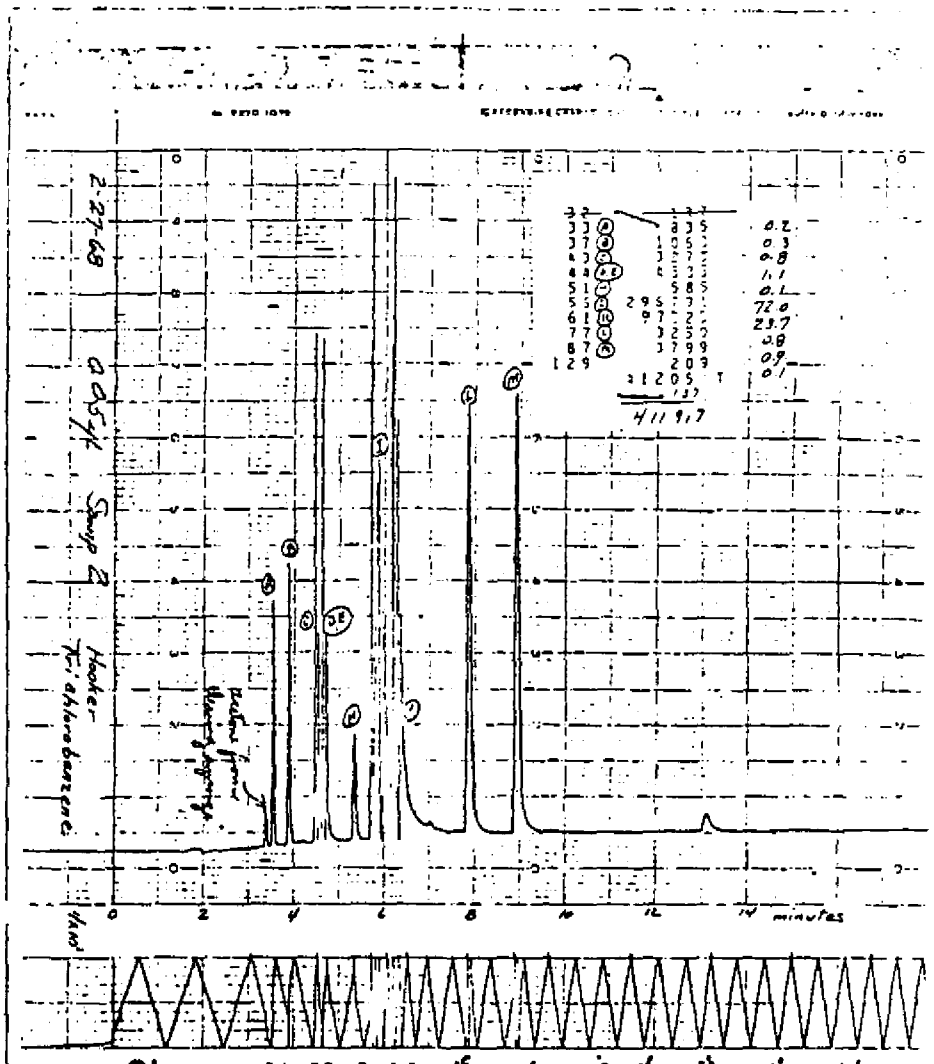

Strange appearance of peaks is due to automatic attenuator on Infotronics CRS 100

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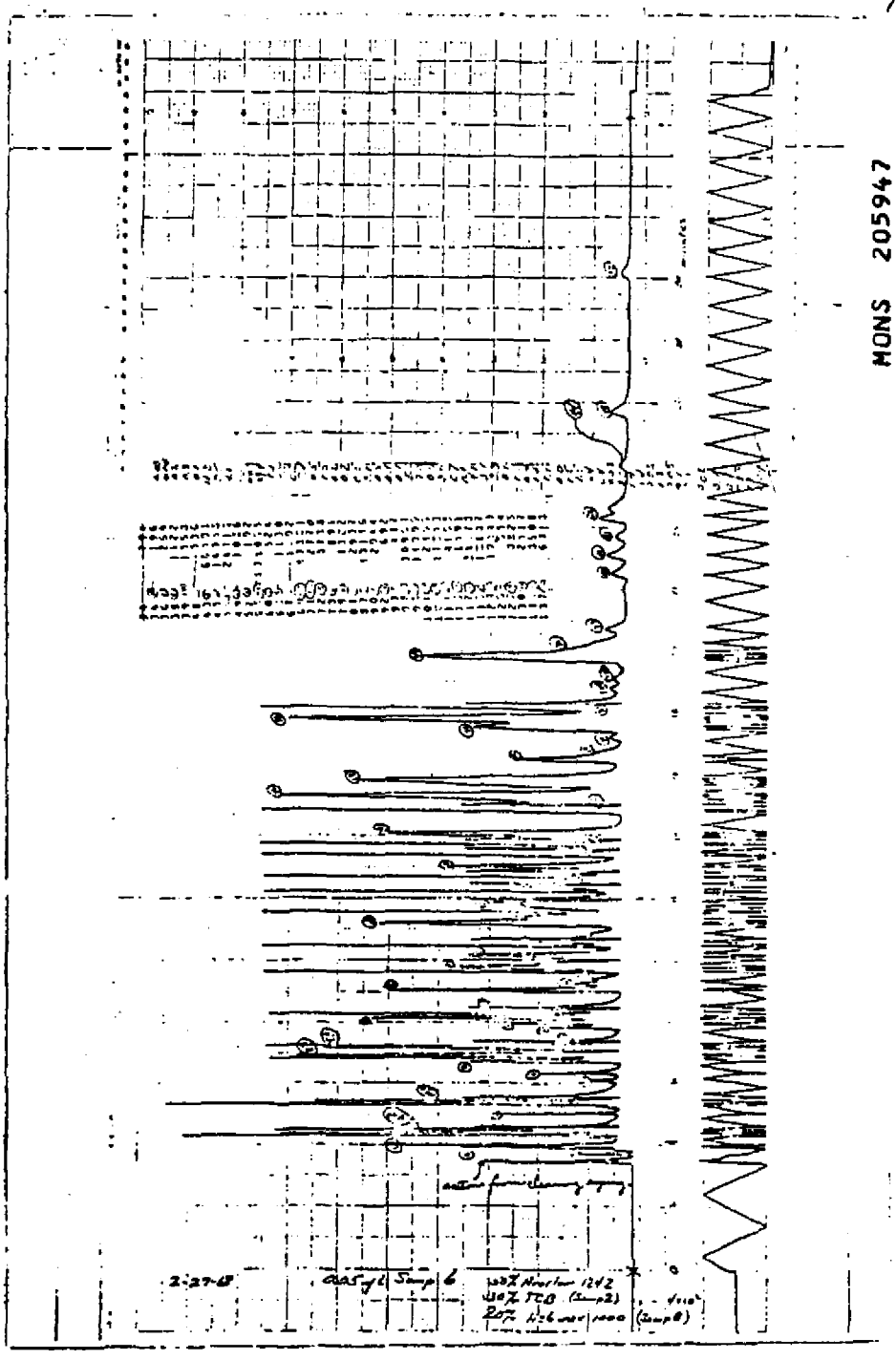

