GC Optimization Just Got "EZ"er!

- Prices slashed!
- Simplify column selection.
- Reduce analysis times and improve sample resolution.
- Optimize dual column run conditions.
- Master Library Set now included FREE!

Many analysts are following methods or using columns and run conditions they know could be optimized. But, who has time to make the hundreds of injections necessary to optimize the temperatures, ramp rates, flow rates, pressures, and column parameters to get the perfect chromatogram? No one!

Let *Pro ezGC'"* for Windows@ do the work for you. *Pro ezGC'"* for Windows@ makes GC optimization a breeze. By using a computer algorithm to predict thermodynamic retention indices for sample components, the software predicts the best combinations of column dimensions, temperature program, and flow conditions for your analysis. It can decrease your analysis time and help you obtain key separations for single column, dual column, and dual detector analyses. What could be easier?

Pro ezGC"" for Windows" is now more affordable than ever. In addition to the lower price, Restek is now including the entire Master Set of Retention Index Libraries at no extra charge! These libraries contain more than 3000 compounds on the most commonly used stationary phases in 10 different application areas including: pesticides, PCBs, flavor & fragrance compounds, drugs of abuse, FAMEs, semi-volatile pollutants, volatile pollutants, and solvents & chemicals.

Pro ezGC will save you time and money by greatly enhancing your productivity and increasing sample throughput. Take advantage of this powerful GC optimization tool today!

Prices Reduced!

Pro ezGC for Windows, Cat.# 21487
Upgrade Pro ezGC version 1.5 (DOS) to Pro ezGC for Windows, Cat.# 21486
Pro ezGC Ver.1.5 for DOS, Cat.# 21481

THE

RESTEK

ADVANTAGE

Sneak Preview! ezGC" Software
Simplifies GC Method Development

- Saves time and money by reducing analysis times and improving sample resolution.
- Automatically determines optimum temperature program rates and column flow rates.
- Works with constant flow, constant pressure, or electronic pressure/ flow programming.
- Visually demonstrates changes in resolution when the column parameters and operating conditions are changed.
- Easy to use, mouse driven software with built in help menus.
- Takes the guesswork out of capillary column selection.
- Easy to install and works on all DOS operating systems with 5 12K of free RAM.
- Costs about the same as a 30-meter column.

Did you ever work with a chromatographer who seems to know how to pick the best temperature program and flow conditions? After years and years of experience they seem to inherently know which GC parameters work best. They have learned how parameters such as temperature, flow, and distribution coefficients affect a separation. Why wait years? Use ezGC" and quickly become a master at capillary column selection and optimization.

Before *ezGC*™
time consuming GC method development guesswork
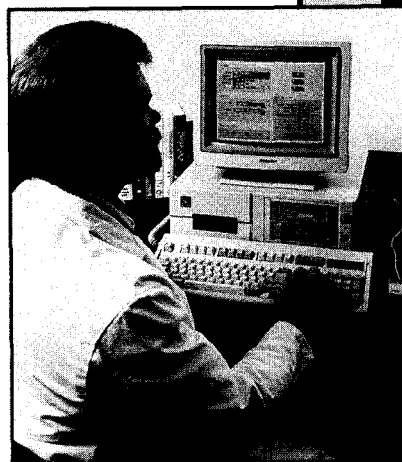
After *ezGC*™
accurate predictions of GC separations in minutes

Even experienced chromatographers will benefit by using ezGCTM. Restek's applications department was hard at work trying to optimize the temperature program rate for the 60 compounds in EPA Method 502.2. They tried 4, 10, 12, and 16"C/min., but there were so many compounds that new coelutions occurred at each temperature program ramp. The separations were so complex that they couldn't figure out whether faster or

slower program rates were better. After several frustrating days of working on the project, they tried ezGC". They entered the retention times into the ezGC" program and let the software do the optimization. ezGC" predicted 7S"C/min. as the optimum temperature program rate and printed a simulated chromatogram illustrating the expected separations. They were impressed but still not convinced. Actual chromatograms were then generated at 7 and 8"C/min., but only 7S"C gave the best separation, just as the program predicted. Now our applications department is so convinced of the power of ezGC" that they use it for all optimization work.

You can save time and money in your laboratory by using ezGC" to optimize all your analyses. If you have a simple analysis with no coelutions, you can use the software to predict the fastest temperature program and flow conditions while

maintaining baseline resolution (R2 1.5). And, if your sample contains compounds which may switch elution orders at the new optimized conditions, ezGC will list the new elution order.

Did you ever wonder how your sample would look on a different film thickness? If you are using a 0.25um film and you suspect that a 0.5um film would improve resolution, use ezGC to print a simulated chromatogram with the 0.5um film. In fact, you can try any other film thickness and ezGC will provide simulated chromatograms at optimized run conditions. How about a longer length or different inside diameter? Enter the desired column dimensions into the ezGC program and it will provide a simulated chromatogram for visual examination. Now you don't have to waste your time or money buying experimental columns to optimize your analysis, ezGC can do it for you.

How does ezGC work?
In the past 20 years, several attempts have been made to predict retention and elution in gas chromatography. Initially, elution order was predicted by Kovats indices (1). However, Kovats indices are restricted to isothermal conditions. With the increasing use of temperature programming, Kovats indices were not applicable in many situations. A modified retention index equation was developed by Van den Dool and Kratz2 that incorporated Kovats indices into temperature programming. This modified retention index works relatively well, as was demonstrated in *The Restek Advantage* (January 1992). However, neither the Kovats or Van den Dool and Kratz methods account for changes in carrier gas viscosity, linear velocity, film thickness, etc. Recently, advances have been made in developing a more sophisticated method to predict GC behavior. Several researchers, Dose3; Curvers and Rijks4; and Snow and McNairJ have contributed to a method for calculating temperature programmed or isothermal retention from thermodynamic parameters. The distribution coefficient K, is

related to the Gibbs free energy of gases in solution by the following equation:

$$AG = RT \ln K_D \text{ and since } AG = AH - TAS$$

substituting $K_D = k * \beta$, the following equation can be derived:

$$\ln k = \left(\frac{\Delta H}{R}\right) * \left(\frac{1}{T}\right) + \ln \left(\frac{a}{\beta}\right)$$

