COMMUNICATIONS

DE LA FACULTÉ DES SCIENCES
DE L'UNIVERSITÉ D'ANKARA

Série B : Chimie

TOME : 31 ANNÉE : 1985

HOME-MADE GAS-LIQUID CHROMATOGRAPHY APPARATUS

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Communications de la Faculté des Sciences de l'Université d'Ankara

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HOME-MADE GAS-LIQUID CHROMATOGRAPHY APPARATUS

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(Received January 11, 1984; Revised, October 22, 1984; Accepted, December 30, 1984)

SUMMARY

A gas-liquid chromatography apparatus which produces a single peak for each component of mixtures is very useful when separating multicomponent systems. Since commercial gas-liquid chromatography instruments complete are too expensive, the home-made apparatus was constructed in order to reduce the cost. The flame ionization detector was prepared and calibrated for quantitative analysis of the ternary system of Benzene, Methyl cyclopentane and n-Hexane. The calibration of the detector was obtained by taking peak height rather than the peak areas in consideration. Reproducibility of results were in the order of $\pm$ 0.1 mole percent. The home-made chromatography apparatus was used with confidence to analyse the ternary distillation samples taken from the 1" Vigreux column.

INTRODUCTION

Multicomponent mixtures are becoming of increasing interest in the chemical and petroleum industries. Although binary separation methods have been studied extensively, little work has been done with multicomponent systems because of the difficulty in quantitative analysing of multi-component mixtures. Nowadays multicomponent mixture compositions can be determined by means of the gas-liquid chromatography method directly and quickly with high accuracy.

Chromatography is one of the most widely used qualitative and quantitative separating method for multicomponent mixtures. The chromatographic methods depend on the distribution of the components of the sample over two phases; one is stationary and the other mobile, and on a subsequent separation of these two phases. The main feature of gas-liquid chromatography is that it produces a single peeak for each component which is of tremendous value when analysing complex mixtures. The advantages of gaz -liquid chromatography over comparable methods of analysis are that it is rapid, sensitive and highly accurate.

Since commercial gas-liquid chromatography instruments complete are too expensive, the home-made gas - liquid chromatography apparatus was constructed to reduce the cost.

In order to install the gas-liquid chromatography apparatus, the factors affecting the chromatography method and the historical development of the apparatus were investigated.

Although gas-liquid chromatography has been developed very quickly since Ray[1] introduced the katharometer as a detector in 1954, the basic design of the equipment has changed little since then. Schematically, the gas-liquid chromatography apparatus consists of a column which may be a straight, U-shaped or coiled or a coated capillary tube containing a stationary liquid phase coated on a solid support. The stationary liquid is of low volatility at the temperature used for separations. The transport of the constituents of the sample through the column is by the mobile phase which is an inert gas, called "the carrier gas". Carrier gas from a cylinder is passed through a pressure reducing valve into a flow regulator. The gas then passes the sample injection port where samples are introduced to the column. The carrier gas and sample mixture passes into the column where the components of the mixture are separated according to their distribution coefficients between the stationary and the mobile phases. The column is maintained at a certain temperature and a constant flow of a carrier gas is passed through it. The gas leaving the column passes through the detector giving electrical signals which are proportional to the amount of components. These signals are amplified and fed to a recorder which draws out the finished chromatograms.

Factors Affecting the Separation and Choice of the Equipment and Materials Solid Support and Partical Size

The liquid stationary phase is supported in the column by a sizegraded solid. Generally it is required that solid support must be chemically inert and must have a high surface area and it should not possess adsorptive properties when impregnated with the liquid.

The most popular solid supports are diatomaceous earths such as Celite and Embacel and crushed firebrick such as Stermachol. The variety of solid supports and their suppliers were given in tables by Kaiser[2].

The adsorbtion characteristics of some solid supports have been compared by Ettre[3] and Bens[4]. These workers have found that firebricks

exhibit strong adsorbtion of nearly all substances except saturated hydrocarbons and other non-polar compounds. On the other hand Celite is normally suitable for every compound. In analysing polar compounds, tailing is more likely to occur with firebrick than with Celite[4,5].

It has been shown that apart from their difference in chemical composition and surface area of support, the evenness of the solid support affects the efficiency of a chromatography column. Grout and Vaughan[6] have used four different grades of Celite in their chromatography columns. They showed that the pressure necessary to maintain a constant flow rate increased rapidly for smaller Celite grades as did the column efficiency. The apparatus used in their investigation was similar to that described by Ray[1].

Grade of Celits	*Nitrogen Pressure cm.Hg*	*Efficiency*
50 mesh	2 .5	357
50 – 80 mesh	3 .5	364
80 – 100 mesh	5 .0	344
100 – 120 mesh	8 .0	398

Keeping the above conclusions in mind, Celite 545, 100–120 mesh size was chosen as a solid support for the gas-liquid chromatography column.

Liquid Stationary Phase and Its Proportion in Column Packing

It is rather difficult to choose the best possible liquid phase for the analysis of a particular mixture. The selection of a liquid phase depends not only upon the types of subtance to be analysed but also upon the complexity of the mixture and the relative amounts of the different components. It the data of the retention volumes of all the components of the mixture on all liquid phases at a given temperature are known, the suitable liquid phase for any desired resolution can be easily chosen. Choice of the particular liquid phase depends also on the column temperature; the liquid phase must not be highly viscous at room temperature and it must not have an appreciable vapour pressure. In order to avoid the loss of column liquid by volatilization, the vapour pressure should not exced about 0.1 mm. Hg.

Comprehensive lists of substances and suitable stationary phases at various temperatures are given in references.[2,7,8] Porter and Johnson[9]

Phillips[10], Hanneman, Spencer and Johnson[11], have used some very unusual stationary phases.