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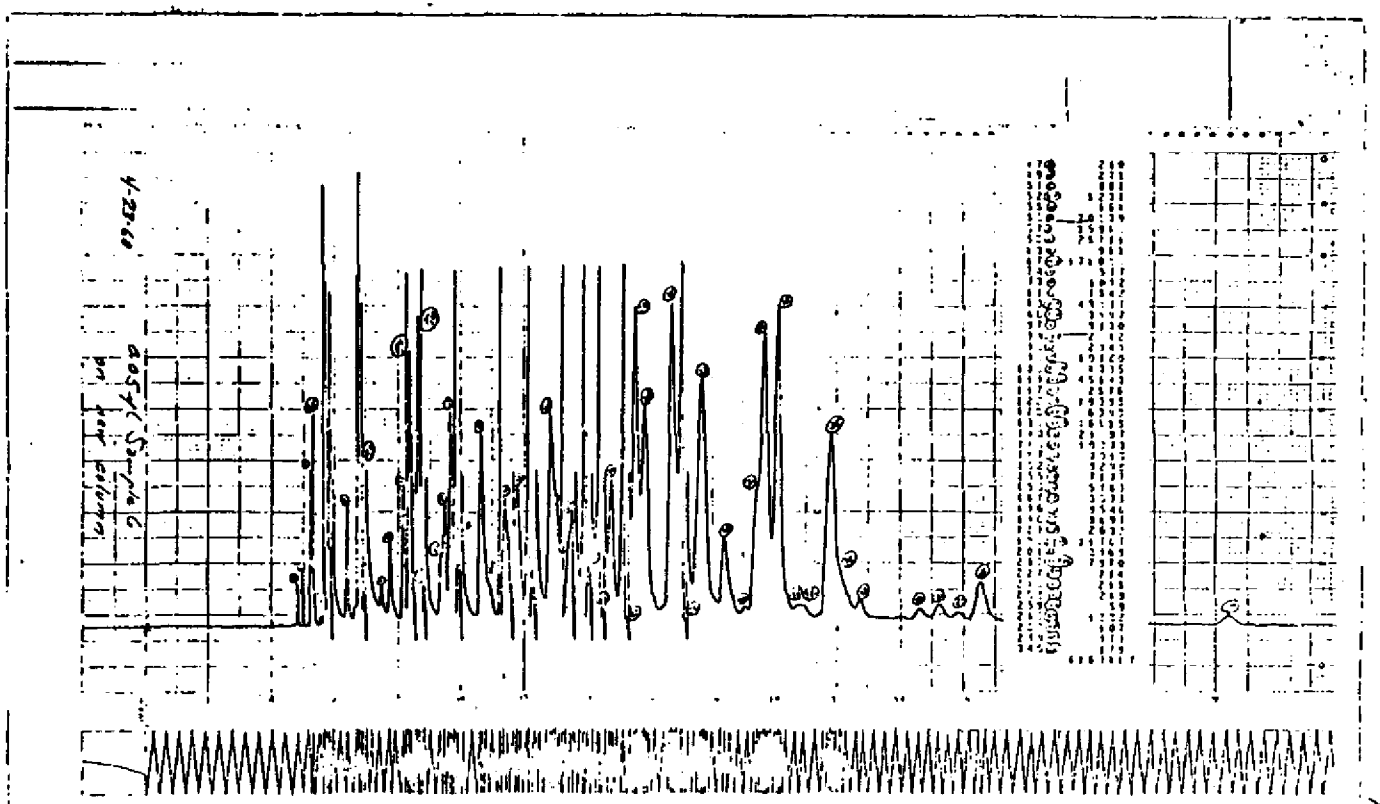

MONS 205949

Application of On-Column Injection to Open Tubular Columns: Instrument Modification for On-Column Injection

by D. Willis and R. M. Engelbrecht, Monsanto Company, St. Louis, Missouri

Abstract

A modified injector insert for the F and M Model 810 gas chromatograph is described permitting on-column injection into open-tubular columns. The insert is simple to fabricate and requires no major modification in the pneumatic system of the instrument. A chromatogram is given to illustrate application of the insert to the analysis of wide boiling range hydrocarbon mixtures.

The use of wide-diameter open tubular columns has adequately demonstrated the ability of these columns to handle samples up to 20 μl. with high efficiency (1-6). The loss in useful resolution in going from 0.01-inch to 0.02 or 0.03-inch i.d. columns is often more than off-set by other practical considerations: more rapid establishment of flows, decreased pressure drop, more versatility of operation, and applications with other than ionization detectors.

A modified insert for the F and M Model 810 gas chromatograph has been built and tested with 0.02-inch and 0.03-inch i.d. open tubular columns. With this injector insert and small-volume Hamilton syringes it is possible to achieve direct on-column applications of samples. While designed specifically for the F and M 810, the insert design could readily be adapted to other instruments.

