

Supercritical Fluid Extraction/Chromatograph System

Nexera UC



Unified Chromatography...

Just another chromatographic technique... or the only technique you'll need?

Conventional LC/MS and GC/MS face these challenges...



Time-consuming sample preparation

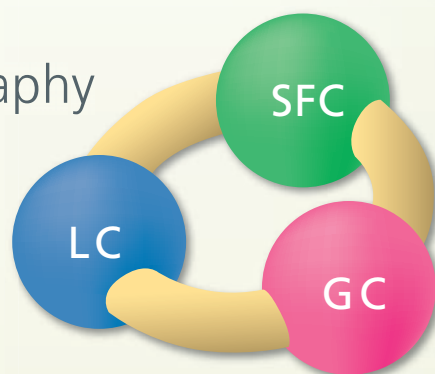


Degradation of labile compounds during sample preparation



Low abundant peaks hidden in noise

Unified Chromatography



Nexera UC improves your analytical workflow by utilizing a completely new separation technology, **Unified Chromatography**, which unites sample separation, analysis with various separation modes, and high-sensitivity detection.



Received a 2015 "R&D 100" award from the American technology information magazine, "R&D Magazine."



Received a Gold Award at the Pittcon 2015 Editors' Awards.

SFE (Supercritical Fluid Extraction) : An extraction method using supercritical fluid. It is available as a pretreatment method for solid sample analyses.

SFC (Supercritical Fluid Chromatography) : The chromatographic technique using supercritical fluids as mobile phases. With its unique properties, it enables high-speed, high-resolution analyses.



Nexera UC Unified Chromatography provides uncompromising solutions to these problems.

Fully automated on-line sample preparation and analysis

Target compounds are automatically extracted and analyzed.

Even labile compounds can be analyzed without degradation

Sample extraction is performed under light-shielding and anaerobic conditions, preventing the degradation of labile analytes.

Unified speed of analysis, sensitivity, and resolution

Supercritical fluid enables highly efficient sample extraction and high resolution chromatographic analysis. The result; improved sensitivity and throughput for multi-analyte analyses.

Supercritical fluid is a fluid over its critical point. It has unique properties like liquid and gas. Low viscosity, high diffusion coefficient, liquid-like dissolving power. CO₂ is most popular for use.

Fully automated on-line sample preparation and analysis of target compounds

Nexera UC on-line SFE-SFC is a revolutionary system that combines on-line SFE and SFC in a single flow path. Target compounds are extracted from solid samples and then automatically transferred to SFC/MS so that no human intervention is required. The Nexera UC on-line SFE-SFC system reduces the time for pretreatment of samples and acquires highly accurate data.

Comparison of QuEChERS sample preparation and Nexera UC in the analysis of residual pesticides

A typical sample preparation takes 35 minutes and requires several manual steps. With Nexera UC, the same sample can be ready for on-line SFE/SFC analysis in as little as five minutes with only a few simple sample preparation steps.

QuEChERS ... Requires **35** minutes of sample preparation



Nexera UC ... As little as **5** minutes to be ready for analysis

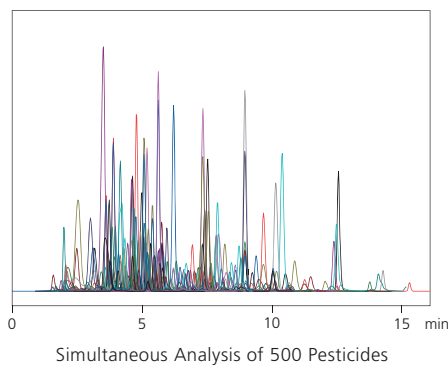
5 min



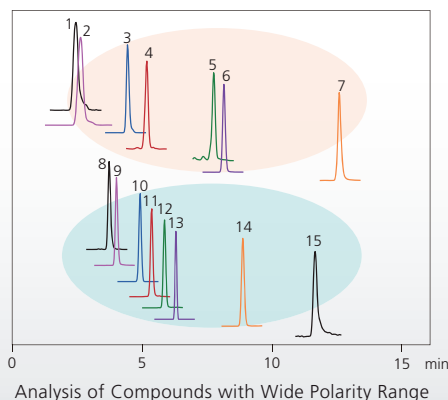
* "Miyazaki Hydro-Protect", Patented in Japan No. 3645552



35 min



Hundreds of compounds are simultaneously analyzed with Nexera UC. These include pesticides that are usually analyzed with LC and LC/MS/MS or GC and GC/MS/MS. Nexera UC enables analysis of compounds over a wide polarity range.