After carefully examining the lists mentioned in the above references Benzyldiphenyl was chosen as a liquid stationary phase for our chromatography column.

Proportions of stationary liquid phase vary from about 1 to 30 percent by weight of the support in the literature. It was reported that with small proportions of stationary phase, separation times became shorhorter and the sorption equilibrium was reached rapidly. Therefore the proportion of the liquid phase "Benzyldiphenyl" to the solid support "Celite 100–120 mesh" was chosen as one to ten. Firstly 110–120 Mesh Celite was sieved from the commercial batch. The weight ratio of the stationary phase to the solid support was taken one to ten as mentioned above. Benzyldiphenyl dissolved in ether was added to the Celite in proportions and the solvent was evaporated on a steam bath with gentle stirring until the creamy mass formed into lumps. The dish was then transferred to an oven at 60°C and heated with occasional gentle stirring for two hours by which time the contents became a free-flowing powder without any odour of ether.

The column was carefully packed using a Vibro-Tool with a known weight of packing. In order to ensure that no fissures and channels formed due to the flow of the carrier gas, the column was further tapped with a pencil. After the column had been filled the ends of the column were plugged with glass wool in such a way, as to prevent an escape of the packing, but at the same time not to add any noticeable resistance to the gas flow. The unused packing was also weighed in order to determine the column loading. The column was then dried for an hour at 85°C in a flow of carrier gas before being used.

Column Temperature

The change in column temperature effects the separation in two ways: The insrease in temperature lowers the column efficiency but shortens the retention time of components being separated. Although the longer retention times may be a disadvantage, the column temperature must be kept as low as possible in order to obtain the optimum column efficiency. Temperature also effects the volatility of the stationary phase.

Since Benzyldiphenyl, which was chosen as liquid stationary phase is solid at room temperature and melts at 78°C, the column operating temperature was chosen as 85°C at which the vapour pressure was believed not to exceed 0 .1 mm. Hg. The column temperature was controlled within 0 .5°C by a 2 amp. variable transformer.

Nature of the Carrier Gas and Flow Rate

Since the HETP depends upon $1 / D_g$ through the second term in the modified van Deemter Equation[12] a column of given length will be more efficient if a gas of high molecular weight is used than one of low molecular weight since $D_g \propto 1 / M^{1/2}$ on simple kinetic theory of gases. Therefore Nitrogen was chosen as the carrier gas.

Since the column efficiency is a function of true linear gas velocity in the column[12] a minimum HETP can be obtained at a specific gas velocity. It is obviously desirable to work as close as possible to the optimum gas velocity giving this minimum HETP in order to make full use of the separating power of the column. The minimum HETP usually occurs with nitrogen or argon as carrier gases in the region of [12] 1–3 cm / sec. Therefore the carrier gas flow rate was kept constant at 20 ml / min. throughout these experiments.

Column Dimensions

The internal diameters of gas-liquid chromatography columns vary from 1 / 8″ to 3 / 8″ in the literature. Wide columns were also used for preparative work and separations[13]. By increasing the column length the separation improves and the pressure drop along the column increases. It was decided to use a U-shaped glass tube with 6 mm. I.D. and 2 m. long as the column.

Detector

The detector is the most important part of the chromatography apparatus. It is used for detecting the components in the effluent. The earliest detectors were of the integral type[14,15]. These give a continuous stepped signal each step corresponding to a different component and the step height is proportional of the amount of the particular component.

Most of the modern detectors are differential type and they give a single peak for each separated component of a mixture. The peaks produced are proportional to the concentration or the mass of that com-

ponent. The first representative of the differential type detectors was the thermal conductivity gauge or so called "Katharometer", introduced by Phililips[16] and Ray[1]. The response of a katharometer depends on the thermal conductivity of the gas stream. Katharometers are sensitive to concentration of components in gas. Their sensitivity is limited by the stability of the gas stream and their response time is usually to long. Ionization detectors which are sensitive to the mass of components in gas are based upon the measurement of the electrical conductivity of gases which have been partially ionized. Their response is almost instantaneous. They are very sensitive and they are stable to fluctuations in the flow rate of the gas and to changes of temperature. Argon ionization detectors were designed by Lovelock[17,18] and Dewar[19]. A comprehensive review of ionization methods for the analysis of gases has been given by Lovelock[20]. Because of the following properties of the flame ioniza tion detector it was chosen as a detector for the gas-liquid chromatography apparatus.

1) They have high sensitivity which enables small amounts of impurities to be detected.

2) They are non-sensitive towards changes in carrier gas pressure or flow rate, provided that high purity gases are used.

3) They are non-sensitive towards mechanical shock.

4) They have the smallest possible detector volume.

5) They have very small noise, in the order of 10^{-14} amps.

6) They record the presence of all organic substances which form carbon dioxide as a final combustion product.

The only disadvantage is that they do not record the presence of all inorganic gases and they are destructive.

The theory of the flame ionization detector was dealt by Ongkiehong[21] and fundamental details were published by Desty[22].

Flame ionization detectors have mainly two parts: the combustion chamber and the impedence conversion circuit. "The carrier gas + Sample mixture" coming from the chromatography column is burnt at a jet in the detector combustion chamber. The flame is produced by the combustion of hydrogen mixed with the nitrogen gas leaving the column in a small jet and the necessary air is supplied to the combustion chamber. When "the carrier gas + organic sample mixture" is burnt

at the jet, there is ionization producing both positive ions and negative electrons. Since the platinum electrode placed above the jet is made positive with respect to ground when compounds are ionized on the jet, the electrons are attracted to the platinum electrods and the positive ions are attracted to the jet. The electrons collected by the electrode flow through the impedence conversion circuit and so create a voltage drop across the input resistor. This voltage drop is a function of the number of electrons flowing through the resistor times the resistance of the resistor, simply from Ohm's Law:

$$\text{Voltage} = \text{Current} \times \text{Resistance}$$

Since the number of electrons flowing in the input circuit is a function of the number of ions formed by combustion, the higher the input resistor the higher will be the signal amplitute. Commonly used values of input resistor range from 10^6 ohms to 10^{11} ohms. A resistor with 10^8 ohms resistance was used. The voltage drop across the input resistor is then measured by the electrometer and output is presented on a potentionmetric recorder in the form of a chromatographic peak.