Experimental

The injector insert design is shown in Figure 1. A 1-inch length of ¼-inch o.d. tubing (or drilled out rod) is fitted snugly to one end of a 10-inch length of ¼-inch o.d. x 0.03-inch i.d. tubing. The large end of the tube is tapered and polished. The tube must be straight and no pitting must occur at the line joining the ¼-inch and ⅛-inch tubes. This insert is fitted in the injection port with a Swagelok ¼-inch to ⅛-inch reducing union which has been bored through with a ⅛-inch drill. A 1-inch length of ¼-inch tubing with two sets of ferrules seated back to back is used to provide a gas-tight seal. Column connection is with a Swagelok ⅛-inch to 1/16-inch reducing union. In fitting the insert in the injection port, allowance must be made for the linear expansion of the insert in order to prevent cutting off the carrier gas flow by expansion of the insert against the septum.

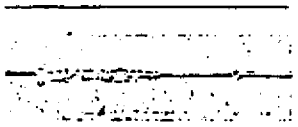

Figure 1. On-column injector insert.

The column used in the present evaluation was a 200-foot x 0.03-inch i.d. SE-52 column coated from 3% solution in n-hexane. (Applications with other columns will be reported in future publications.)

After coating, the column was conditioned overnight at 300°C with helium flowing through the columns. The tubing used was Handy and Harmon 316 stainless steel, 10-32 microfinish, annealed to a bright finish.

The instrument used was the F and M Model 810, with dual flame ionization detectors and a 1 mv. Honeywell Model 15 recorder with 1 second full-scale pen response. All gases were passed through silica gel scrubbers before entering the instrument. The dead volume in the flame ionization detector was minimized by the use of a ¼-inch to 1/16-inch adapter which permitted the column effluent to be fed to the flame base. No changes were made in the pneumatic system of the instrument.

Discussion

Although the larger-bore open tubular column was used in the present study, flow rate used was lower than normally used for 0.02-inch i.d. columns and was in the range to yield maximum efficiency (2). It is felt that flow-rate and temperature of operation could be adjusted for use with thermal conductivity detectors, or a make-up gas could be added at the column exit to reduce the effective volume of the thermal conductivity detector.

Figure 2 is a chromatogram of a synthetic aromatic boiling point mixture analyzed on the SE-52 capillary column programmed from 60°C to 270°C at 10° per minute and illustrates the application of this column to the analysis of high-boiling components with capillary efficiency. The mixture contained aromatics boiling from 80°C (benzene) to 452°C (2,2'-binaphthyl) (see Table I). The retention time for 2,2'-binaphthyl is ca. 29 minutes: this can be reduced to 25 minutes by programming from 100°C to 270°C at 10°C per minute with virtually complete resolution of all other components in the mixture. This column gives boiling point resolution and will not resolve compounds boiling less than 1-2° apart.

e.g., o-xylene and styrene.

The sample size used has been 0.05 to 0.1 μl injection with a 0.5 or 1.0 μl Hamilton syringe. With this size sample it was possible to use range 10^9 (100 megohm input resistor) at attenuations of x8 to x32 with improved signal to noise ratio.

The insert and technique described technically do not fulfill the requirements for "on-column" injection since the sample is not placed directly on the coated portion of the column. From a practical standpoint, injection is virtually on-column; the slight tailing observed with the aromatic separation may be due to adsorption in the liner. The use of the insert design with instruments having different oven geometry should permit injection of the sample on the coated portion of the column.

The injection port temperature for the chromatogram shown was 250°C. Analysis of a sample with this wide a boiling point range would have required a much higher temperature on the injection system to insure representative sampling if a splitting device had been used. Use of the high temperature on the splitter prevents accurate control of oven temperature at the beginning of a programmed temperature analysis. As a result, retention times of components will vary from run to run, preventing component identification by comparison of retention times.

The use of the insert described in this paper has several advantages over conventional splitting techniques. More rapid establishment of analytical conditions is possible since only the column flow must be adjusted. Application to flow programming should be possible as well as use for trace analysis. The larger sample sizes permit rapid scan mass spectrometric analysis of the column effluent to be made with high sensitivity to even minor components. No major instrument modifications are required, permitting rapid conversion from packed to open tubular columns as may be required by use of the appropriate reducing union without removal of the insert.

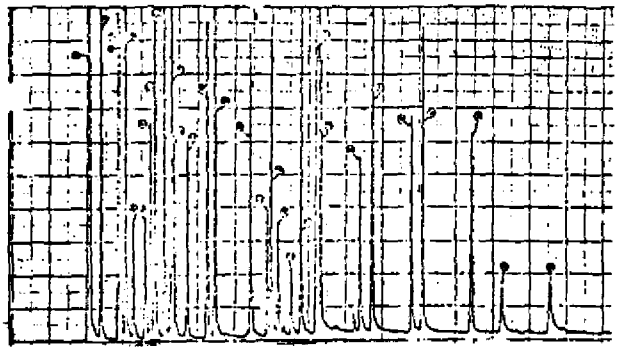

Figure 2. Chromatogram of Synthetic Aromatic Blend on SE-52 Column

Conditions:
Sample size—0.1 μl
Temperature—60°C to 270°C at 10° per minute
Helium flow—6 ml per minute
Hydrogen flow—30 ml per minute
Air flow—300 ml per minute
Detector temperature—320°C
Range — 10^9 Attenuation — x16

Table I. Identification of Components in Aromatic Blend

1	Benzene	18	1-Methylnaphthalene
2	Toluene	19	Biphenyl
3	Ethylbenzene	20	1 + 2-Ethylnaphthalene
4	m- + p-Xylene	21	1,6-Dimethylnaphthalene
5	o-Xylene	22	1,8-Dimethylnaphthalene
6	1-Propylbenzene	23	Bibenzyl
9	m- + p-Ethyltoluene	24	4,4'-Dimethylbiphenyl
10	o-Ethyltoluene	25	Fluorene
11	1,2,4-Trimethylbenzene	26	1-Phenylnaphthalene
12	1,2,3-Trimethylbenzene	28	Anthracene
13	Indene	29	Fluoranthene
14	n-Butylbenzene	30	Pyrene
15	Decalin	31	1,1'-Binaphthyl
16	Tetralin	32	Chrysene
17	Naphthalene	33	2,2'-Binaphthyl

Acknowledgments

The authors wish to acknowledge the contributions of R. C. Brushwitz in the design and testing of the insert.

