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Technical Report

Heightened Analytical Efficiency and Integrated Management of Multifaceted Data Using the Dual Injection Function in the SIL-40 Series Autosampler

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Abstract:

The unique dual injection function is optionally available for the Nexera series. At analysis sites, there are cases in which analysis must be performed twice under different analytical conditions because multiple components from a single sample cannot be separated at the same time, or two completely different compounds must be quantified. With the dual injection system, two independent flow lines are built into a single platform. Chromatograms are acquired simultaneously under two different conditions, and the results obtained are integrated into a single data file. Examples of such analyses include fermentation monitoring, which involves the simultaneous measurement of organic acids and amino acids, the metabolites of microorganisms, as well as the test of complex impurity property in the drug that are hard to separate at the same time under a single set of conditions. In these analyses, this function not only significantly improves analytical efficiency, but also integrates the two chromatograms into a single data file, ensuring traceability with respect to the sample. Additionally, not only the data files but also the method files and batch files are each integrated respectively into a single file, simplifying data management, and ensuring data integrity. In this article, we introduce the actual process starting with how to use the dual injection system, as well as the sequence of steps up to integrated data management, and the heightening of efficiency.

Keywords: Dual injection function

1. Dual Injection Function

The dual injection function is an optional function for the SIL-40 series. It enables a sample to be injected into two analysis flow lines.*

With a dual injection system using this function, two flow lines are incorporated into a single system, enabling two analyses to be performed simultaneously (Fig. 1).

The two sets of analysis data obtained by using this system are integrated into a single data file. This ensures traceability of the data with respect to the sample and eliminates the risk of incorrect associations between pairs of data files originated from different samples.

Additionally, the method files, batch files, and data files from the two analyses are each integrated into a single file. This simplifies data management and ensures data integrity.

Furthermore, analyses that conventionally used multiple systems, as well as analyses implemented by switching the conditions for each target component can now be performed simultaneously. This results in shorter analysis times (Fig. 2), smaller installation space requirements, and lower initial costs (Fig. 3).

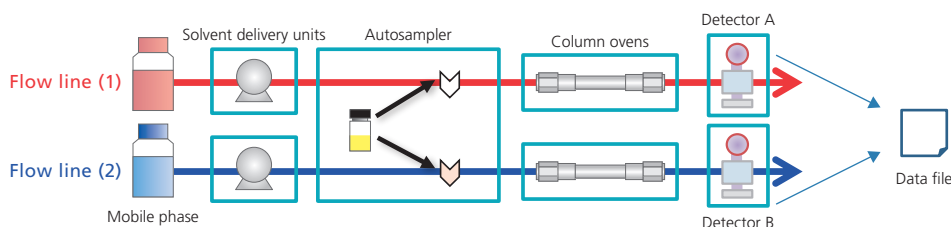* An optional kit is required to use the dual injection function.

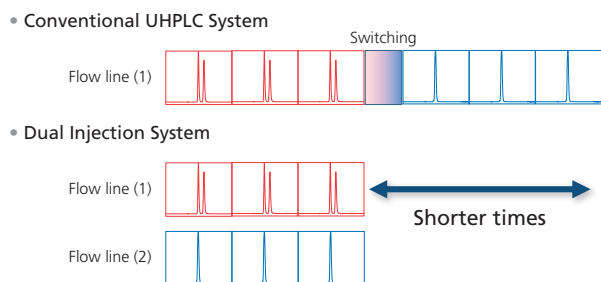Fig. 1 Flow Lines in the Nexera Dual Injection System

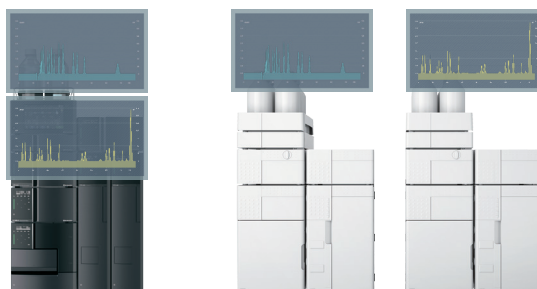Fig. 2 Dual Injection System Contributes to Shorter Analysis Times