Recorder

The recorder is a Continuous Balancing Potentiometer. It responds to a change in input voltage by balancing the feed back voltage against the input voltage. Recorders may be obtained with spans from 0 .5 or 1 mV. upwards. They require an impedence conversion circuit to operate with the high impedance detectors to avoid damping. A 1 sec. response in the recorder is desirable.

Apparatus

The general layout of the home-made gas-liquid chromatography apparatus is shown in Fig. 1 and illustrated in Plate 1. The carrier gas Nitrogen was passed through a two-stage pressure reducing valve and a precision needle valve into a capillary flow meter. Since the calibration factors for quantitative analysis depend upon the carrier gas flow rate this should be maintained constant. A glass capillary flow meter was chosen for this purpose. The carrier gas passed through the capillary and the pressure drop was measured by the manometer. The calibration of the capillary flow-meter was made against a soap-bubble flow meter.

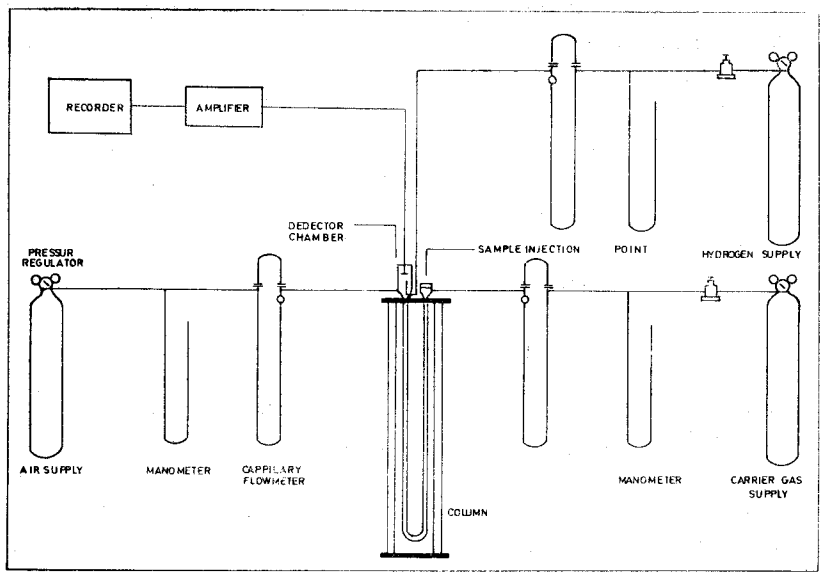
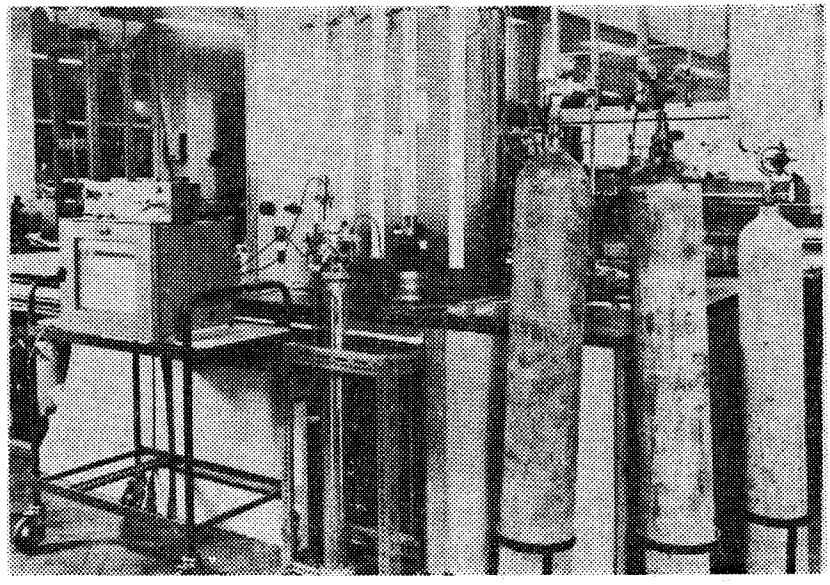


FIG. 1 THE GENERAL LAYOUT OF THE GAS-LIQUID CHROMATOGRAPHY APPARATUS



The soap-bubble flow - meter was constructed from a 50 ml. burette. A buble was formed in the burette by squeezing a little detergent solution into the gas stream with the rubber bulb at the bottom of the burette. The ascent of the soap film was timed with a stopwatch between the zero and 25 ml. calibration.

After leaving the capillary flow-meter the carrier gas passed the injection point where samples were introduced to the column. Gas samples were injected into the carrier gas stream through a serum cap at the top of the column. Then "the carrier gas + sample gas" mixture passed into the column. The column was a glass U–tube of 6 mm. I.D. and 2 m. long. It was packed with Celite 110–120 mesh coated with Benzyldiphenyl. Since fluctuations in the column temperature effect the separation power of the column, the column was insulated by two concentric glass tube. A heating coil was wound around the inner tube. A 2 amp. variable transformer controlled the energy input. The ends of the two concentric tubes were closed with asbectos plates. The temperature of the column jacket was measured by a thermometer placed between the column and the inner tube.