Literature Cited

1. Ettre, L. S., Cieplinski, E. W., and Averiff, W., J. Gas Chromatog. 1, No. 2, 7 (1963).
2. Jentzsch, D., and Hoverman, W., J. Chromatog. 11, 440 (1963).
3. Quirem, E. R., Anal. Chem. 35, 593 (1963).
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Manuscript received May 18, 1966

Revised manuscript received July 23, 1966

Louis Res. Report No. 3244, [illegible] Gas Chromatography - 1964; [illegible]

III. EXPERIMENTAL WORK AND DISCUSSION (cont'd.)

B. Auxiliary Injection Block for an F&M Model 1609 or Model 609 Gas Chromatograph (cont'd.)

Connect the thermocouple to a pyrometer and the cartridge heater to a Variac. Install a column using the 1/4" Swagelok fitting on the rear of the auxiliary block for the inlet end of the column and the regular outlet connection for the other end of the column. Place the regular column oven lid over the column resting on top of the transite pipe. Turn on the Variac connected to the 75 watt cartridge heater and heat the auxiliary injection block by adjusting the Variac settings until the desired temperature is obtained. Then proceed to use the instrument as usual, except pushing the syringe needle through the center of the auxiliary injection block septum and into the center of the metal insert before depressing the syringe plunger to inject the sample.

The metal insert can be replaced as often as found necessary with the particular sampling being analyzed. To replace the metal insert, remove the injection nut and septum using a 9/16" deep socket. Insert a screw driver through the opening and unscrew the metal insert. Using a piece of 1/16" stainless steel rod which has been bent over sharply and filed down to form a sharp hook on the end, pull the metal insert out to a point where a pair of pliers can be used to completely remove the insert from the block. Put another metal insert with small glass wool plug at both ends into the opening, push it in and screw it down with the screw driver. Replace the septum and injection nut.

C. Silicone Gum Rubber Capillary Columns

In the past, we were not able to make consistent capillary columns coated with silicone gum rubber from Superior Tubing Company 316 stainless steel capillary tubing (1/16" O.D. X 0.020" I.D.). However, three consecutive successful columns were made in the spring of 1964 by using 316 stainless steel capillary tubing purchased in two different orders from Handy & Harmon Tube Co., Inc., P.O. Box 549, Norristown, Pennsylvania. In both orders, the tubing was specified as 1/16" O.D. X 0.020" I.D., ground to a 15-20 micro finish and annealed to a bright finish. The price was $37 per 100' in 200' quantitites.

One 150' length and two 200' lengths of this tubing were successfully coated with SE-52 as follows: Each length of tubing was cleaned by passing through it three 10 ml. portions of methanol followed by one 10 ml. portion of n-hexane followed by three 10 ml. portions of methanol followed by one 10 ml. portion of n-hexane. Then 10 ml. of a 3 w/v per cent solution of SE-52 in n-hexane was

III. EXPERIMENTAL WORK AND DISCUSSION (cont'd.)

C. Silicone Gum Rubber Capillary Columns (cont'd.)

pushed through the tubing under 100 psig. nitrogen pressure followed by one hour of flushing with nitrogen at room temperature under the same pressure. The column was then conditioned overnight at 210°C. under 10 psig. nitrogen pressure.

All three columns performed with excellent resolution at about 230°C. for the analysis of Aroclor chlorinated biphenyl isomers and HB-40 hydrogenated terphenyl isomer mixtures.

D. Pyrolysis-Gas Chromatography Technique

Materials which would normally not exert sufficient vapor pressure for an analysis by gas chromatography can be analyzed by attaching a pyrolysis unit directly to the injection block of a gas chromatograph. A quartz tube, flash pyrolysis furnace, similar to the one described by Mrs. K. Ettre and Mr. P. F. Varadi in Analytical Chemistry 35, 69-73 (January, 1963), has been constructed and successfully demonstrated. The unit does not include a gas sampling valve as does the unit described in the reference paper, thus eliminating a source of cold spots where high boiling pyrolysis products could condense.

Since the samples are placed in a small COORS porcelain combustion boat, both liquid and solid samples can be handled. Very small sample sizes (about 2 mg) should be used to reduce the possibility of secondary recombination of pyrolysis fragments.

All of our work to date has been qualitative rather than quantitative. The technique is very reproducible qualitatively. If two pyrograms are placed on a light box and lined up so the starting points are overlaid, the retention times correspond, the peak areas superimpose, and the peak heights vary with the sample size.

An additional plus feature of the laboratory constructed unit is that it will fit on the inlet of any gas chromatograph. The unit is connected to the injection block of the gas chromatograph by means of a 2" section of 20 gauge needle stock which has a diagonal cut at each end. Each end of the section is like the end of a syringe needle. One end of the needle stock section pierces the regular injection block septum and the other end pierces a septum attached to the outlet of the pyrolysis unit, using a 1/4" to 1/4" Swagelok union. This method of connecting to the chromatograph is similar to the one used on the Beroza carbon skeleton determinator. A