► Pesticide compound analysis with GC or GC/MS/MS

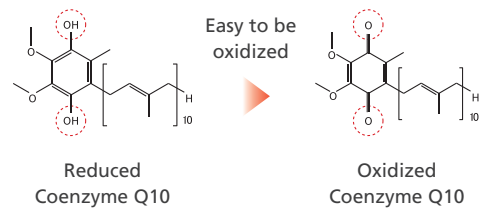
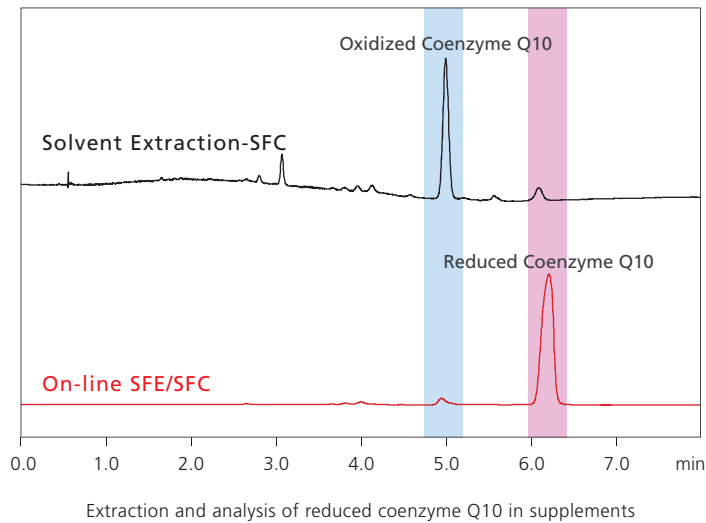
- | | |
|---------------------|-----------------|
| 1. Diazinon | 5. Mepronil |
| 2. Metalaxyl | 6. Dioxathion |
| 3. Tolclofos-methyl | 7. Cypermethrin |
| 4. Lenacil | |

► Pesticide compound analysis with LC or LC/MS/MS

- | | |
|---------------|--------------------|
| 8. Aramite | 12. Cyazofamid |
| 9. Isouron | 13. Diquat |
| 10. Acephate | 14. Chromafenozide |
| 11. Aminocarb | 15. Imidacloprid |

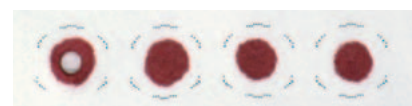
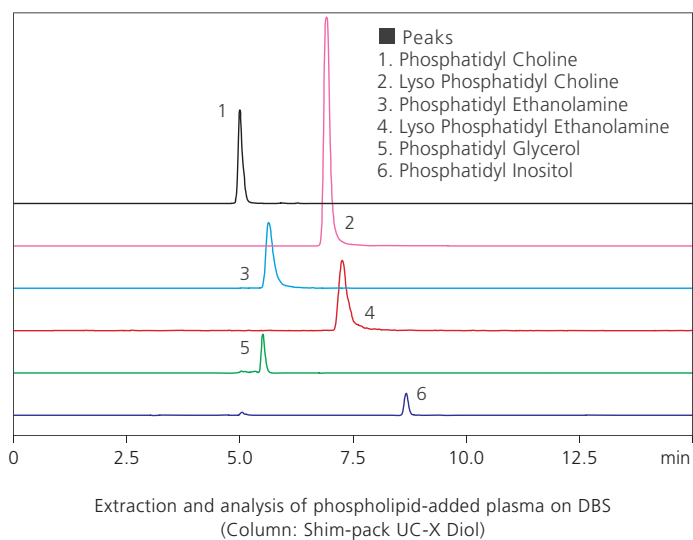
Prevent degradation of labile compounds

With conventional solvent extraction, labile compounds may react with extraction solvents or could be oxidized and/or degraded.



Analysis of biomarkers from dried blood spots (DBS)

Nexera UC can extract a trace amount of liquid samples. For biomarker validation, the preparation requires simply enclosing a blood spot in the 0.2 mL special extraction vessel.