The gas mixture emerging from the column passed through the detector. The detector was a flame ionization type and gave a differential type signal. The detector which was made of glass was constructed in the glass blowing work-shop of the Department. As mentioned earlier, the flame ionization detector was first introduced by McWilliam and Dewar[19] in 1958. In their detector the carrier gas used was a mixture of approximately equal parts by volume of hydrogen and nitrogen and emerging gas was burnt at two jets made from 23 gauge hypodermic needles. Thomson[23] modified the double-jet flame ionization of McWilliam and Dewards' into a single jet form and instead of introducing the equal volumes of Hydrogen and Nitrogen as a carrier gas, Thomson[23] used Nitrogen alone as the carrier gas and introduced Hydrogen to the effluent gas stream by means of the three way tube between the column and the jet. In order to facilitate the cleaning of the ionization chamber, Haahti and et al[24] suggested that the detector could be made in two parts connected by a B 29 ground Pyrex glass joint. Therefore our flame ionization detector was constructed from two B40 joints. It is schematically illustrated in Fig. 2. The three way capillary tube was cemented into the base of the B 40 glass socket which served as a combustion chamber and the other end of the capillary tube fitted on to

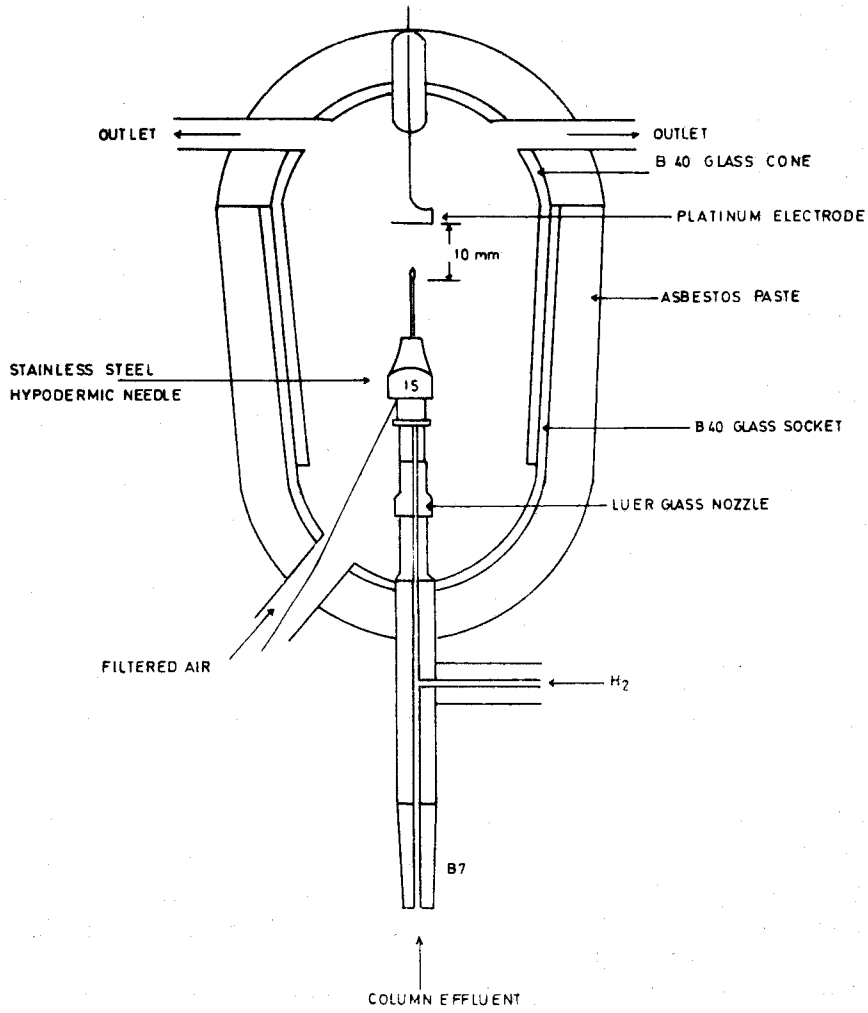


FIG. 2 THE DETECTOR COMBUSTION CHAMBER

the column by means of B7 conical joints. An "Agla" micrometer all-glass syringe Luer nozzle was placed over the top of the capillary tube in the combustion chamber. A 15 gauge stainless steel hypodermic needle was used as a jet and it formed the negative electrode. The capillary tube between the column and the jet ensured that there was no back diffusion of hydrogen into the column and no remixing of the column

effluent before burning on the jet. The air was supplied to the combustion chamber by means of an 8 mm. I.D. glass tube inserted into the bottom of the B 40 socket after the filtration through the glass wool. Hydrogen and air flow rates were also measured by means of capillary flow meters. The combustion chamber was covered with a B40 glass cone which had two side arms open to the atmosphere. "The carrier gas + excess air + products of combustion mixture" passed out through these side arms.

An L-shaped platinum electrode was inserted from the top of the B 40 cone and placed exactly 100 mm. above the jet. This high impedance electrode was attached to a sparking plug for insulation and support. The platinum electrode was connected to the impedance conversion circuit inlet by a mechanically stable coaxical cable. The steel jet was earthed. The detector was insulated with asbestos paste in order to avoid heat losses and carefully screaned electrostatically. In operaing the detector the ratio of hydrogen flowrate to air flowrate was taken as one to ten. Hydrogen and Nitrogen flowrate were manitained equal at 20 ml/min. each.

The detector conversion circuit was connected to the recorder. The recorder had a full scale balance speed of 1 second and was used with imput spans as low as 1 millivolt. The current in the electrometer was maintained at a constant value by a Constant Voltage Unit. The recorder also had a gear box for changing the chart speed to 8 different values. The chart speed was kept at 5 "/hr. throughout the experiments.

