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Software for Efficient Method Development "LabSolutions™ MD"

Application News

AI-Driven Automated Column Screening and Gradient Optimization for LC Method Development

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User Benefits

- The AI algorithm of LabSolutions MD can automatically optimize gradient conditions to greatly reduce labor of LC method development.
- Gradient conditions are automatically optimized for multiple columns by column switching valve.
- Automatic optimization of gradient conditions can be applied not only to new method development, but also to existing method to efficiently improve resolution.

■ Introduction

In the typical LC method development, the process begins with "preparation" which includes mobile phase preparation, column installation, and creation of analysis schedules, then the analysis is started. After that, the acquired data is analyzed and "preparation" for the subsequent analysis is carried out, followed by starting the next analysis again. The method development progresses by repeating these processes, but in addition to the significant time required to repeatedly create analysis schedules, expertise in chromatography is necessary to explore optimal conditions based on data analysis. In other words, typical method development requires "human intervention". Therefore, eliminating human involvement and automating such method development processes would be desirable to improve labor efficiency. This article introduces an automatic exploration of a combination of the column and gradient conditions that meet the criteria of resolution by automatic optimization of gradient conditions on multiple columns consecutively.

■ Analytical Conditions and Target Compounds

The analytical conditions and target compounds are shown in Table 1. In this article, a mixture of six compounds was used as the model sample. Criteria for the resolution and elution time of the last peak were specified for this sample, and a combination of a column and gradient conditions that met these criteria were automatically searched using LabSolutions MD (A dedicated software for supporting method development : Technical Report C190-E309). For the optimization, three columns were used : column A (Shim-pack Velox™ C18), column B (Shim-pack Scepter™ C18-120), and column C (Shim-pack™ GIST C18-AQ).

Table 1 Analytical Conditions and Target Compounds

System : Nexera™ X3	
Sample : ① Hydrocortisone, ② Furosemide, ③ Ketoprofen, ④ Probenecid, ⑤ Diclofenac, ⑥ Indomethacin	
Mobile phase:	
Pump A : 0.1% formic acid in water	
Pump B : Acetonitrile	
Column A : Shim-pack Velox C18 *1	
Column B : Shim-pack Scepter C18-120 *2	
Column C : Shim-pack GIST C18-AQ *3	
(100 mm × 3.0 mmI.D., 1.9 µm for all columns)	
Analytical conditions	
B Conc.	: Automatically set by LabSolutions MD
Column Temp.	: 40 °C
Flow rate	: 0.7 mL/min
Injection Vol.	: 5 µL
Detection	: 254 nm (SPD-M40, UHPLC cell)
Criteria of automatic optimization of gradient conditions	
Minimum resolution	: 1.5
Elution time of last peak	: < 10 min

*1 : 227-32008-02, *2 : 227-31013-03, *3 : 227-30808-02
(Shimadzu GLC product number)

■ Automatic Optimization of Gradient Conditions

Fig. 1 shows the workflow of automatic optimization of gradient conditions using LabSolutions MD. This software has a unique AI algorithm to automatically explore gradient conditions that satisfy resolution criteria by alternately repeating "improvement of gradient conditions by AI (condition search)" and "analysis under improved conditions (correction analysis). For the criteria, "resolution" and "elution time of the last peak" can be set. Automatic optimization can be performed by simply inputting flow rate and column oven temperature (Fig. 2), providing easy operation for anyone, regardless of experience in chromatography. In this article, automatic optimization of gradient conditions was applied to column A, B, and C to meet the criteria of minimal resolution of 1.5 and maximum elution time of 10 minutes for the last peak (Fig. 2) to consider the reduction of analysis time.