where

$$a = \left(\frac{\Delta S}{R}\right)$$

This new equation is in the form of y = mx + b where $\frac{\Delta H}{R}$ is the slope of the line and the quantity $\ln (a/\beta)$ is the y intercept. The ezGC software incorporates these fundamental concepts into a computer algorithm that makes it possible to accurately predict GC retention times routinely to within 2 %.
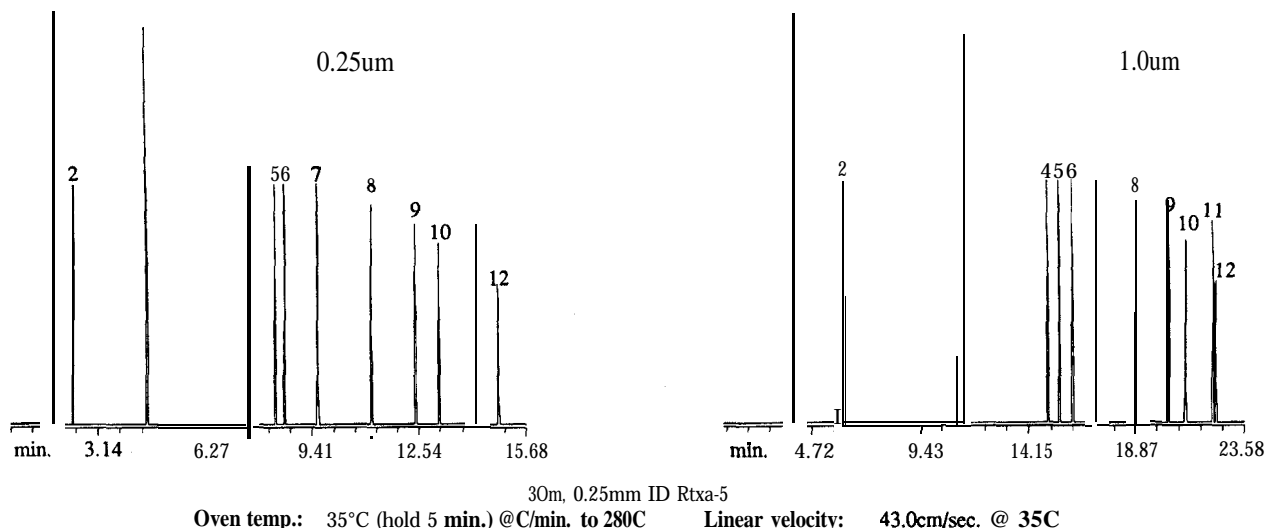
How hard is it to use ezGC?
By following a few simple steps, optimum operating conditions can easily be predicted for any analysis. To utilize ezGC simply obtain an accurate dead time and run your sample at fast and slow temperature program ramps. Enter the retention times for both runs in the program and you are ready to try new temperature program rates, flow rates, column IDs, film thicknesses, or column lengths. An on-line help manual is available at any time to answer questions, and in those rare cases when you need extra help, experienced Restek technical service chemists will be available to assist you with your more detailed questions.

Ways to generate optimum conditions
Optimum temperature programmed run conditions can be generated two ways. In one case, a specific set of GC conditions is entered and under those conditions, the ezGC" program will predict the retention times of the components.

Figure **1** - **ezGC** quickly predicts actual peak resolution when increasing the film thickness from 0.25 to 1.0um when using the same temperature program.

30m, 0.25mm ID Rtxa-5
Oven temp.: 35°C (hold 5 **min.**) @C/min. to 280C   **Linear velocity:**   43.0cm/sec. @ 35C

#	Component Name	Exp. tR (min.)	Calc. tR (min.)	Exp.- Calc. Error (min.)	(Exp.-Calc.) /Exp. % Error (min.)
	Table I - Comparison of Experimental vs. Calculated Retention Times				
1	hexane	3.891	3.900	-0.009	-0.2
2	benzene	6.032	6.117	-0.085	-1.4
3	toluene	11.001	11.076	-0.075	-0.7
4	cblorobenzene	15.002	14.991	0.011	0.1
5	etbylbenzene	15.500	15.495	0.005	0.0
6	m-xylene	16.184	16.059	0.125	0.8
7	styrene	17.395	17.129	0.266	1.5
8	isopropylbenzene	19.082	18.861	0.221	1.2
9	n-propylbenzene	20.5 17	20.345	0.172	0.8
10	1,3,5_trimetbylbenzene	21.202	21.07	10.131	0.6
11	tert-butylbenzene	22.385	22.259	0.126	0.6
12	decane	22.501	22.364	0.137	0.6
	Average error 0.7				

Predicted results can be viewed in either a table format or a computer simulated chromatogram. Figure 1 shows simulated chromatograms demonstrating how the analysis would look if the stationary phase film thickness was increased from 0.25 to 1 .0pm with the same program conditions. The 30m, 1.0um film thickness increases the analysis times from approximately 14 to 22 minutes. Figure 2 shows the predicted optimum temperature program ramp for the 5m, 11.0um column to maximize resolution and minimize analysis times. Baseline resolution is obtained in under 6 minutes with the 5m column.

Another way to generate the optimum conditions is by entering a range of desirable temperature program conditions into the program. The optimum conditions, yielding the shortest analysis time with the best resolution, will be listed first with other possibilities listed sequentially. Computing time varies with the number of permutations requested.*
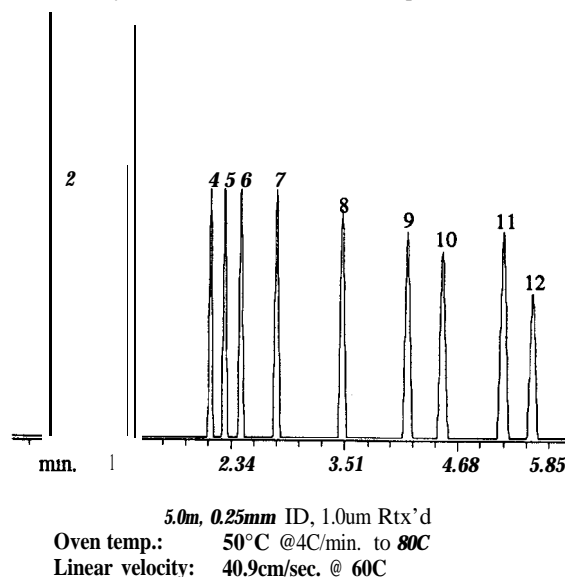
Quickly compare differences in analysis and resolution changes when varying linear velocity, ID, film thickness, length, or theoretical plates
etGC permits a visual comparison of analysis times and resolution when column parameters such as linear velocity (including electronic pressure or flow programming), column diameter, theoretical plates, film thickness, and/or the column length are varied. Table I shows the predicted vs. actual retention times for a 1.0um Rtx-5 using data generated on a 0.25um capillary column. The absolute error is approximately 2%.

ezGC **simplifies method development**
ezGc greatly reduces the workload of GC method development. It also insures the best resolution and analysis time conditions for existing methods. This versatile program allows any parameter or combination of parameters to be changed and

*A 386SX-25 *without a coprocessor was able to evaluate 350 temperature programs for I2 components in under I minute.*

Figure 2 - ezGC predicts the optimum resolution and fastest analysis times with a 5.0m, 1 .Opm column.

5.0m, 0.25mm ID, 1.0um Rtx'd
Oven temp.:   50°C @4C/min. to *80C*
Linear velocity: 40.9cm/sec. @ 60C

quickly viewed in either a table format or simulated chromatogram. ezGC can be installed on any IBM PC or compatible system with a hard drive and 512K of free memory.