EXPERIMENTAL

Operation of the Column

The columns was operated at 85°C. The columns temperature and gas flow rates were checked before each run. The detector flame was ignited. Samples were introduced to the column throught the rubber serum cap by means of a gas-tight syringe. Samples taken from the 1" Vigreux column[24] were first evaporated in 250 ml. glass sample tubes containing glass beads. These samples tubes had vacuum taps at each end to permit flashing with nitrogen gas before the liquid samples were introduced. The resulting gas samples were thoroughly shaken and mixed by means of the glass beads before the samples were drawn into the gas-tight hypodermic syringe. The needle was pushed through the column rubber serum cap which covered the top of the column inlet. The

gas was then expelled into the carrier gas stream as quickly as possible and the needle of the syringe was withdrawn from the self-sealing serum-cap. In order to produce a good straight recorder base line gas leaks should be completely avoided. Therefore the serum cap was checked for leaks before each run.

Requirements and Strandardization for the Quantitative Evaluation of Gas Chromatography Results

1. Linearity of the Recorder Response: The recorder must have linear characteristics. This was tested by a potentiometer for a given input voltage. The output signals were read on the recorder chart. The calibration is shown in Fig. 3.

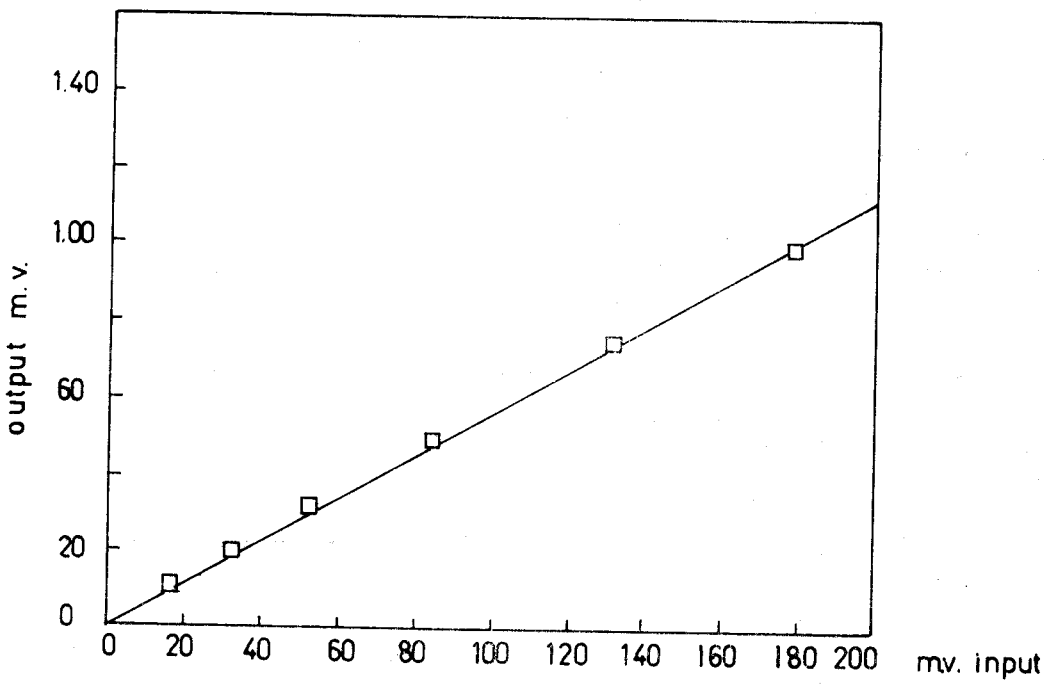


FIG. 3 LINEARITY OF RECORDER RESPONSE

2. The linearity of the Detector Response: The detector must give linear output under working conditions. The linearity of the detector was tested by injecting different amounts of the same uniform mixture into the chromatography column. The individual peak heights were measured

and plotted against the amounts of the materials. During the test the operating conditions of the apparatus were kept constant. The results are shown in Fig. 4.