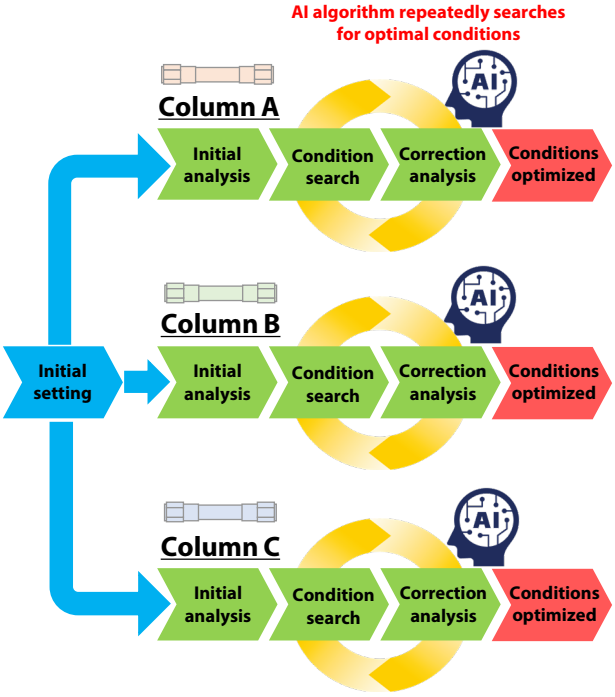

Fig. 1 Workflow for Automatic Optimization of Gradient Conditions by LabSolutions MD

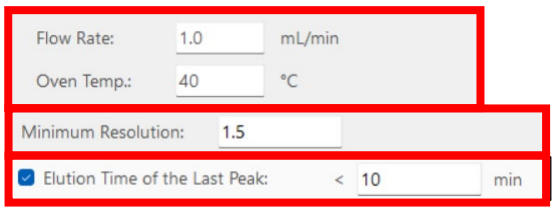

Fig. 2 Setting for Automatic Optimization

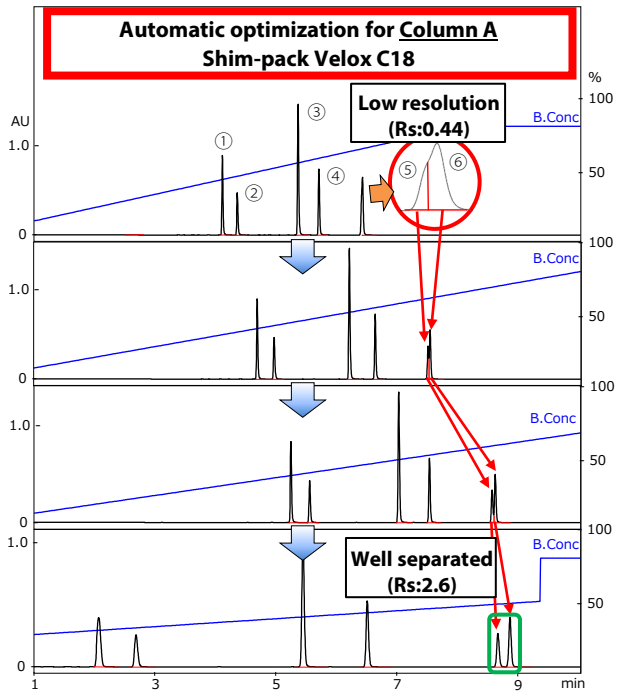

Fig. 3 Result of Automatic Optimization on Column A
* blue line shows gradient conditions