After reading about ezGC, you may ask, "How could method development be easier?" The answer is, by having Restek generate thousands of thermodynamic retention index libraries on volatile organics, industrial solvents, pharmaceutical compounds, and flavors/fragrances using a wide variety of bonded phases. Restek has dedicated a large portion of our application chemists' time towards generating extensive libraries that interface to ezGC. See the July 1993 issue of The Restek Acfvuntuge for information on Restek's thermodynamic retention indice libraries. ∎

References
(1) Kovzits, E., Giddings, J.C., and Keller, R.A., *Advances in Chromatography,* Volume 1, Chapter 7. New York: Marcel Dekker (1965).
(2) Van den Dool, H. and Kratz, P.D., *Journal of Chromatography,* Volume 11, pp.463-471, (1963).
(3) Dose, E.V.,Anul. *Chem.,* 1987,59,2414-2419.
(4) Curvers, J., Rijks, J., Cramers, C., Knauss, K., Larson, P., *HRC & CC,* Vol. 8, Sept. 1985.
(5) Snow, N.H. and McNair, H.M., .I. *of Chrom. Sci.,* Vol. 30, July 1992.

● ●
ezGC Software
(includes 51/4" and 3 1/2" disks)
cat.# 21480, 21495

ezGC will be available for shipment in May 1993.
● ●

ezGC" was developed jointly by Analytical Innovation, Inc. in cooperation with Restek Corporation.
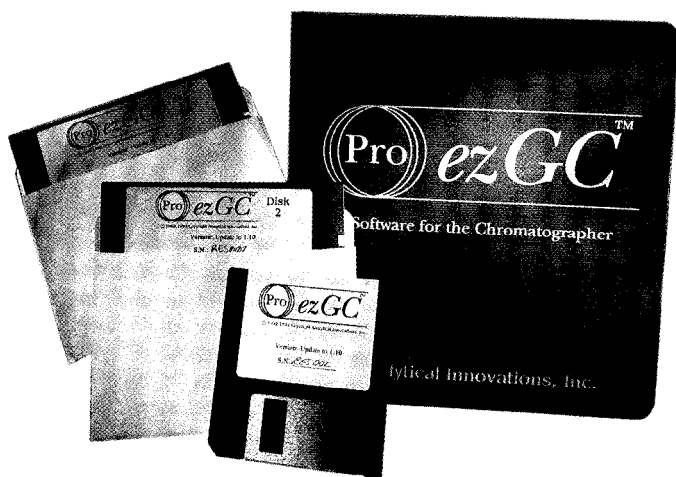
Pro ezGC Software (Ver 2,0) for Windows,

The most powerful GC optimization software has new features!

by Mike Feeney

- Optimize temperature and flow programs from a single analysis.

- Model retention gap and guard column applications including Restek's Integra-Guard™ columns.

- Model columns in series for process GC and multi-dimensional GC analyses.

- Software routines expanded for Fast GC and Windows® 95.

Pro ezGC'" software is a powerful optimization software and retention index database for gas chromato-graphy. This program accurately predicts GC separations on any capillary column and is useful for selecting the best column and conditions for your GC analysis. Pro ezGC'" software utilizes either your chromato-graphic retention data or you can use the extensive library containing thousands of commonly analyzed compounds. From this data, it is possible to automatically evaluate thousands of combinations of column dimensions, oven temperature program, and carrier gas pressure program to determine the best separation with the fastest analysis time. This saves days of method development time for new analyses and can decrease analyses times of existing analyses by more than 50%. Several new features incorporated into version 2.0 make Pro ezGC'" software for Window? even more powerful and easy to use.

Optimize separation and analysis time from a single GC run

In order to accurately simulate separations and analysis time, the software requires either selecting a compound from an existing library or entering retention times from a GC analysis. This new version of Pro ezGC" software for Windows@ can calculate the thermodynamic retention indices from a single chromatographic run. This analysis can be your current method, retention data from a scientific journal, or retention times from publications such as Restek's chromatography products catalog. This makes it possible to select a GC column for your analysis and estimate the separation quickly and easily.

Model GC separation including guard colun~ns and capillary restrictors

The analysis of contaminated samples often requires the use of a guard column to minimize contamination of the analytical column. Cool on-column injection often utilizes retention gaps to improve peak widths and to facilitate injection using standard gauge syringes. These "precolumns" can either be connected using a low-volume union or built-in as with Restek's Integra-Guard'" columns. In GUMS applications, a length of deactivated tubing is sometimes added to the end of the analytical column to either increase the GC inlet pressure or to decrease background bleed from the transfer line tube. Pro ezGC'" software for Windowsa now permits accurate modeling when these types of columns are used, even when the diameters are not identical to the analytical column.

Predict the optimum column for dual columns connected in series or parallel

Many times, resolution of all components in a sample is not possible using a single column. This is where the power of Pro ezGC'" software becomes especially obvious because the program can either model two columns connected in parallel to two separate detectors or two columns connected in series. With series connections, the lengths of the two columns are often cut to give the best combination. This approach would be costly and time consuming without Pro ezGC'" software. Now, any laboratory can quickly evaluate whether serially coupled columns will give the separation without cutting up valuable capillary columns.

Take the guesswork out of selecting the best column and conditions for your GC analysis with Pro ezGC'" software for Windowsa. Increase the productivity of your existing gas chromatographs by improving separations and shortening analysis time with optimized temperature and carrier gas programs. For more information, download a copy of the demo software directly from Restek's website at http://www.restekcorp.com or call your local distributor and request a demo disk of Pro ezGC'" software for Windows@.

Pro ezGC™ for Windows® version 2.0
cat.# 21487

Upgrade from Pro ezGC™ for DOS to Pro ezGC™ for Windows®
cat.# 21486

Pro ezGC
Method Development Software Updates

Pro ezGC" has become more powerful with new Version 1.5

. Increase your labs' competitive advantage!

. Optimize temperature and pressure programming parameters to decrease analysis times and increase sample throughput.

. Improve resolution to meet or exceed method protocols.

. Optimize column length, diameter and film thickness before purchasing the column.

. Import data from ASCII or AIA(AND1) formats to reduce data entry time.

. Calculate Kovats and Linear Temperature Program Indices, as well as Equivalent Chain Length (ECL) values, for qualitative analysis.

The addition of several new features allows simultaneous optimization of column length, internal diameter, and film thickness, as well as pressure programming. These features are added to the temperature program optimization features already in place. By using **Pro ezGC, you** can improve the resolution of your analysis, shorten analysis times, increase sample throughput, and save money.