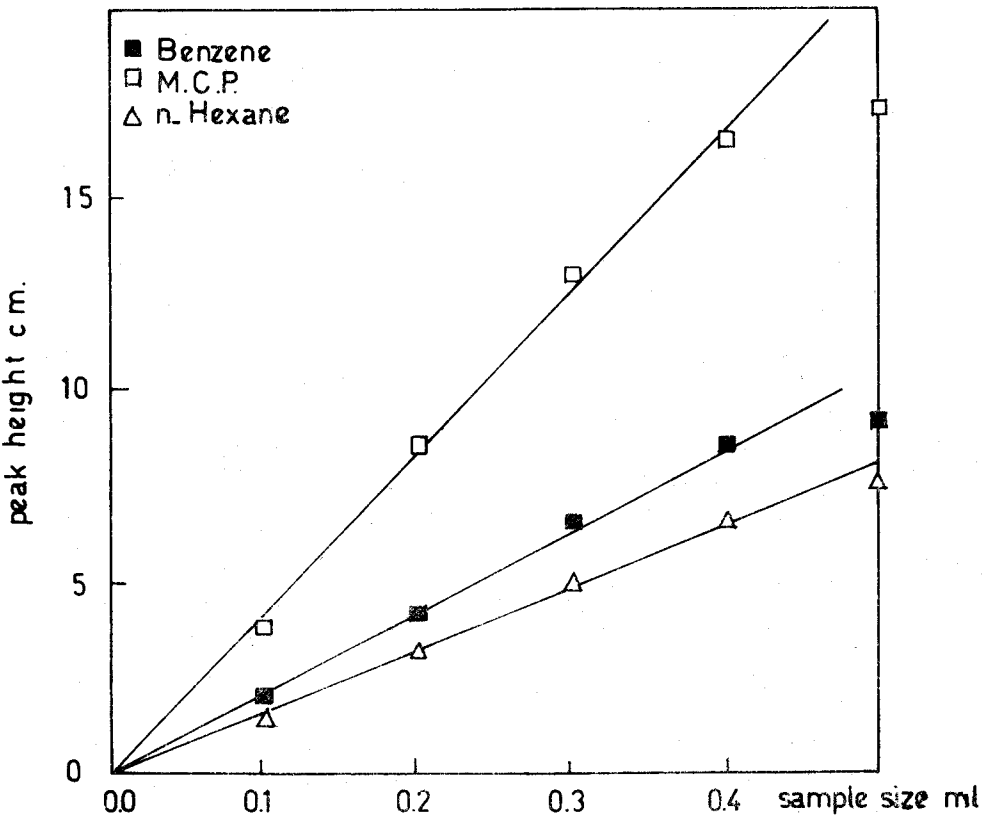


FIG. 4 LINEARITY OF DETECTOR RESPONSE

The integral type detectors register the absolute amounts of the samples and then the amounts of components can be evaluated. In this case, it is not necessary to calibrate the detector. James Martin's[15] "Automatic Titration Device" was of this type. With the Janak's[26] absortion method, it is also possible to evaluate the quantity of a given component in the mixture by measuring the volumes of components after they have left the column.

In the case of differential type detectors, it is generally assumed that the areas under a peak represents the quantity of a subtance. But

equal areas for different substances do not correspond to equal amounts. The area under a peak may be measured,

1. by means of a planimeter,
2. by means of an electronic integrator,
3. by cutting out the peak areas and weighing them,
4. by multiplying the peak height by the retention time[27],
5. by measuring the peak height and the corresponding width at half height and multiplying them together.

Jaulmes and Mestres[28] multiplied the peak height by the width at 45.5 % of height in order to find the peak areas.

The use of a flame ionization detector in quantitative analysis has been studied by many workers[21,22]. Ettre and et al[29] introduced the use of the substance-specific correction factors for the flame ionization detector. The Marker method which is also called "The External Standardization Method" was fully described by Keulemans[30] and was found to be satisfactory by Lee[31] in analysing ternary and quaternary samples.

Our flame ionization detector was calibrated for quantitative analysis under the selected constant operating conditions by using the known mixtures of Benzene / Methyl cyclopentane / n-Hexane system. The column temperature and flow rates were checked before each sample was introduced into the column, Since even slight changes in temperature and in gas flow rates cause a great disturbance in the amount of vaporized liquid phase entering the detector per unit time, samples were injected into the column in the gas phase.

Typical chromatographic peaks obtained for the components Benzene, Methyl cyclopentane and n-Hexane with the flame ionization detector are shown in Fig. 5. They are rather narrow and sharp. Therefore it was not possible to apply one of the earlier mentioned methods for quantitative analysis. But it has also been suggested that if the volume of samples introduced were always the same the peak heights could be used instead of peak areas for quantitative analysis[31], only provided that the operating conditions of the instrument were kept constant.

The calibration of the detector for quantitative analysis was obtained by taking peak heights rather than peak areas into the consideration. Calibration liquid samples with known compositions were pre-

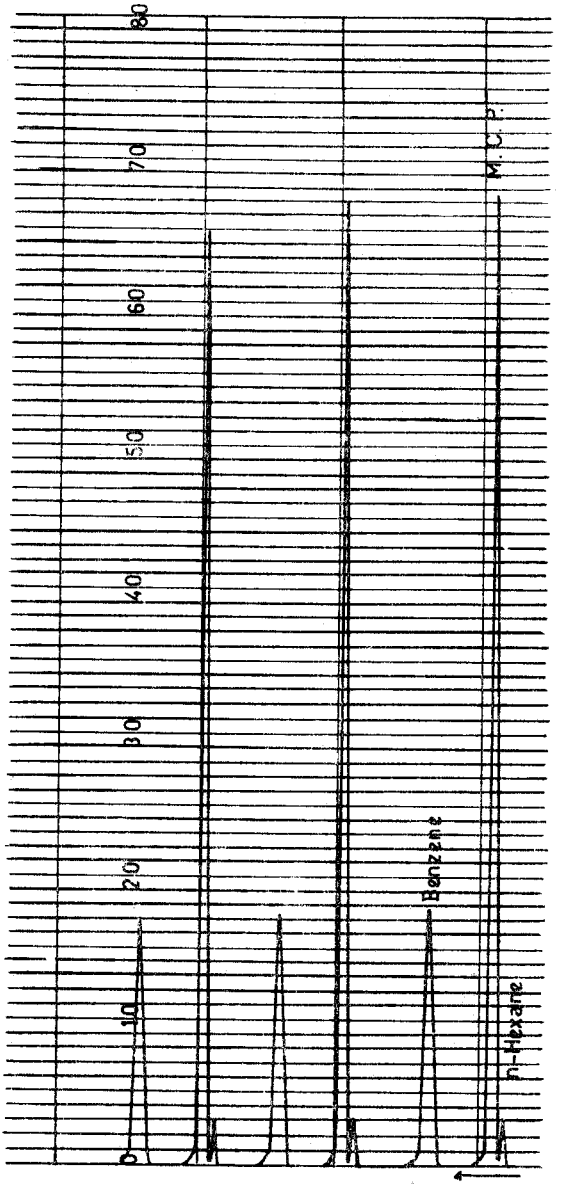


FIG. 5 TYPICAL CHROMATOGRAM OF THREE COMPONENTS

pared. The liquid samples were vaporized in sampling devices and gas samples were injected into the column. The chromatograms were obtainned for each sample on the recorder chart. The height of each peak was measured and the peak height ratio of two components of the mixture was plotted against the weight ratio as well as the concentration ratios of these two components. (Fig. 6 and Fig.7). It was shown that the de-