Blood spots on DBS



An extraction vessel for DBS

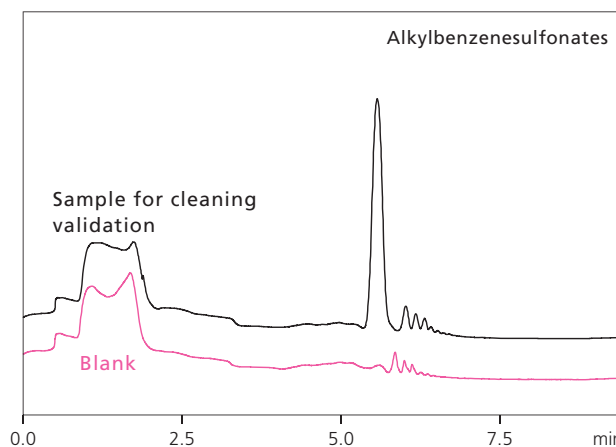
Only a few simple preparation steps for cleaning validation

Nexera UC can be applied to cleaning validation which is performed in the pharmaceutical industry to confirm that manufacturing equipment has been properly cleaned. Nexera UC automatically runs a series of steps from extraction to analysis, by only putting the sample swab in the extraction vessel. In conventional cleaning validation, the sample swab needs to be extracted with water, and then the extraction is analyzed by TOC. However, when a target compound is hydrophobic, swab extraction is performed with ethanol and TOC is not applicable. Nexera UC is capable of performing both types of cleaning validation.



An extraction vessel enclosing sample swab

The sample is provided by Daiichi Sankyo Co., Ltd.



Extraction and analysis of a detergent-added swab

Supercritical fluid extraction of trace additives in polymers

Polymer additives are widely used to prevent optical or thermal degradation, or to enhance functionalities. An example, Irganox 1010, is insoluble in THF or Chloroform, and hard to sublime. Therefore, analysis by GPC or GC is difficult. By simply homogenizing a sample and enclosing it in the extraction vessel, Nexera UC can detect labile or trace quantities of additives.

Soxhlet extraction

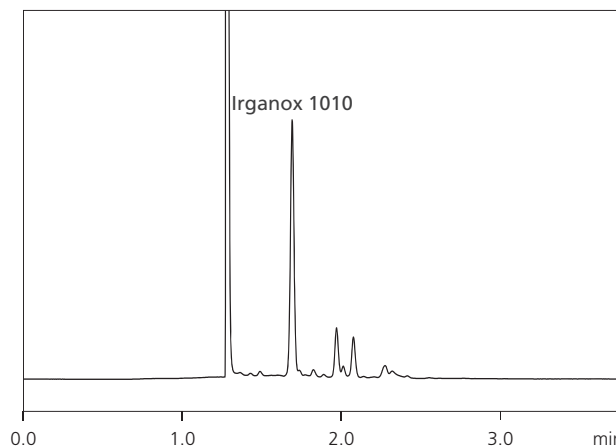


About 8 to 24 hours reflux

Extraction by Nexera UC



Place sample directly into extraction vessel



Extraction and analysis of polymer additives in polyethylene

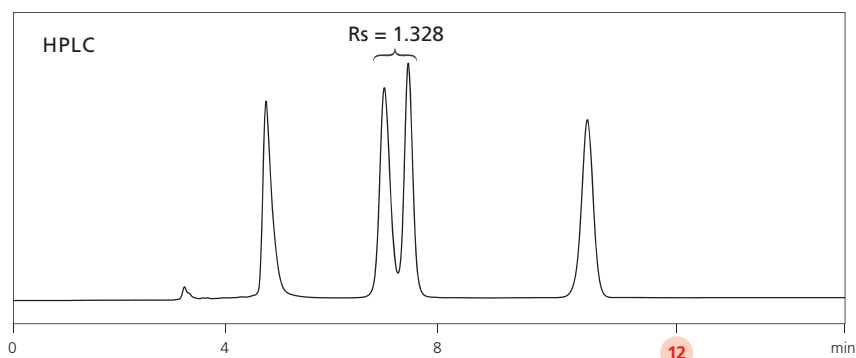
Unified speed of analysis, sensitivity, and resolution