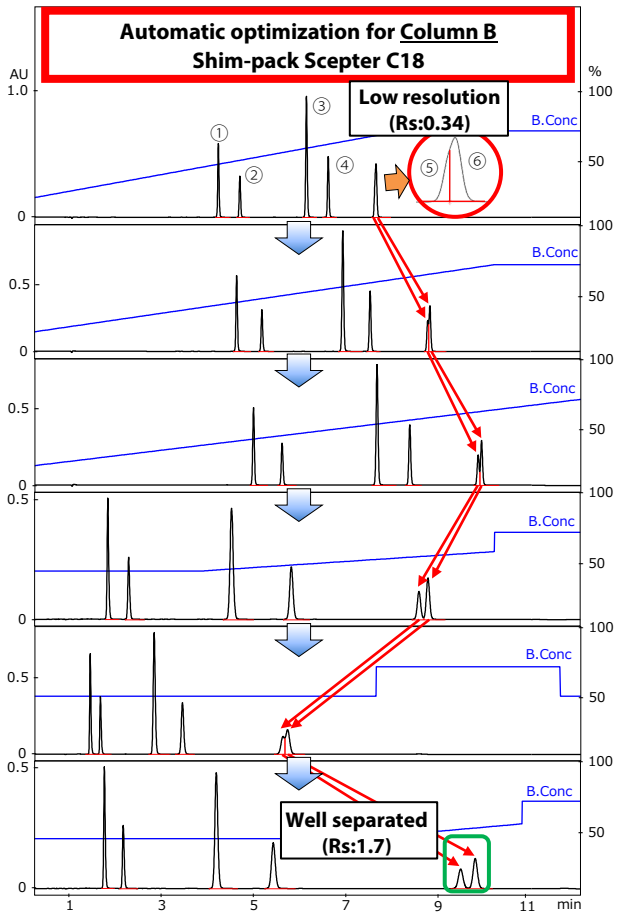

Fig. 4 Result of Automatic Optimization on Column B
* blue line shows gradient conditions

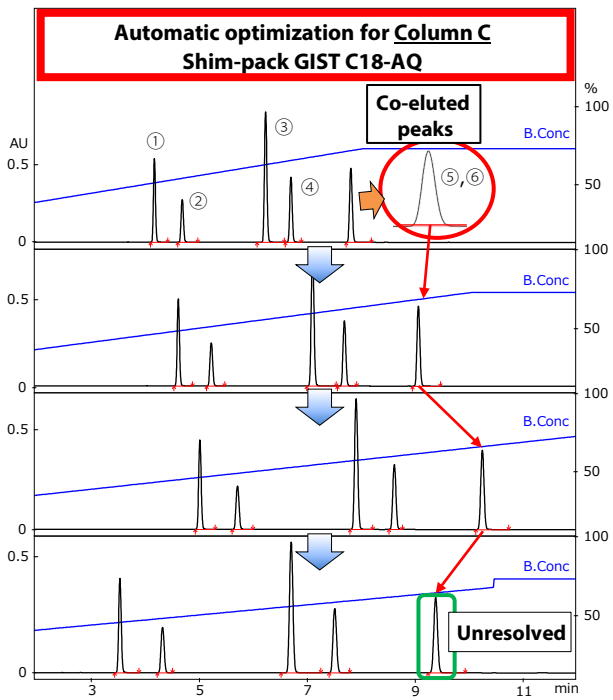

Fig. 5 Result of Automatic Optimization on Column C
* blue line shows gradient conditions

The results of automatic optimizations of gradient conditions on column A, B, and C are shown in Fig. 3~5, respectively. The resolutions of some peaks on column A and B were not sufficient in initial analyses (indicated by red circles in Fig. 3 and 4) considering the criteria of minimal resolution of 1.5. Subsequently, "improvement of gradient conditions by AI" and "analysis under improved conditions" were applied to automatically improve the gradient conditions to finally meet the criteria for column A and B (green boxes in Figs. 3 and 4). On the other hand, for column C, two peaks (⑤ and ⑥) were co-eluted and could not meet the criteria of resolution. These results showed that column A, providing the highest resolution (2.6), was optimal for this sample. As shown above, the optimization of gradient conditions can be applied to multiple columns consecutively, allowing anyone to easily search for conditions that meet the criteria regardless of their experience in chromatography.

■ Conclusion

Automatic optimization of gradient conditions using AI algorithm of LabSolutions MD was applied to a model sample (mixture of six compounds of small molecule) with three columns. As a result, the column and gradient conditions that met the resolution criteria were successfully explored. In method development, human intervention, such as analysis batch creation and data analysis, is required to optimize gradient conditions. However, LabSolutions MD can provide significant labor savings in this area. For more information on LabSolutions MD, please refer to the Technical Report "Efficient Method Development Based on Analytical Quality by Design with LabSolutions MD Software (C190-E284)".

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