SHIMADZU APPLICATION NEWS

LA180-E010

● GAS CHROMATOGRAPHY

No.G212

Reduction of Analysis Time in Capillary GC (Part 4)
Factors Affecting Analysis Time (Isothermal Analysis)

Reducing the analysis time is the simplest way to enhance the productivity of gas chromatography. However, little information is available on how the analysis time and resolution change when certain analysis conditions are altered.

As basic information on reducing analysis time, this Application News introduces the results of investigations into how the analysis time and resolution change due to changes of the column temperature, carrier gas linear velocity, column length, or liquid-phase film thickness in isothermal analysis.

The retention time and resolution for toluene, ethyl benzene, m-xylene + p-xylene, and o-xylene were investigated using a nonpolar column.

Fig. 1 shows the chromatograms for column temperatures of 75˚C, 100˚C, and 125˚C. Table 1 shows the retention times and resolutions. Increasing the temperature by 25˚C halved the analysis time, with a 20% to 30% drop in resolution.

Fig. 2 shows the chromatograms for carrier gas linear velocities of 20 cm/s, 40 cm/s, and 80 cm/s. Table 2 shows the retention times and resolutions. Doubling the carrier gas linear velocity approximately halved the analysis time. Doubling the carrier gas linear velocity from 20 cm/s to 40 cm/s caused no apparent drop in resolution, whereas doubling it from 40 cm/s to 80 cm/s resulted in approximately 20% drop in resolution.

Fig. 3 shows the chromatograms for column lengths of 30 m and 60 m. Table 3 shows the retention times and resolutions. Halving the column length approximately halved the analysis time, with approximately 30% drop in resolution.

Fig. 4 shows the chromatograms for the liquid-phase film thickness of 1μm and 0.25μm. Table 4 shows the retention times and resolutions. Reducing the film thickness to 1/4 resulted in approximately 1/4 the analysis time, with approximately 30% drop in resolution.

The results above indicate that the analysis time for isothermal analysis can be approximately halved by increasing the column temperature by 20˚C or 30˚C, doubling the carrier gas linear velocity, halving the column length, or halving the liquid-phase film thickness. However, with each of these methods, poorer resolution accompanies the reduced analysis time. Of these methods, increasing the carrier gas linear velocity appears to have comparatively little detrimental affect on the resolution.

Therefore, the isothermal analysis time can be most easily reduced by increasing the carrier gas linear velocity. If resolutions between each components are sufficiently high, the analysis time can also be efficiently reduced by increasing the column temperature in the range where the separation state is not deteriorated. The other methods require replacing the column, with associated cost and work.

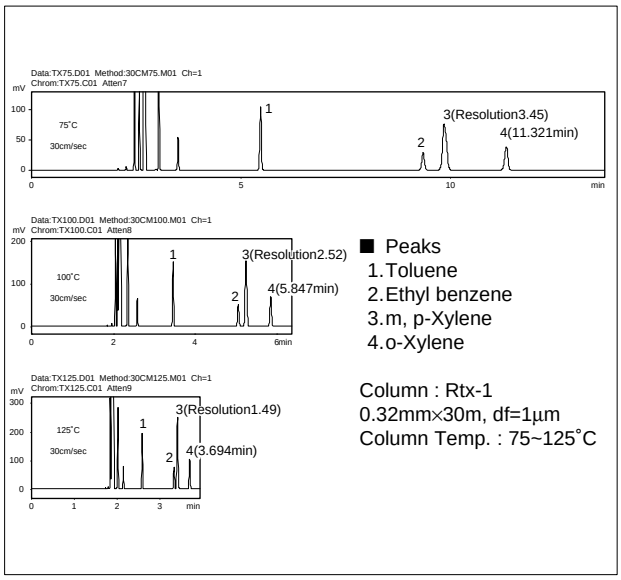

Fig. 1 Factors Related to Analysis Time 1 – Relationship between Column Temperature and Retention Time

Table 1 Factors Related to Analysis Time 1 – Relationship between Column Temperature and Retention Time

	75˚C constant 30cm/sec		100˚C constant 30cm/sec		125˚C constant 30cm/sec	
	Rt (min)	Resolution	Rt (min)	Resolution	Rt (min)	Resolution
Toluene	5.455		3.457		2.584	
Ethylbenzene	9.333	41.70	5.053	28.93	3.300	16.63
m, p-Xylene	9.836	3.45	5.240	2.52	3.408	1.49
o-Xylene	11.321	9.36	5.847	7.68	3.694	5.26