Fig. 3 Dual Injection System Contributes to Installation Spaces Savings

2. Operation of the Dual Injection System

When using the dual injection function, the injection ports in the autosampler and the valves in the neighboring column ovens are increased by one each respectively. The respective injection ports are connected to separate valves and sample loops, resulting in a configuration in which they are connected with the sample loops and flow lines via valve switching (Fig.4, 5).

The loop injection method is used for both flow lines. It is possible to select the sample loop with the optimal capacity and change the injection volume to suit the intended analysis.
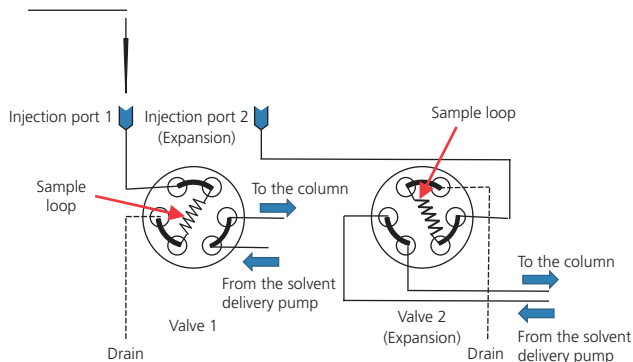
Fig. 4   Flow Line when the Sample is Loaded into the Sample Loops
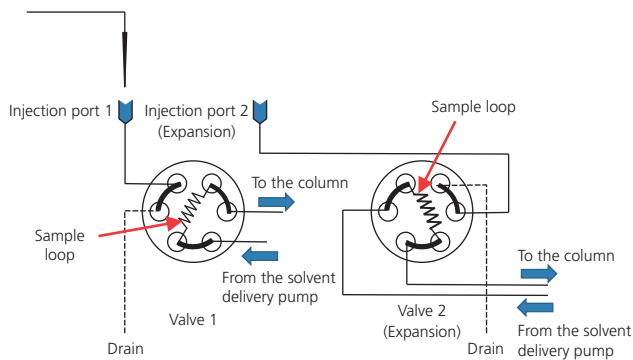

Fig. 5   Flow Line when the Sample is Injected into the Columns

An overview of the autosampler injection process is shown below (Fig. 6).

After the valve is switched to select a flow line during sample loading, the sample is loaded into the sample loop (pretreatment). After loading the sample into each flow line, the valves are switched to flow line (1) and flow line (2) simultaneously. The sample in the flow lines during injection is then introduced to the columns. Afterwards, the autosampler rinses the flow lines used for injection (post treatment).
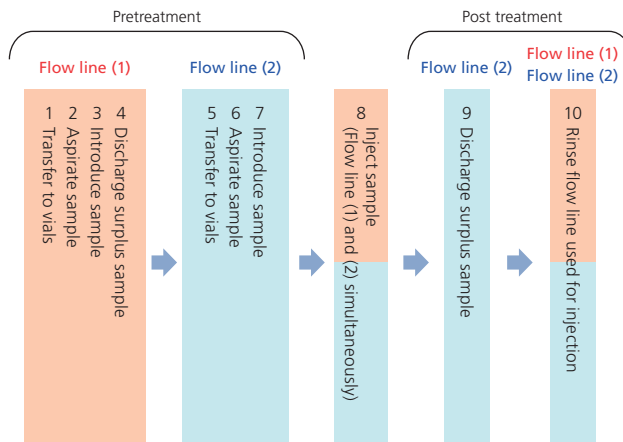