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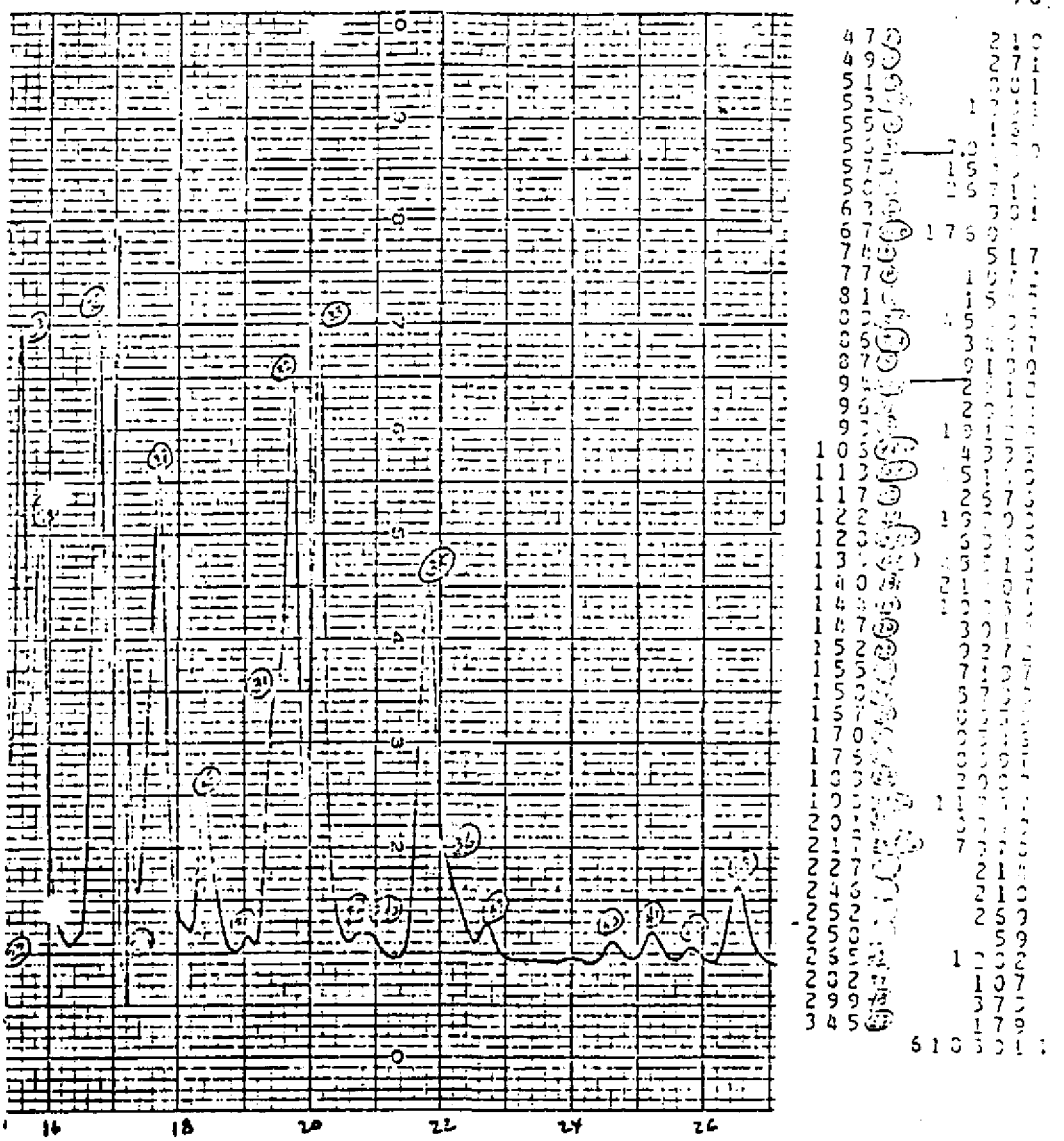

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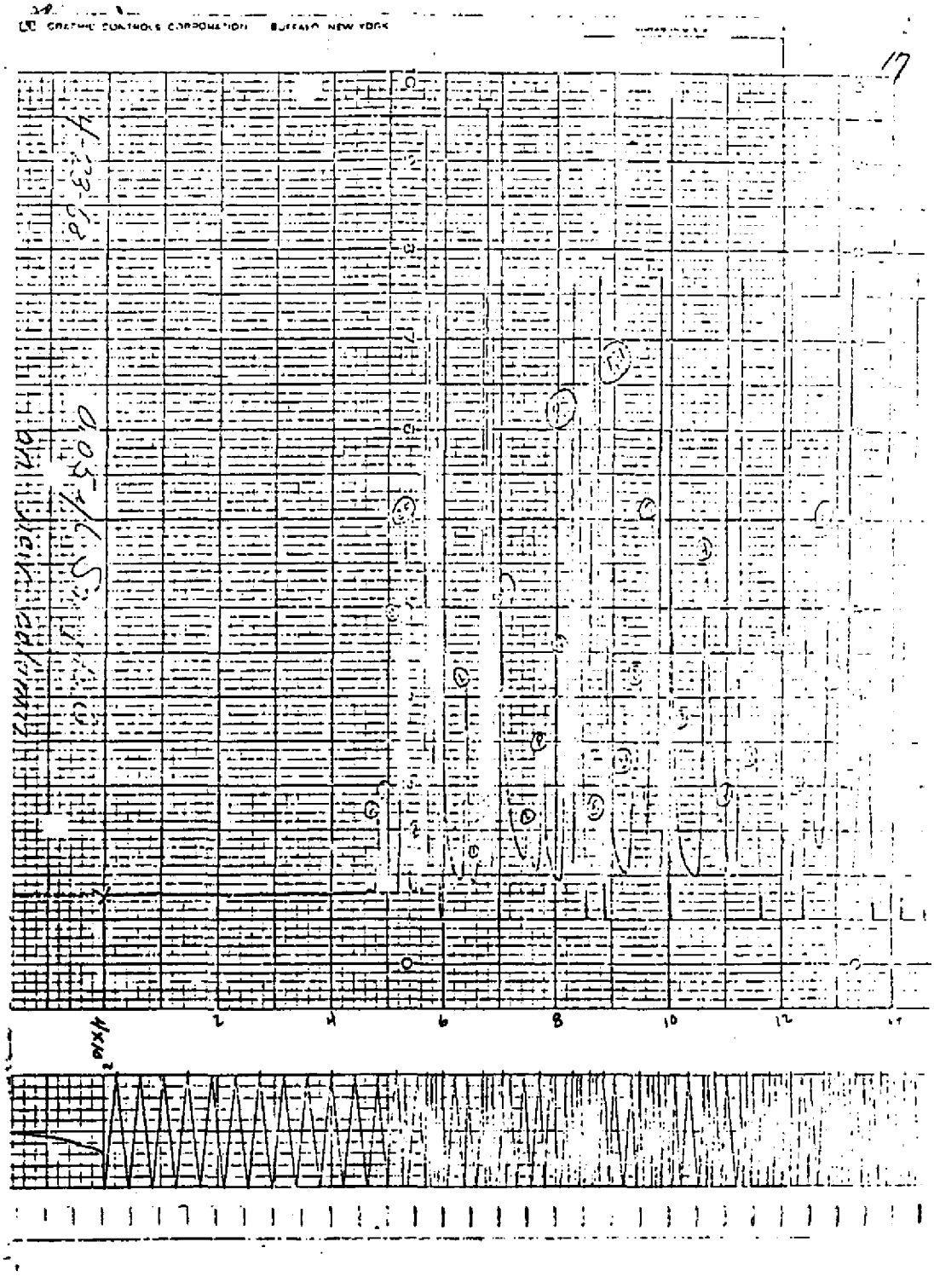
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Information 3

Comparison of MMK's peak No and MC's peak No.