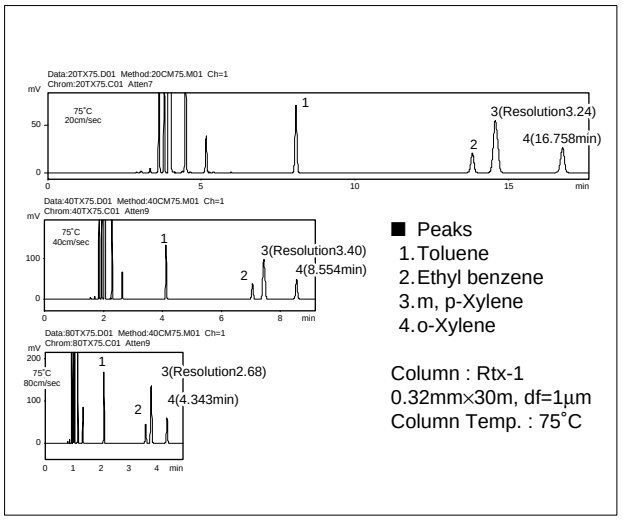

Fig. 2 Factors Related to Analysis Time 2 – Relationship between Carrier Gas Linear Velocity and Retention Time

Table 2 Factors Related to Analysis Time 2 – Relationship between Carrier Gas Linear Velocity and Retention Time

	75˚C constant 20cm/sec		75˚C constant 40cm/sec		75˚C constant 80cm/sec	
	Rt (min)	Resolution	Rt (min)	Resolution	Rt (min)	Resolution
Toluene	8.078		4.120		2.094	
Ethylbenzene	13.821	38.03	7.052	41.21	3.582	30.19
m, p-Xylene	14.568	3.24	7.434	3.40	3.777	2.68
o-Xylene	16.758	8.75	8.554	9.24	4.343	7.22

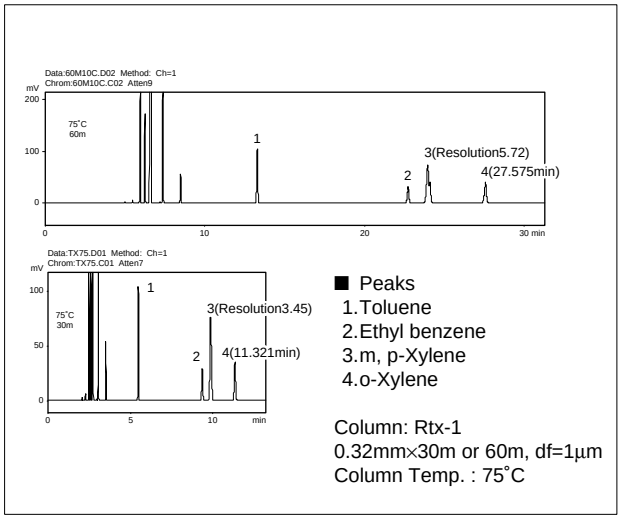

Fig. 3 Factors Related to Analysis Time 3 – Relationship between Column Length and Retention Time

Table 3 Factors Related to Analysis Time 3 – Relationship between Column Length and Retention Time

	30m 30cm/sec		60m 30cm/sec	
	Rt (min)	Resolution	Rt (min)	Resolution
Toluene	5.455		13.273	
Ethylbenzene	9.333	41.70	22.725	62.00
m, p-Xylene	9.836	3.45	23.947	4.75
o-Xylene	11.321	9.36	27.575	12.99

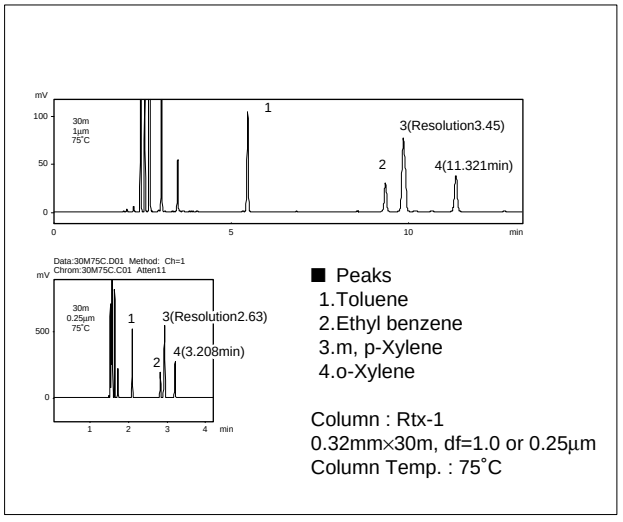

Fig. 4 Factors Related to Analysis Time 4 – Relationship between Film Thickness and Retention Time

Table 4 Factors Related to Analysis Time 4 – Relationship between Film Thickness and Retention Time

75˚C	30m×0.25mm, 0.25μm		30m×0.25mm, 1μm	
	Rt (min)	Resolution	Rt (min)	Resolution
Toluene	2.101		5.455	
Ethylbenzene	2.829	24.76	9.333	41.70
m, p-Xylene	2.938	2.63	9.836	3.45
o-Xylene	3.208	6.24	11.321	9.36

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