Pro ezGC uses thermodynamic retention indices (TRIs) to calculate retention times and elution characteristics for a set of components on a given stationary phase. By entering a column dead time and two temperature programmed runs of experimental data, the user can calculate TRIs. TRIs are then used to predict the performance of these components when any of the column parameters (length, ID, film thickness, carrier gas, or flow control) are changed. By using component libraries and

TRIs generated by Restek, you can pick the best column and run conditions without ever installing a column. GC method development and analysis optimization couldn't be easier.

Version 1.5 now allows simultaneous optimization of temperature programs, column length, ID, film thickness and flow or pressure parameters. New component libraries include FAMEs, Pesticides, and PCBs. Call your local distributor to request a complete listing of all the component libraries.

Pro ezGC Software ver. 1.5:
cat# 21481, $1495

**Pro ezGC" ver. 1.0 to
Pro ezGC" ver. 1.5:**
cat.# 21485, $595

ezGC" **ver. 1.0 or 1.5 to
Pro ezGC" ver. 1.5:**
cat.# 21482, $1095

Three New Retention Index Libraries Available

**Fatty Acid Methyl Ester (FAME)
cat.# 21455**
FAME thermodynamic retention index libraries are now available for 70 compounds on the Rtx@-2330 and Stabilwax" stationary phases. All straight chain saturates from methyl butanoate(C4:O) to methyl tetradocosanoate(C24:O) are included, along with unsaturates ranging from monounsaturate methyl undecenoate (C 11: l) to the polyunsaturate methyl docosahexanoate(C226).

**Environmental - Pesticides/Herbicides
(Part 1)
cat.# 21456**
A collection of 62 chlorinated pesticides from EPA methods 505,507,508,608.1, 608.2, 1618, and CLP Pesticides, as well as 19 derivatized phenoxy-acids found in EPA methods 515.1,815OB, and 615 are included in this library. Thermodynamic retention indices are provided on the Rtx@-5, Rtx@-35, and Rtx"-1701 stationary phases.

**Environmental - PCBs
cat# 21454**
A complete collection of retention indices for the 209 polychlorinated biphenyls (PCBs) on the Rtxa-5 stationary phase are included in this library.

Other Retention Index Libraries Available:

*Food and Flavor Volatiles (cat3 21451)
Drugs & Pharmaceuticals (cat9 21453)
Environmental - Volatiles (cat.# 21452)
Solvents & Chemicals - Part 1 (cat.# 214.50)*

Please call your local distributor for additional information.

ezGC and **Pro** ezGC
for Fast, Economical GC Method Development

The March 1993 issue of *The Restek Advantage* previewed ezGC", a new software program that uses computer modeling to accurately simulate changes to a GC analysis. The software calculates the peak widths and retention times for a given set of chromatographic conditions and then displays the resulting chromatogram. In addition, the software predicts the optimum temperature program for a given analysis that provides baseline resolution in the shortest time. A chromatographer can see, within seconds, the effect of changes in column dimensions, carrier gas, and operating conditions instead of spending hours or days in the laboratory. The ezGC" software improves column selection, optimizes peak resolution, minimizes analysis times, and greatly increases laboratory productivity. Both method development labs and analytical labs performing routine analysis can benefit from ezGC". The following examples demonstrate the capabilities of ezGC" using a typical set of columns and chromatographic conditions.

Let ezGC" optimize your GC method for resolution in the shortest analysis time
To begin optimizing a GC method, first obtain two sets of retention times for the components of interest at two different temperature programs. In the following example, retention times were collected from two injections of a volatile fragrance mixture using temperature program rates of 3 and 8"C/min. Next, the chromatographic conditions and retention times were entered using the menu driven screens of the ezGC" program.

Figure 1 - Easily enter information into ezGC" from menu driven screens.

Figure 1 shows the screen used to input the retention time data. The first scenario we will investigate is where a particular column is already installed and the chromatographer wants to determine the conditions that will separate all components with the shortest analysis time. The ezGC" software can be set to automatically evaluate different temperature programs and print a solution list. The solution list is prioritized according

to the temperature(s) that resolve the most components in the shortest time. A resolution factor can be specified, or defaulted to a value of 1 S, which approximates baseline separation. Figure 2 illustrates the predicted chromatogram obtained for 19 flavor and fragrance compounds using a 30 meter, Rtx@- 1 column with a 1 .0pm film thickness. The program predicted a 10 minute initial hold at 65"C, providing baseline resolution in under 40 minutes.

Figure 2 - **Predict** the optimum conditions for baseline separation in the shortest time.

30m, 0.32mm ID, l.Opm Rtx'-1 (cat.# 10154)
Dven temp.: 65T (hold 10 min.) to 280°C @ 5 "C/min.
Carrier gas: helium **Regulation:** Constant Pressure
lLinear velocity: 25cm/sec. @ 65°C **Dead time:** 2 min. @ 65T
Peak identifications are on page 5.
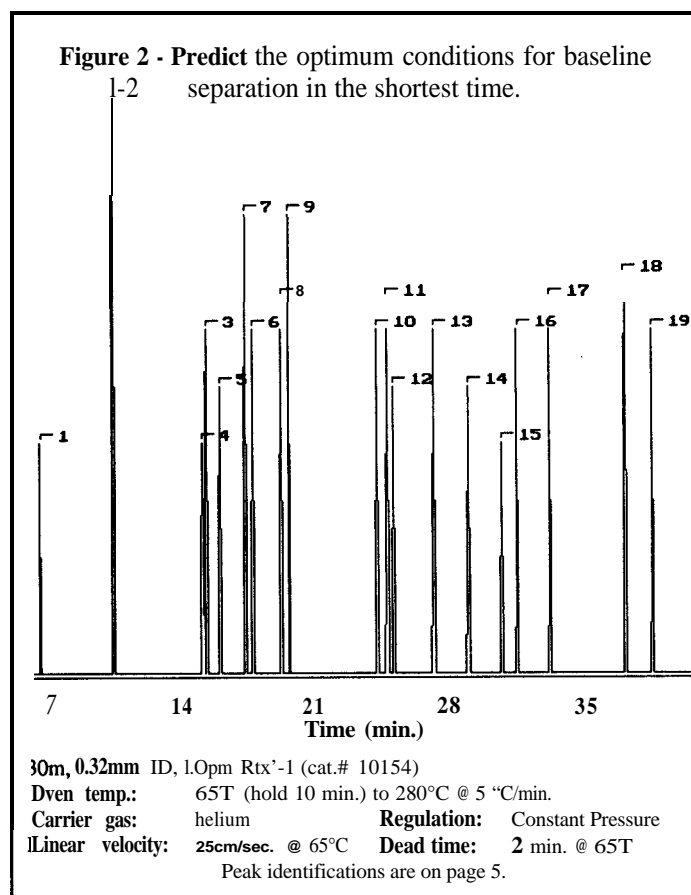
**Determine how changes in column and carrier gas will improve separations**
GC method development can be very costly when considering the expense of evaluating different stationary phases, column dimensions, and oven temperatures. Many chromatographers empirically optimize their chromatographic conditions for a particular column and then accept these as the "best separation" achievable. This is understandable considering the cost of buying and installing new columns. With ezGC" you can determine within minutes how changes in the column and operating conditions will effect separations.(Table I). All that is needed are the retention times for your components from two temperature programs using any column which has the same stationary phase. Previously calculated indices can be retrieved either from disk or loaded from a commercial data base or library.