* MMKのピークNO. とMC (ANNISTON LAB. and DR MCNEIL のデータ)のピークNo. の対比表

MMKのカラムはMCより多少分離能がよいため、MCのピークに多いピークが現われて、ピークNo.が少しずれるので、下の表にその対比表を記す。

MMK's peak No	MC's peak No.	MMK's peak No.	MC's peak No.
① diphenyl →	① diphenyl	(24) →	(20)
② 2-	② 2-	(25)	(21)
③ 3-	③ 3-	(26)	(22)
④ 4-	④ 4-	(27)	(23)
⑤ 2,2'- / 2,6-	⑤ 2,2'- / 2,6-	(28)	(24)
⑥ 2,5- / 2,4-	⑥ 2,5- / 2,4-	(29)	(25)
⑦ 2,3'-	⑦ 2,3'-	(30) 3,4,4'-	(26) 3,4,4'-
⑧ 2,3- / 2,4'-	⑧ 2,3- / 2,4'-	↓	↓
⑨ 3,5-	⑨ 3,5-	↓	↓
⑩ 3,3'-		↓	↓
⑪ 3,4- / 3,4'-	⑩ 3,4- / 3,4'-	4塩化以上とする	4塩化以上とする
⑫ 4,4'-	⑪ 4,4'-	(Cl. No. >4)	(Cl. No. >4)
⑬	⑫		
⑭			
⑮ 2,3,2'-	⑬ 2,3,2'-		
⑯			
⑰	⑭		
⑱	⑮		
⑲ 2,5,4'-	⑯ 2,5,4'-		
⑳	⑰		
(21)	⑱		
(22)			
(23) 2,3,4'-	⑲ 2,3,4'-		

A4 上級紙　　三菱モンサント化成株式会社四日市工場

★ COMPARISON = CHEMICAL COMPOSITION BETWEEN AROCLOR 1242, MCS-1016, AND MCS-1043 by MMK (Page)

of UNIT %

PEAK No	COMPOSITION	AROCLOR 1242	MCS-1016	MCS-1043
1	BIPHENYL	1.04	1.64	
2	MCB ϕ_1-Cl	0.15	1.15	6.76
3			0.49	2.19
4		0.03	0.29	.633
5	DCB ϕ_2-Cl$_2$	2.20	5.33	1.846
6		0.21	1.25	.794
7		0.87	2.24	.926
8		6.29	10.26	32.53
9		1.22	1.05	.662
10			0.01	.044
11		12.37	11.00	3.17
12		1.02	6.94	1.40
13	TCB ϕ_3-Cl$_3$	0.67	0.66	0.09
14		1.89	6.64	
15		5.72		1.24
16		0.03	0.06	0.18
17		1.68	1.51	
18		0.62	0.64	
19		8.86	8.19	
20		9.50	8.85	
21		8.39	7.87	
22		0.19	0.17	
23		3.56	3.28	
24		0.81	1.60	
25		3.83	2.83	
26		2.57	2.84	
27		0.63	0.75	
28		0.98	1.02	
29		3.92	4.34	
30		3.06	2.41	
31		2.71	3.29	