Fig. 6   Autosampler Injection Process

3. Settings and Data Analysis in LabSolutions

The dual injection system is configured using LabSolutions. The analytical conditions and analysis sequence for the two flow lines are configured in a single method file and batch file (Fig. 7 to 9). Conventionally, for two analyses, it was necessary to create different files. However, using the dual injection function, the respective information is integrated in a single file, simplifying data management and ensuring data integrity.
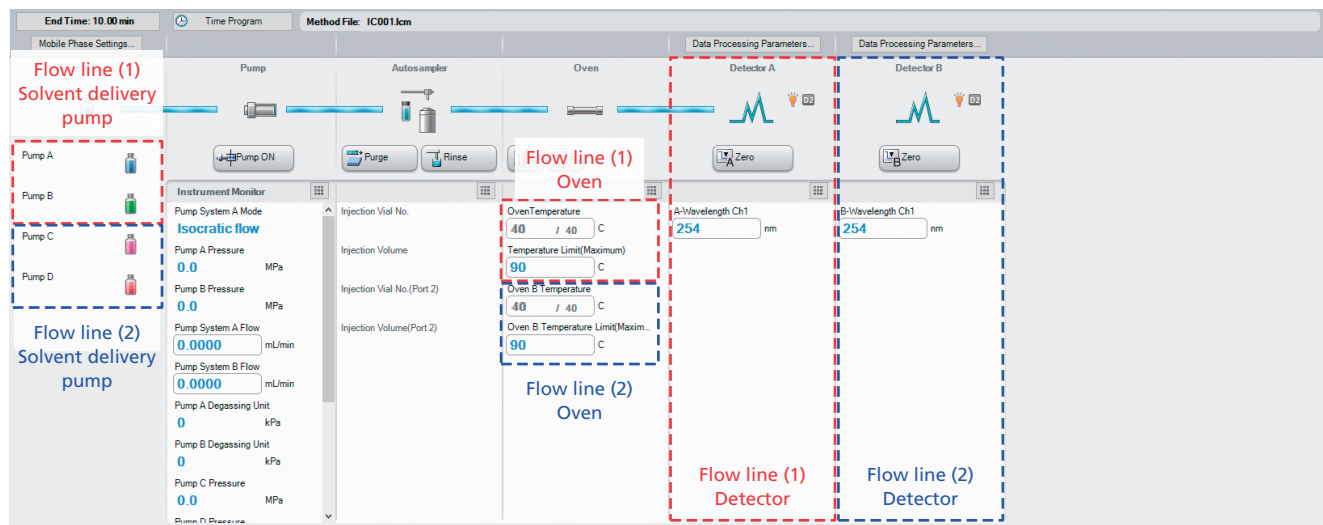

Fig. 7   Example of the Analytical Condition Settings (Solvent Delivery Pump, Oven, and Detector)

Additionally, use of the dual injection function is enabled by selecting [Simultaneous (Port 1, 2)] for the ports used in the settings for the autosampler in the method file (Fig. 8). Also, it is possible to perform an analysis using only one of the flow lines by specifying the port to use.

In the settings for consecutive analysis, the vial number and injection volume for the sample injected into each flow line are entered on one line. Either the same vial numbers or different vial numbers can be specified (Fig. 9).