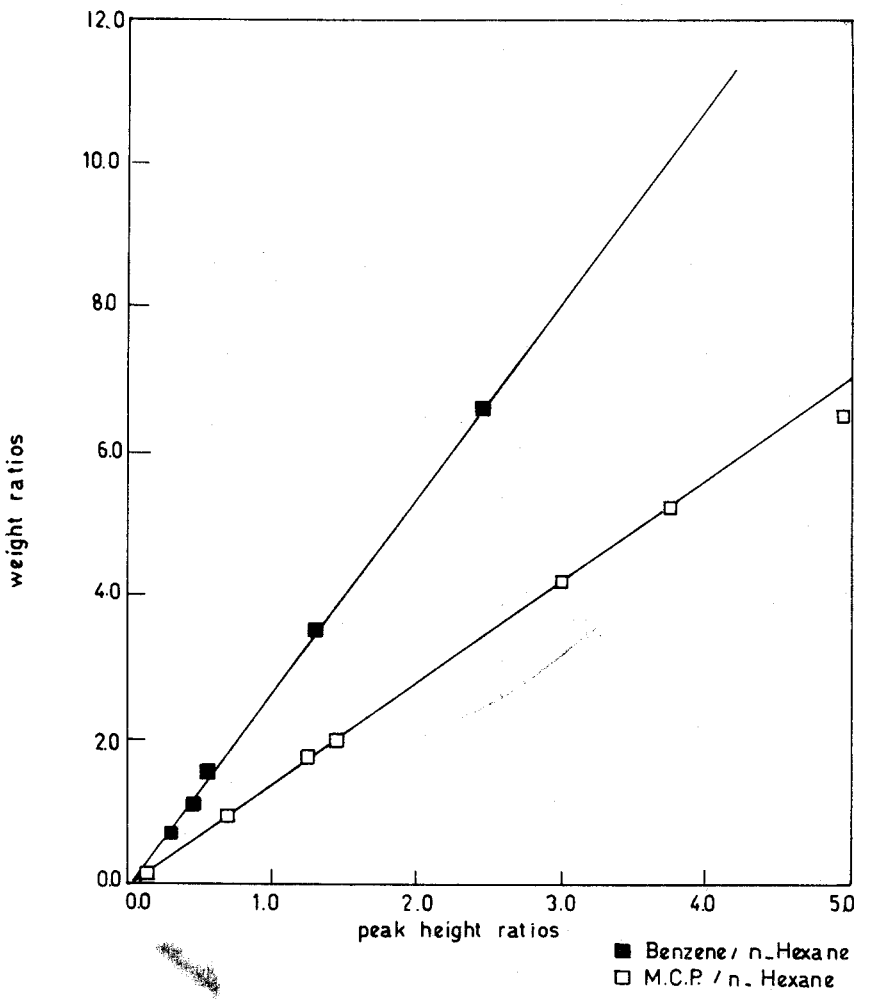


FIG. 6 QUANTITATIVE CALIBRATION OF CHROMATOGRAPHY APPARATUS

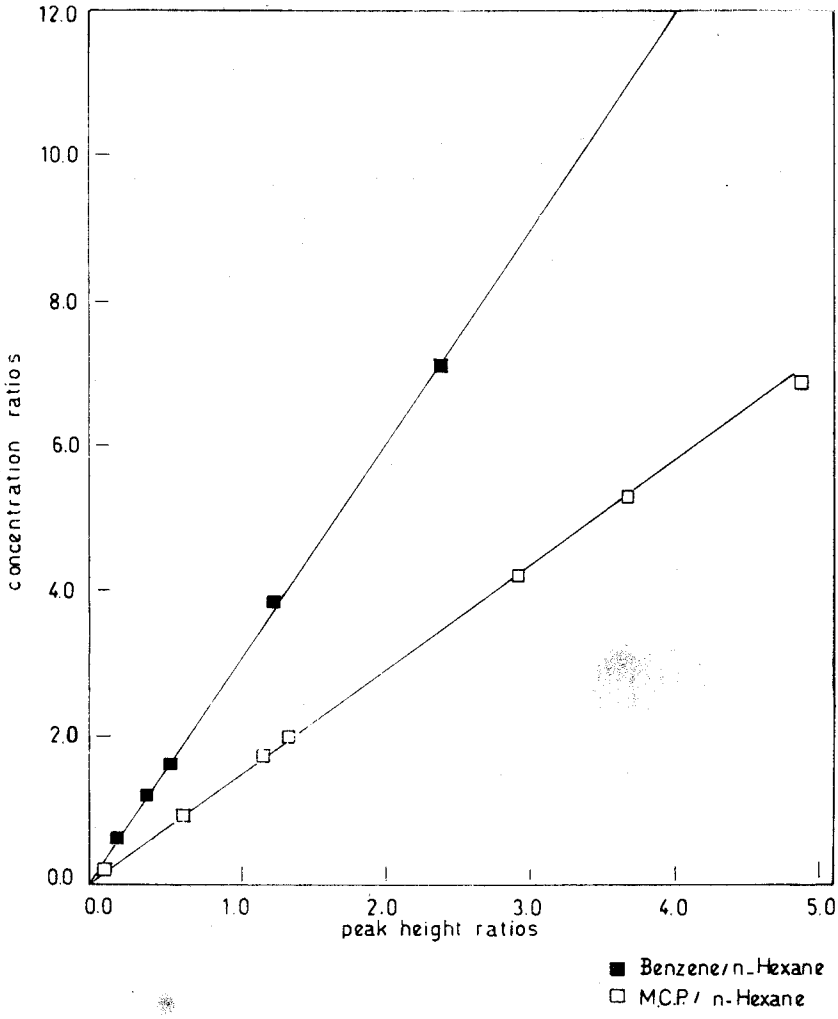


FIG. 7 QUANTITATIVE CALIBRATION OF CHROMATOGRAPHY APPARATUS

tector response was a linear function of the mole concentration ratios rather than weight ratios. The linearity constants K_1 (for Benzene / n–Hexane) and K_2 (for Methyl cyclopentane / n–Hexane) were calculated from experimental points by the least squares method (Table 1.).