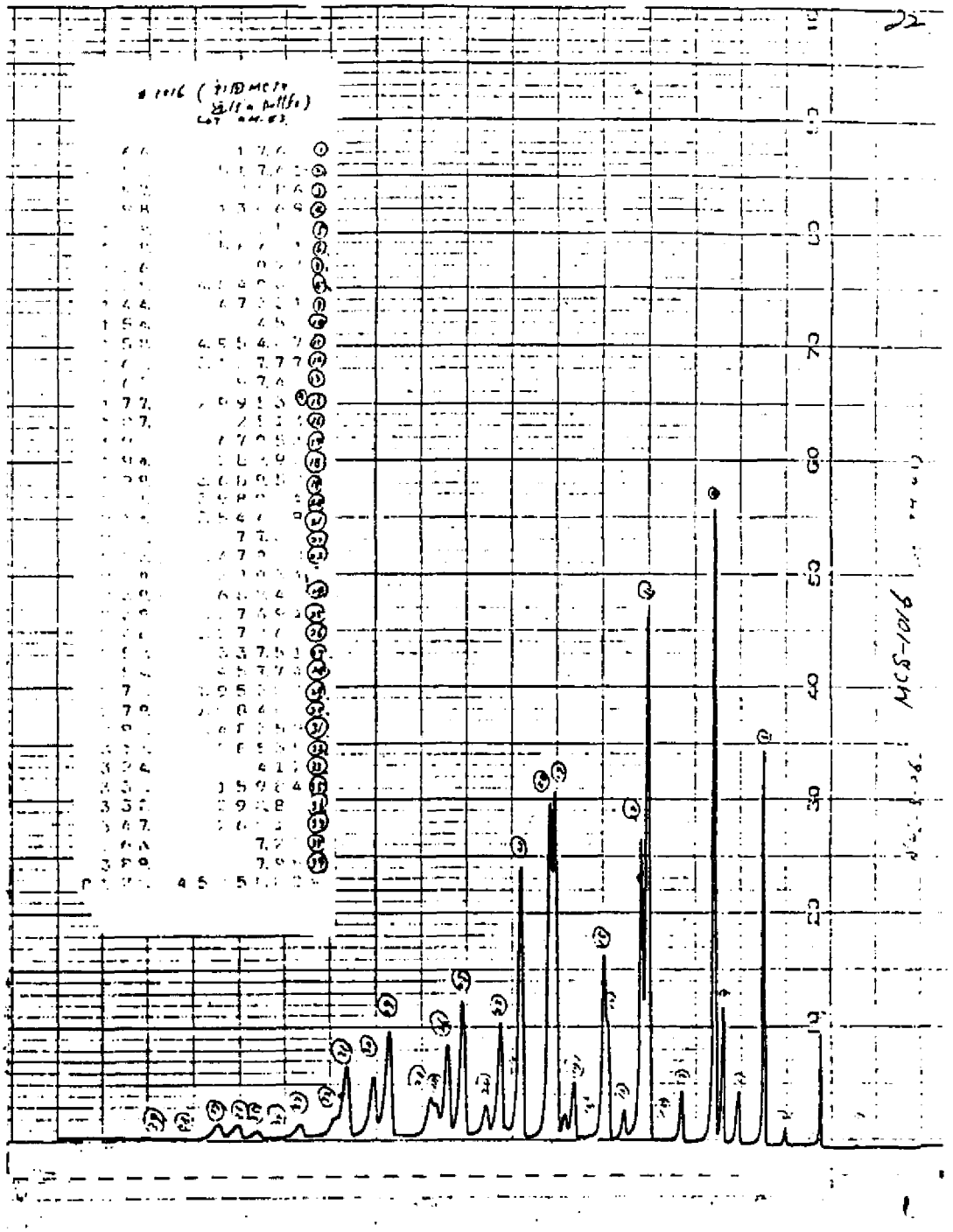
A4 判 三菱モンサント化成株式会社鹿島市工場

32			0.41	0.63
33			1.79	0.01
34			0.06	
35			1.37	0.36
36			2.64	0.66
37			2.53	0.58
38		TeCB.	0.01	0.02
39		PCB.	0.01	0.02
40		HCB. etc	2.17	
41		>φ2-Cl4	0.15	
42			0.07	
43			0.01	
44			0.07	
45			0.08	
46			0.02	
47			0.20	
48				
49				
50				

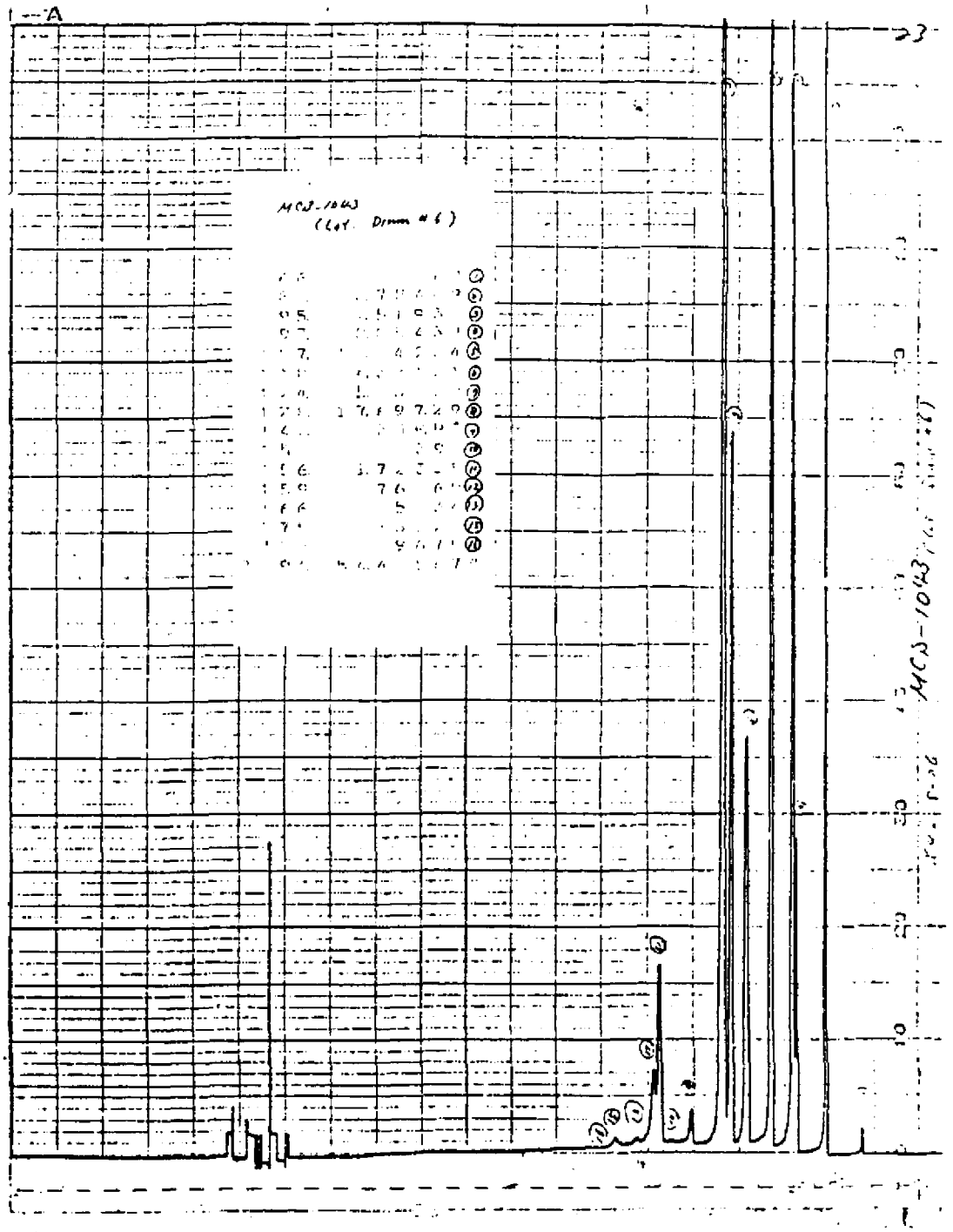
Cl No.	Composition 組成(%)	A-1242	MCS-1016	MCS-1093
0	ビフェニル	0.04 %	0.04 %	–
1	1塩化	0.18	1.93	25.4
2	2 〃	29.6	38.6	73.3
3	3 〃	56.9	53.7	0.51
>4	4 〃以上	13.2	5.6	–

A-1742

MONS 205959



MONS 205960



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Information 4

Physical and Electrical properties of Aroclor 2000S (Page)

＊アロクロール 2000 S*（仮名）の一般特性

＊ S46-10-4～7 に [illegible]