For example, after injecting the standard samples used to create a calibration curve into each of the flow lines from the different vials, the actual sample can be injected into both flow lines from a single vial.
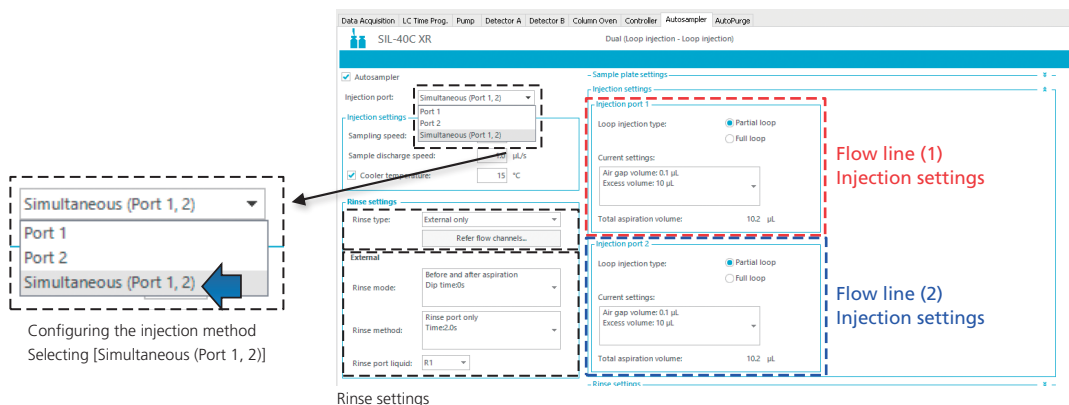
Fig. 8   Example of the Analytical Condition Settings (Autosampler)

Fig. 9   Example of the Vial Number Settings

With the dual injection system, the two sets of data for the same sample are managed in an integrated way by automatically combining them into a single data file. This eliminates the risk of incorrect associations of sample and data file pairs, ensuring data traceability.

Additionally, using the LabSolutions data browser function and quantitative browser function, the data can be displayed in an easy to understand manner, simplifying the data analysis process (Fig. 10 and 11).
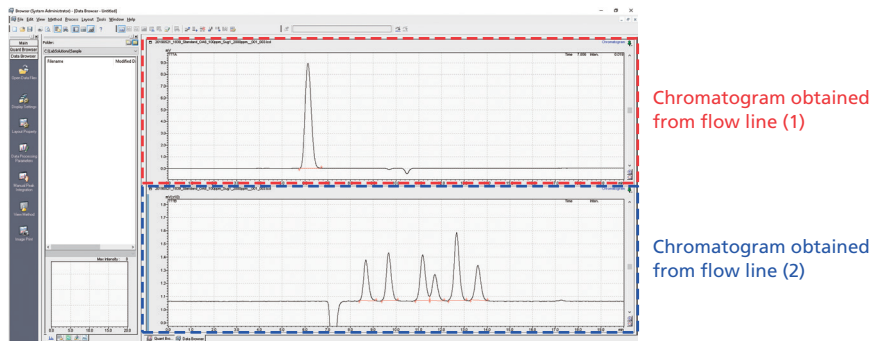

Fig. 10   Example of the Batch Display of Two Chromatograms Using the Data Browser Function
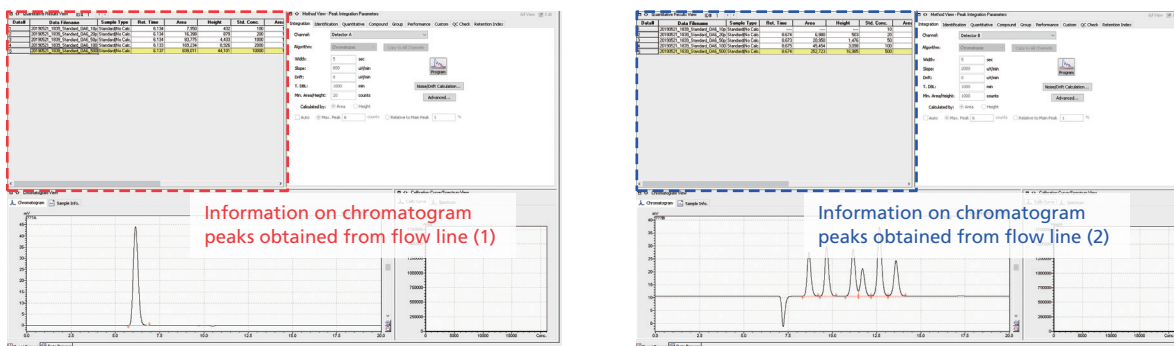

Fig. 11   Example of the Display of Quantitative Results with Two Chromatograms Using the Quantitative Browser Function

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4. Application Example

To quantify the organic acids and sugars in yogurt, a simultaneous analysis was performed under two different conditions using the dual injection system. The column temperature conditions differ for each analysis method, but with this system, the temperatures can be controlled separately using two column ovens (Fig. 12).