Table 1
Calibration Results of the Chromatography Column

Sample No.	Weight percentage of components in Prepared Samples			Weight Ratio of		Mole Ratio of		Peak Height Ratio of	
	Benzene	M.C.P.	n. Hexane	Benzene / n. Hexane	Benzene / M.C.P.	Benzene / n. Hexane	Benzene / M.C.P.	Benzene / n. Hexane	M.C.P. / n. Hexane
1	0.0555	0.0813	0.8632	0.0642	0.0708	0.0708	0.0964	0.0243	0.0688
2	0.0601	0.1961	0.7408	0.0811	0.2647	0.0895	0.2710	0.0300	0.1881
3	0.1047	0.2836	0.6117	0.1711	0.4336	0.1886	0.4747	0.0637	0.3362
4	0.0238	0.8468	0.1294	0.1893	6.5440	0.2022	6.9670	0.0672	4.9446
5	0.2517	0.3562	0.3921	0.6419	0.9084	0.7096	0.9324	0.2350	0.6575
6	0.3977	0.0831	0.5192	0.7660	0.1600	0.8445	0.1639	0.2922	0.1137
7	0.1502	0.7148	0.1350	1.1126	5.2948	1.2263	5.419	0.4272	3.7398
8	0.3542	0.4108	0.2350	1.5072	1.7481	1.6613	1.789	0.5538	1.2320
9	0.6869	0.2088	0.1043	6.586	2.002	7.260	2.049	2.444	1.4015
10	0.4035	0.4816	0.1149	3.512	4.191	3.873	4.292	1.3040	2.9868

Reproducibility of Quantitative Analysis

Each sample taken from the 1″ *V*igreux column[25] was analysed twice by gas-liquid chromatography. Although every effort was made to keep the sample size constant by means of a gas-tight syringe, slightly different peak heights were obtained for each component for each injection. But the peak ratios were found to be constant for a particular composition. Reproducibility of results were in the order of $\pm$ 0.1 mole percent. Several selected experimental values and their reproducibility are given in Table 2.

Table 2
Reproducibility of Quantitative Analysis
(Samples from the 1″ Vigreux column)24

Run No.		Measured peak heights of			Evaluated concentration of		
		Benzene	M.C.P.	n.Hexane	Benzene	M.C.P.	n.Hexane
	B	0.27	0.77	15.02	0.017	0.064	0.889
		0.27	0.75	15.21	0.047	0.063	0.890
1							
	T	0.28	0.62	14.97	0.050	0.053	0.897
		0.28	0.62	15.04	0.050	0.053	0.897
	B	3.44	7.82	8.48	0.342	0.374	0.284
		3.47	7.84	8.53	0.343	0.373	0.284
6							
	T	2.48	7.06	9.57	0.273	0.373	0.353
		2.51	7.14	9.68	0.273	0.373	0.354
	B	5.53	1.39	1.60	0.821	0.099	0.080
		5.41	1.37	1.59	0.819	0.100	0.081
18							
	T	5.29	3.36	5.89	0.595	0.182	0.223
		5.13	3.25	5.67	0.596	0.182	0.222
	B	2.48	3.93	4.63	0.418	0.319	0.263
		5.41	9.06	9.50	0.416	0.320	0.264
32							
	T	1.72	3.70	5.48	0.322	0.333	0.345
		3.42	7.30	10.74	0.324	0.333	0.343
	B	6.48	1.94	9.03	0.620	0.089	0.291
		6.66	1.99	9.28	0.620	0.089	0.291
40							
	T	3.51	1.77	10.21	0.450	0.109	0.441
		3.65	1.83	10.58	0.451	0.109	0.440

CONCLUSIONS

The home-made gas-liquid chromatography apparatus was constructed and used successfully for analysing the ternary distillation samples.

Reproducibility of results were in the order of $\pm$ 0.1 mole percent. Standard deviations and confiedence limits of ternary compositions gave assurance of sufficient reproducibility . And it is concluded that home-made chromatography apparatus can always be prepared in the laboratory in order to reduce the cost.

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ÖZET

Her bileşen için ayrı ve tek bir sinyal veren gaz - sıvı kromatografi cihazı, çok bileşenli sistemlerin kantitatif analizinde çok kullanışlıdır. Gaz-sıvı kromatografisi komple cihazları çok pahalı olduğundan, maliyeti düşürmek amacıyla, laboratuvarda yerli yapı bir cihaz hazırlandı. Benzen, Metilsiklo pentan ve N-Hegzan'dan oluşan üçlü sistemlerin kantitatif analizini yapabilmek için alev-iyonlaşma detektörü hazırlanarak ayarlandı. Detektörün ayarlanmasında pik alanları yerine pik yükseklikleri gözönüne alındı. Kantitatif analiz sonuçlarının tekrarlanabilme hata sınırı mol yüzdesi olarak $\pm$ 0.1 gibi küçük bir değer olarak bulundu. Yerli yapı kromatografi cihazı 1" Vigreux distillasyon kolonundan alınan üçlü karışımların analizinde büyük bir güvenle kullanıldı.