~~Aroclor - 2000 S.~~

PROPERTY	RESULT
Specific Gravity (15/4°C)	1.354
Viscosity @75°C cst	3.2
Acidity mgKOH/g	0.001
Water ppm	20
Inorganic chloride ppm	0.06
Pour Pt °C	−25
Evaporation Loss JIS Method @98°C x 5Hrs	0.05
Color APHA	5
Refractive Index @25°C	1.6214
ε @100°C 50Hz	4.87
Tan δ @100°C 50Hz %	0.01
VR @100°C Ωcm	1×10^{14}
DS @25°C 2.5mm Gap KV	100
HST Cl′ ppm	0.0
MST Cl′ ppm	0.09
TCC Cl′ ppm	0.1
Biphenyl %	0.06

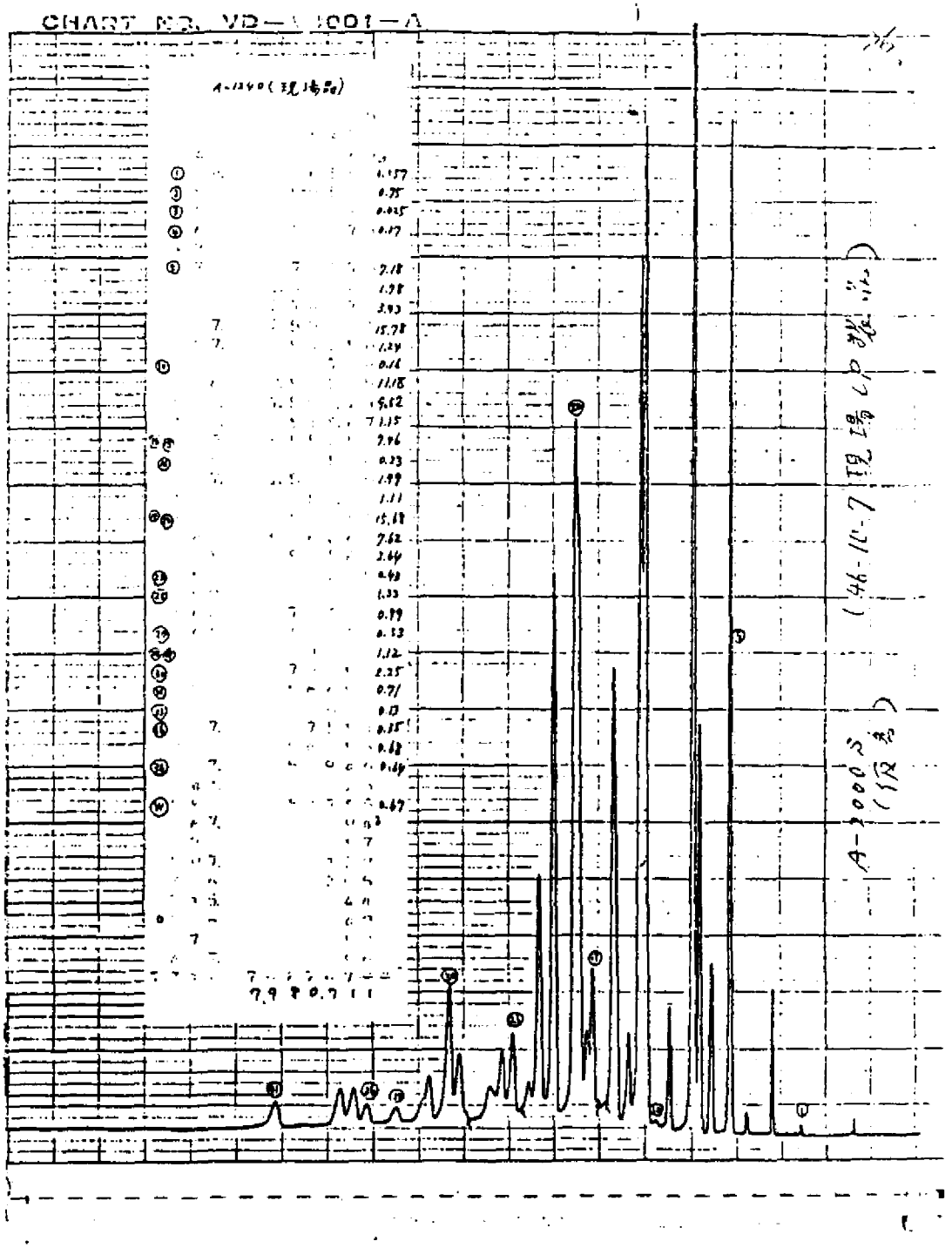
Chemical composition of Aroclor 2000S (Page)

★ アロクロール2000S (仮名) のガスクロ組成

(ガスクロ組成の解析は 1968年1月 [illegible] のアロクロール [illegible] 1968年9月5日 付 Dr. Munch は 1.53)

Peak No.	組成 (composition)	組成 (%)	Peak No.	組成	組成 (%) (composition (%))
1	Biphenyl	0.057	26		0.99
2	2-Cl-Biphenyl	0.75	27		} 0.53
3	3-	0.03	28		
4	4-	0.17	29		1.12
5	2,2'; 2,6-	7.18	30	3,4,4'-	2.25
6	2,5; 2,4-	1.78	31		} 0.71
7	2,3'-	3.43	32		
8	2,3-; 2,4'-	15.78	33		0.13
9	3,5-	1.24	34		—
10	3,3'-	0.16	35		0.15
11	3,4-; 3,4'-	11.18	36		0.68
12	4,4'-	9.52	37		0.64
13		1.15	38		—
14		} 7.46	39		—
15	2,3,2'-		40		0.67
16		0.23	41		
17		1.99	42		
18		1.11	43		
19	2,5,4'-	} 15.67	44		
20					
21	2,4,2'-	7.62			
22		—			
23	2,3,4'-	3.64			
24		0.43			
25		1.33			

Peak No.	組成 (Composition)	組成 (%)
1	Biphenyl	0.057
2~4	Monochloro Biphenyls	0.95
5~12	Dichloro Biphenyls	50.27
13~30	Trichloro Biphenyl	45.53
31~	Tetra Penta Hexa C.B	3.18



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