Table I - Parameters that can be optimized using *ezGC*

oven temperature and program rate (multi-ramp)
minimum analysis time
maximum resolution
column length
film thickness
internal diameter
carrier gas type (He, H_2, N_2, Ar)
carrier gas flow or velocity
constant pressure or pressure program

To illustrate how ezGC" can be used to quickly determine the optimum analysis time for a particular sample, Restek's applications group optimized each of the parameters listed in Table I for the flavor and fragrance compounds shown in Figure 1. ezGC" predicted that a 15meter column, 0.25mm ID, a 0.25nm film thickness, in conjunction with a 25"C/min. temperature program would greatly decrease the analysis time without sacrificing resolution. The new optimum analysis was obtained using a lower-cost 15-meter column with an analysis time under 5 minutes with '/lo the analysis time and i/z the column length originally used (Figure 3). ezGC" more than pays for itself.

Figure 3 - Complete separation obtained using a 15-meter column in under 5 minutes.

Time (min.)
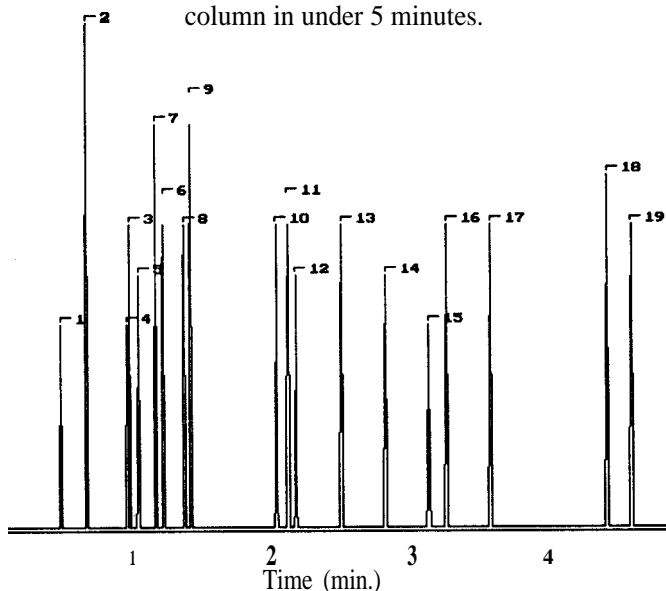
lSm, 0.25mm ID, 0.25pm Rtx@-l (cat.# 10120)
Oven temp.: **5X** to 230°C @ 25 'T/min.
Carrier gas: hydrogen   **Regulation:** constant F%eswre
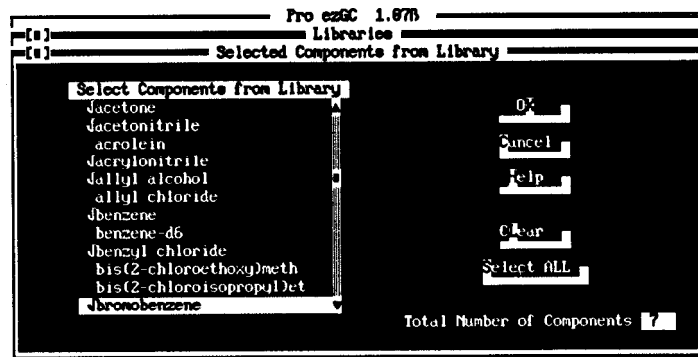**Linear velocity:** 89.lcm/sec. @ WC **Dead time:** 0.281 min. @ 55T

Peak Identification for Figures *2 & 3.*

1	ethyl butyrate	~rymene 8	15	eugenoi
2	trans-2-hexenol	9 D-limonene	16	vanillin
4	benzaldehyde	10 methone	17	ethyl vanillin
3	a-pinene 11	menthofurao	18	ethyl lamate
5	camphene. 12	menthol 19 amyl		cinnamic aldehyde
7	fi-pinene 13	carvone		
6	octanal 14	cinnamic alcohol		

Do method development without installing a column
Method optimization is much faster using ezGC", but is it possible to make column selection easier? Restek now offers data bases of thermodynamic retention indices called libraries, making it possible to select a column and predict chromatographic separations without even installing a column. These libraries contain hundreds of commonly analyzed components. These libraries have been generated in Restek's Applications Laboratory using the most appropriate stationary phases. Entries are added to the library after certifying each identification using GC/MS. Once the libraries are complete, it is possible to select components by simply choosing the entry from the library section of either ezGC"' or ***Pro ezGC"*** Figure 4 is an example of the select menu, showing a portion of the Environmental Volatiles library. This library currently contains 138 organic components (along with surrogates and internal standards) commonly analyzed in water and solid wastes, analyzed on three different stationary phases (Rtx@-502.2, Rtx"-1 and Rtx"-624). Furthermore, using ***Pro ezGC"*** makes it possible for each laboratory to create their own "User" libraries, adding compounds which can be modeled along with library data supplied by Restek. Restek now offers five libraries and plans to introduce several more libraries in the upcoming months. We also have plans to continue expanding the number of compounds offered and the number of stationary phases in each library.

Almost every chromatographic method currently in use could be made more efficient by separating the components of interest in less time. The thought of spending days of additional method time and/or purchasing columns which may not give better results often keeps analysts from investigating these options. With ezGC" it is possible to quickly and easily determine: "What is the best column?" and "What is the optimum temperature program and carrier flow?". The advanced features of ***Pro ezGC"*** make GC computer modeling

Figure 4 - Select the specific components for a stationary phase to separate and then optimize your method for any column, oven temperature and carrier gas parameters.

(ezGC" article is continued on page 6.)

Ⅲ *Pro ezGC%lethods Development Software*
The most powerful GC optimization software has new features!

- Simplify column selection.
- Optimize temperature and flow programs from a single analysis.
- Reduce analysis times and improve sample resolution.
- Model retention gap and guard column applications including Restek's Integra-Guard™ columns.
- Model columns in parallel or in series for process GC and multi-dimensional GC analyses.
- Software routines expanded for Fast GC, Windows@ 95, and Windows@ NT.
- Optimize dual-column run conditions.
- FREE Master Library Set!

FREE
Master Library
contains over 3,000 compounds!

Pro ezGC"" now includes the entire Master Set of Retention Index Libraries at no extra charge! These libraries contain more than 3000 compounds on the most commonly used stationary phases in ten different application areas including pesticides, PCBs, dioxins/furans, flavor &fragrance compounds, drugs of abuse, FAMEs, semivolatile pollutants, volatile pollutants, petroleum hydrocarbons, and solvents & chemicals. These librariespermitcomputer simulation without entering actual laboratory data.