With these analytical conditions, the citric acid, lactic acid, and lactose in yogurt were analyzed in 15 minutes.

These two chromatograms were integrated into a single data file, simplifying the association and management of the data sets obtained from one vial.
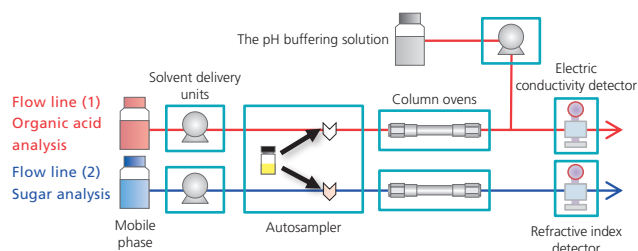
Fig. 12　Flow Line for the Batch Analysis of Organic Acids and Sugars

Table 1　Analytical Conditions of Organic Acids

Column : Shim-pack SCR-102H (10 µm, 7.9 x 300 mm)
Mobile Phase : 5.0 mmol/L aqueous *p*-toluenesulfonic acid solution
pH Buffer Solution : 5.0 mmol/L *p*-toluenesulfonic acid
　　　　　　20 mmol/L Bis-Tris,
　　　　　　0.1 mmol/L EDTA mixed aqueous solution
Column Temperature : 40 °C
Detector : Electric conductivity detector
　　　　　　(Post column pH buffering method)
Injection Volume : 10 µL

Table 2　Analytical Conditions of Sugars

Column : Shim-pack SCR-101C (10 µm, 7.9 x 300 mm)
Mobile Phase : Water
Column Temperature : 80 °C
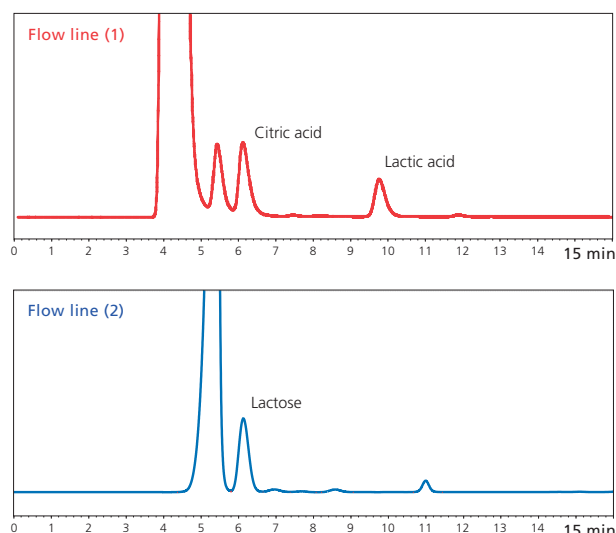Detector : Refractive index detector
Injection Volume : 10 µL

Fig. 13　Chromatograms of Yogurt
(Top: Organic Acid Analysis; Bottom: Sugar Analysis)

5. Conclusions

- The SIL-40 series features the dual injection function, which enables the injection of a single sample into two analysis flow lines.

- The dual injection system simplifies the data analysis process by automatically integrating the two data sets with respect to the sample into a single data file. Additionally, this ensures traceability with respect to the same sample.

- The two analysis method files, batch files, and data files are each integrated into a single file, simplifying data management and ensuring data integrity.

- Analyses that used multiple systems, as well as analyses implemented by switching the conditions for each target component can now be performed simultaneously using the same system. This shortens analysis times, reduces the installation space requirements, and lowers initial costs.

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