Many analysts are following methods or using columns and run conditions they know could be optimized. But who has time to make the hundreds of injections necessary to optimize the temperatures, ramp rates, flow rates, pressures, and column parameters to get the perfect chromatogram? No one!

Let **Pro ezGC""** for Windows@ do the work for you. **Pro ezGC"** software is a powerful optimization software and retention index database for gas chromatography. This program accurately predicts GC separations on any capillary column and is useful for selecting the best column and conditions for your GC analysis. **Pro ezGC"** software utilizes either your chromatographic retention data or you can use the extensive library containing thousands of commonly analyzed compounds. From this data, it is possible to automatically evaluate thousands of combinations of column dimensions, oven temperature program, and carrier gas pressure program to determine the best separation with the fastest analysis time. This saves days of method development time for new analyses and can decrease analyses times of existing analyses by more than 50%. Several new features incorporated into Version 2 make **Pro ezGC"'** for Windows@ even more powerful and easy to use.

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Model GC separation including guard columns and capillary restrictors
The analysis of contaminated samples often requires the use of a guard column to minimize contamination of the analytical column. Cool on-column injection often utilizes retention gaps to improve peak widths and to facilitate injection using standard gauge syringes. These "precolumns" can either be connected using a low-volume union or built-in as with Restek's Integra-Guard™ columns. In GUMS applications, a length of deactivated tubing is sometimes added to the end of the analytical column to either increase the GC inlet pressure or to decrease background bleed from the transfer line tube. **Pro ezGC"** for WindowP now permits accurate modeling when these types of columns are used, even when the diameters are not identical to the analytical column.

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Pro ezGC" Method Development Software

Take the guesswork out of selecting the best column and conditions for your GC analysis with **Pro ezGC** for Windows@. Increase the productivity of your existing gas chromatographs by improving separations and shortening analysis time with optimized temperature and carrier gas programs. **Pro ezGC""** will save you time and money by greatly enhancing your productivity and increasing sample throughput. Take advantage of this powerful GC optimization tool today!
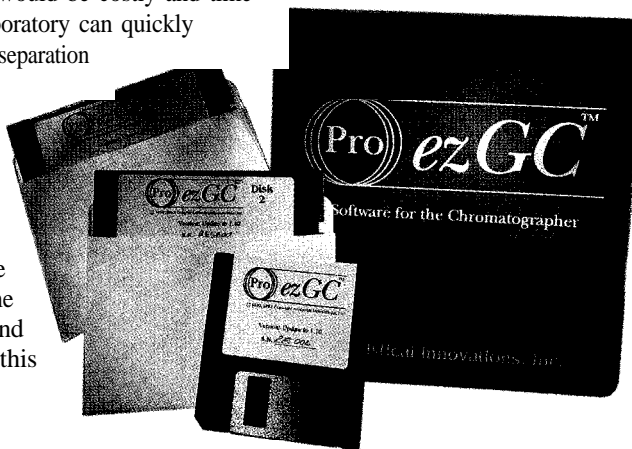
Pro ezGC"' for Windows@ ver. 2: cat.# 21487, ea.
Pro ezGC"' (DOS) to Pro ezGC"' for Window6 ver. 2 Upgrade: cat.# 21486, ea.

Attention EPC users!

Learn how to best use EPC with Pro ezGCM software. This sofhvare allows chromatogram optimization using constant flow, constant pressure, and pressure programming.

🔲 *Capillary Column Installation Video0*

The technical wizards at Restek produced an instructional video that takes the mystery and frustration out of capillary column installation. This essential resource covers critical points in the proper installation of a capillary column such as:

* Choice of carrier gas
* Instrument preparation
* Trouble-free installation
* Leak checking
* Setting carrier and detector gas flows
* Column conditioning

The installation sequence allows you to install your capillary column correctly, minimize downtime, and get your GC up and running quickly. The video follows ASTM Method E1510-93 for installing fused silica open tubular capillary columns in gas chromatographs to ensure your lab conforms with industry standards.

VHS: cat.# 20490, ea.
PAL: cat.# 20491, ea.
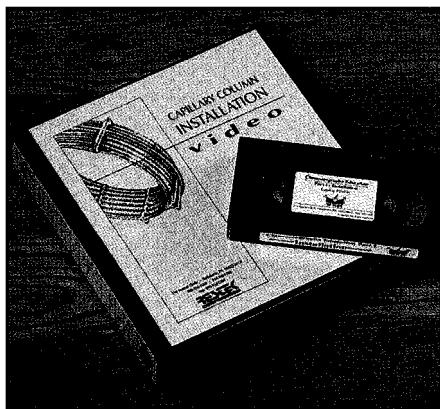
Ideal **Training**
T o o l

We guarantee this video will be the most useful instructional tool you'll ever use or we'll refund your money!

🔲 Educational Materials

Solvents & Chemicals Library Cotipound Index - Part 1

Version 1.0-cat#21450

Benzyl akohol	2-(2-Ethoxyethoxy)ethanol	2-(2-Methoxyethoxy)ethanoi	2-0ctn.n01
2,3-Butanediol	2-Ethyl- I-butanol	a-Methyl- I-butanoi	2-Gctanone
I-Butanol	2-Ethyl-I-hexanol	3-Methyl- I-butanol	3-Gctanone
2-Butanol	3-Ethyl-3-pentanol	2-Methyl-2-butanol	Pentadecane
2-Butanone	Heptadecane	3-Methyl-2-butanol	Pentanal
3-Buten- 1-01	Heptanal	3-Methyl-t-buten-l-o1	Pentane
3-Buten-2~1	Heptane	S-Methyl-3-heptanone	I-Pentanol
cis-2-Buten- 1-01	I-Heptanol	5-Methyl-2-hexanone	2-Pentanol
2-Butenal	2-Heptanol	2Methyl- I-pentanol	t-Pentanone
2-Butoxyethanol	CHeptanol	4-Methyl-2-pentanol	3-Pentanone
t-(2-Butoxyethoxy)ethanol	2-Heptanone	2-Methyl-3-pentanol	cis-2-Penten- 1-01
Butymlactone ; ·	3-lieptanone	3-Methyl-3-pentanol	3-Penten-2-one
Cyclopentanol	CHeptanone	t-Methyl-3-pentanone	2-Phenoxyethanol
Decanal	Hexanal	2-Methyl-pmpanal	CPhenyl-2-butanone
Decane	Hexadecane	2-Methyl- I-propanol	lb-Pmpanediol
l-Decanol	Hexane	I-Methyl-2-pyrrolidinone	I-Propanol
2-Decanol	1-Hexanol	a-Methyl benzyl alcohol	2-Propanone
2-Decanone	2-Hexanol	Methyiisobutylketone	2-Pmpen- l-o1
2,6-DimethylJ-heptanone	3-Hexanol	4-Methyl-j-penten-2-one	Propionai
2,4-Dimethyl-2pentanol	t-Hexanone	Nonanal	2-Pmpyn- I-01
2.4-Dimethyl-3-pentanol	3-Hexanone	Nonane	Tetradecane
2,2-Dimethyl-3-pentanol	cis-3-Hexen- 1-01	I-Nonanol	Tetraethylene glycol
2.2-Dimethyl-l-pentanol	trans-ttlexen- l-01	t-Nonanol	Tridecane
2,4-Dimethyl-3-pentanone	4-Hexen-3one	2-Nonanone	Triethylene glycol
Dodecane	tetra-Hydro-tfuran-methanol	3-Nonanone	2,2,2-Trifluoroethanol
I-Dodeunol	4-Hydmxyl-methyl-2-pentanone	5-Nonanone	Undecrme
t-Dodecanone	Isopropyl alcohol	Octanal	I-Undecanol
Ethanol	Methanol	Octane	2-Undecanone
2-Ethoxyethanol	2-Methoxyethanol	I-Octanol	

Conditions:

Column 1   IOSm, OJ3mm ID, 3.0um Rtx*-I (cat.# 10189)
         Slow run: 35°C (hold 10 mm.) to 270°C 8 4'Cimin. (hold 20 min.)
         Fast run: 40°C (hold l0 min.) to 275'C O lZ"C/min. (hold 20 min.)

Column 2   105m, 0.53mm ID, 3.0um RtxO-502.2 (cat.!+ 10910)
         Slow run: 35°C (hold IO min.) to 265°C @ 4"C/min.
         Fast run: 40°C (hold 10 min.) to 270°C @ 12'C/min. (hold 10 min.)

Column 3   60m, 0.53mm ID, l.Opm Stabiiwax" (cat.# 10658)
         Slow run: 40°C (hold 10 min.) to 245°C Q 4"C/min. (hold 20 min.)
         Fast run: 45°C (hold 10 min.) to 250°C @ It"C/min. (hold 20 min.)

Carrier: Helium
Instrument: HP 589011 GC and HP5971A MSD
Outlet: .l   Vacuum (MSD), 0.00 psi

Note: *Some stationary phases may contain species nor common to all libran'es.*

Restek Corporation
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Drugs & Pharmaceuticals Library Compound Index

VersionLO-cat#21453

Acetophenetidin
Acetopromazine
Alphaprodine
Alprazolam
Amitriptyline
Amobarbital
Aprobarbital
Atropine
Barbital
Benzocaine
Benzphetamine
Bromazepam
Brompheniramine
Bupivacaine
Butabarbital
Butalbital
Butethal
Caffeine
Carisoprodal
Chlorpheniramine
Chlorpromazine
Chlorprothixene
Clobazam
Clomipramine
Clonazepam

Cocaine
Codeine
Cotinine
Desipramine
Desmethyldiazepam
Dextromethorphan
Diazepam
Dibucaine
Dimenhydrinate
Diphenhydramine
Diphenylhydantoin
Doxepin
Doxylamine
Ethosuximide
Fiunitrazepam
Fhuazepam
Glutethimide
Haloperidol
Hexobarbital
Hydrccodone
Hydromorphone
Imipramine
Ketamine
L-evorphanol
Lidocaine

Lorazepam
Maprotyiine
Medazepam
Meperidine
Mephobarbital
Meprobamate
Methadone
Methapyriline
Methaqualone
Methyprylon
Nalorphine
Nicotine
Norcodeine
Nortriptyline
Papaverine
Pentazocine
Pentobarbital
Phencyclidine
Pheniramine
Phenobarbital
Phenothiazine
Phenylbutazone
Phenyltoloxamine
Prazepam
Primidone

Procainamide
Prochlorperazine
Promazine
Propoxyphene
Pyrilamine
Scopolamine
Secobarbital
Strychnine
Temazepam
Tetracaine
Thiamylal
Thiopental
Thioridazine
Trazodone
Triazolam
Trifluoperazine
Trimeprazine
Trimipramine
Tripelennamine
Triprolidine
Valproic Acid
Verapamil

Conditions:		Experimental Runs:
Column 1:	3Om, 0.25mm ID, 0.25pm Rtx*-5, cat.# 10223	**Slow Temperature Program:** 50°C (hold 0 min.) to 325°C @ 4"C/min. (hold 20 min.)
Column 2:	3Om.0.25mm ID. 0.25um Rtx*-50, cat.# 10523	
Column 3:	3Om. 0.25mm ID, 0.25um RtxO-200, cat.# 15023	
Inlet:	Constant pressure Outlet: Vacuum (0.00 psi)	**Fast Temperature Program:** 100°C (hold 0 min.) to 325°C @ lZ"C/min_ (hold 20 min.)
Linear velocity: 35cm/sec.	Dead time: 1.4 min.	
Carrier gas:	Helium	

Environmental Volatiles Library
Compound Index
Version l.0 - cat.# 21452

Acetone
Acetonitrile
Acrolein
Acrylonitrile
Ally1 alcohol
Ally1 chloride
Benzene
Benzene-d6
Benzyl chloride
Bis(2-chloroeethoxy)methane
Bis(2-chloroisopropyl)ether
Bromobenzene
Bromochloroacetonitrile
2-Bromochlorobenzene
3-Bromochlorobenzene
4-Bromochlorobenzene
Bcomochloromethane
Bromoichloromethane
CBromofluorobenzene
Bromoform
Bromomethane
2-Bromo-1-Chloropropane
t-Butyl alcohol
n-Butylbenzene
sec-Butylbenzene
tert-Butylbenzene
Carbon disulfide
Carbon tetrachloride
Chloroacetonitrile
Chlombenzene
Chlorobenzene-d5
l-Chlorobutane
Chloroethane
2-Chloroethanol
2-Chloroethyl vinyl ether

Chloroform
1-Chlorohexane
Chloromethane
3-Chloropropionitrile
2-Chlorotoluene
4-chlorotoluene
l-Chloro-2-Fluorobenzene
Cyclohexane
Dibromoacetonitrile
Dibromochloromethane
1,2-Dibromoethane
Dibromofluoromethane
Dibromomethane
1,2-Dibromo-3-chloroopropane
Dichloroacetonitrile
I,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,2-Dichlororobenzene-d4
1,4_Dichlorobenzene-d4
l,2-Dichlorobutane
Dichlorodifluoromethane
l,l-Dichloroethane
1,2-Dichloroethane
1,2-Dichloroethane-d4
1, I-Dichloroethene
cis- I,2-Dichlorothene
trans-1,2-Dichloroethene
Dichloromethane (CH2Cl2)
l,2-Dichloropropane
1,2-Dichloropropane
2,2-Dichloropropane
l,l-Dicchloropropane
1, I-Dichloropropene
cis-l,3-Dichloropropane

trans- 1,3-Dichloropropene
cis- 1.4-Dichloro-2-butene
trans- 1,4-Dichloro-2-butene
1,3-Dichloro-2-propanol
Diethyl ether
I,4-Difluorobenzene
1,4-Dioxane
Epichlorohydrin
Ethanol
Ethyl methacrylate
Ethylbenzene
Ethylbenzene-dl0
Ethylbenzene-d5
Ethylene oxide
Fluorobenzene
Hexachlorobutadiene
Hexachloroethane
2-Hexanone
Iodomethane
Isobutyl alcohol
Di-isopropyl ether
Isopropylbenzene
p-lsopropyltoluene
Malononitrile
Methacrylonitrile
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (MIBK)
Methyl methacrylate
Methyl tertiary butyl ether
Methylacrylate
Naphthalene
Nitrobenzene
2-Nitropropane
Pentachloroethane

Pentafluorobenzene
ZPicoline
Propargyl alcohol
Propionitrile
n-Propylamine
n-Proopylbenzene
Pyridine
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-TetracNoroethane
TetmcNometh&e
THP
Thiophenol (Benzenethiol)
Toluene
Toluene-d8
Trichloroacetonitrile
1,2,3-Trichloroenzene
1,2,4-Trichlorobenzene
l,l,l-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Triclhlorofluoromethane
1,2,3-TricNoropmpane
l.l,l-TricNoro-2-propanone
1,1,2-Trichloro-1,2,2-
tifluoroethane (FIF1)
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Vinyl acetate
Viiyl chloride
m-Xylene
o-Xylene
p-Xylene

Conditions:		Experimental Runs:
Column 1: IOSm, 0.53mm ID, 3.0pm R&-1 cat4 10189	Column 2: 105m, 0.53mm ID, 3.0pm Rtx*-502.2 cat.# 10910	Slow Temperature Program: 35°C (hold 10 min.) to 220°C @ 4'Cmin. (hold 3 min.)
Carrier: Helium	Dead time: 3.16 min. @ 50°C	
Instrument: HP 589011 GC and HP 5971 MSD		
Inlet: constant pressure	Column 3: 105m. 0.53nun ID. 3.0pm R&*-624 caL# 10975	Fast Temperature Program: 40'C (hold 10 min.) to 230°C @ 12'C/min. (hold 3 min.)
Dead time: 3.03 min. @ 5WC		
Outlet: Vacuum (MSD), atmospheric	Dead time: 3.31 min. @ 50°C	

Y664mA
Dam 7193

Flavor & Fragrance Library Compound Index

Version 1.0-cat.#21451

4-~ybllliSOlC
amyl cinnamic aldehyde
trans-anethole
alpha-angelicalactone
anisaldehyde
anisole
benxaldehyde
borne01
bomyl acetate
camphene
camphor
3-carene
catvacrol
carveol
r-carvone
s-carvone
carvone acetate
catvone hydrate
cis-carvyl acetate
trans-carvyl acetate
cis-carvyl propionate
trans-catvyl proprionate
alpha-znyophyllene
beta-caryophyllene
caryophyllene oxide
1.8-cineole
trans-cinnamic acid
cinnamic alcohol
trans-cinnamaldehyde
cinnamide
cinnamyi acetate
citral a
citral b
citronella1
beta-citronelloi
citronellyl acetate
citronellyl formate
coumarin
cumic acid
cumin alcohol

cuminaldehyde
para-cymene
dihydmCaNeo1
cisdiiydrccarvone
transdihydrocarvone
diiydrocoumarin
dihydrojasmone
2,3-dimethylkisole
2.4dimethyianisoIe
2,5diiethylankole
2,6-diiethylanisole
2..5diiethylfuran
2,3dimethyl-p-anisaldehyde
2,5-dimethyl-panisaldehyde
D-n-menthol
estragole
ethyl butyrate
ethyl laurate
ethyl vanillin
2-ethyKuran
eucalyptol
eugenol
cis-famesol
trans-famesol
fenchone
tiufurai
furfuryl acetate
furfuryl alcohol
geranial
geraniol
geranyl acetate
guaiaxulene
tmns-2-hexenal
trans-2-hexenol
alpha-humulene
indole
alpha-ionone
beta-ionone
isobomeol
isoeugenol

cis-jasmone
liionene
linalool
linalyl acetate
malt01
menthofuran
+/- menthol
menthone
cis-menthyl acetate
tram+menthyl acetate
methyl cinnamate
2-methyhutisole
3-methylanisole
4-methylanisole
alpha-methylcinnamic acid
6-methylcoumarin
7-methylcoumarin
2-methylfumn
S-methylfutfural
3-methyl-p-anisaldehyde
2-methyl-trans-cinnamic aldehyde
myrcene
neral
cis-nerol
netyl acetate
nootketone
cis-ocimene
trans-ocimene
octarlal
l-octen-3-01
perillaldehyde
perillyi alcohol
phellandrene
pinacol
pinacoi alcohol
pinacolone
alpha-pinene
beta-pinene
pulegone
trans-sabinene hydrate

salicaldehyde
alpha-terpinene
gamma-terpinene
terpirlen4ol
alpha-terpineol
alpha-terpinolene
terpinyl acetate
thiaxole
thiophene
alpha-thujone
beta-thujone
thymol
triacetin
tricyclene
valencene
deha-valerolactone
gamma-vaierolactone
vanillin
vanillin acetate
verbenone

C!honane
C10:decane
C 11 :undecane
C1Z:dodecane
C13:tridecane
C14:tetradecane
ClS:pentadecane
C16:hexadecane
C 17:heptadecane
C18:octadecane
C 19:nonadecane
C20:eicosane
C21:heneicosane
C22:docosane
C23:tricosane
C24:tetracosane
CZkhexacosane

Conditions:				Experimenhl Runs:
Column 1:	6Om, 0.25mm ID, 0.2.5pm RtxO- 1 cat.# 10126	Column 2:	60m. 0.25mm ID. 0.25um StabilwaxO cat.# 10626	Slow Temperature Program: 35°C (hold 0 min.) to 250°C @ 3'C/min. (hold 15 min.)
Carrier:	Helium	Carrier:	Helium	
Instrument:	HP 589011 GC and HP5971A MSD	Instrument:	HP 589011 GC and HP5971A MSD	
Inlet:	Constant Pressure, 18.74 psi	Inlet:	Constant Pressure, 16.21 psi	Fast Temperature Program:
Dead time:	3.988 min. at 50°C	Dead time:	4.110 min. at 50°C	5O'C (hold 0 min.) to 28O'C
Outlet:	Vacuum (MSD), 0.00 psi	Outlet:	Vacuum (MSD), 0.00 psi	@ 8"C/min. (hold 15 min.)

Rest&Corporation

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