Solutions provided by Nexera UC

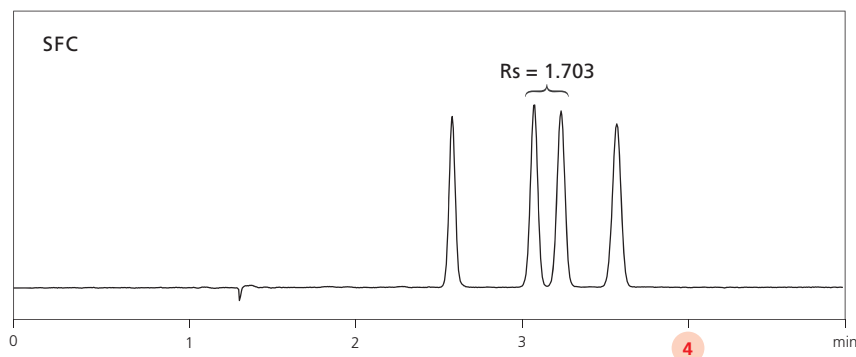
- Very fast separation speed due to the relatively low viscosity of supercritical fluid
- Improved peak capacity and chromatographic resolution
- Efficient separation of analogues and/or chiral compounds by high penetration mobile phase
- Different separation mode leads to high sensitivity
- Improved sensitivity resulting from split-less introduction into detector
- Reduction of environmental impacts and costs by reducing amount of organic solvents needed

Higher resolution

Improved separation and detection capabilities result from the low viscosity and high diffusion coefficient of supercritical fluid. As shown below, Nexera UC demonstrates high-separation selectivity for isomeric compounds that are difficult to separate by conventional LC.



Approx. 1/3

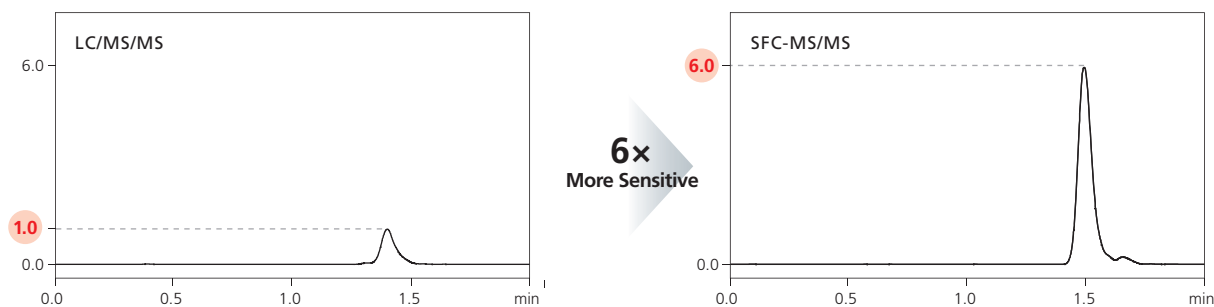


Comparison of retention time and separation acquired by Conventional LC and SFC
(sample: α -tocopherol, column: Shim-pack UC-X Sil)

Sensitivity results from different separation modes in HPLC vs SFC

Supercritical fluid has unique properties different from liquid.

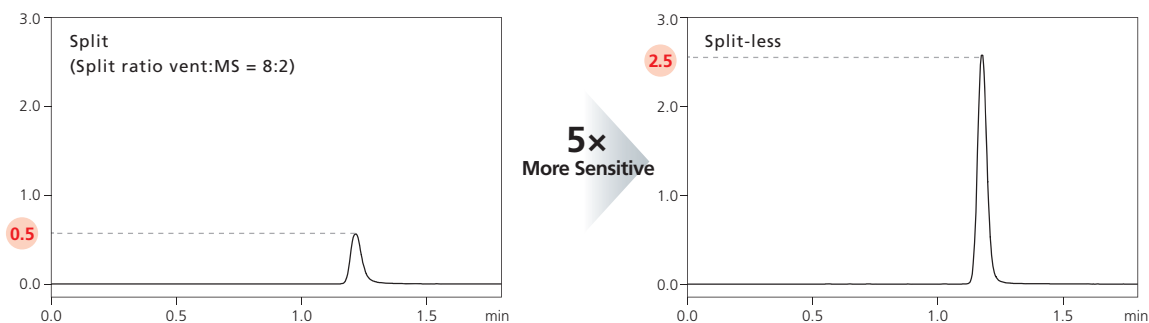
Using SFC in front of a mass spectrometer offers greater sensitivity than achieved with LC/MS/MS.



Comparison of peak intensity detected by the same MS detector.
(Sample: Prostaglandin D2 10 pg)

Enhanced sensitivity using splitless transfer to MS

Low dead volume back pressure regulator suppresses diffusion of peaks and can transfer the total eluate directly to a mass spectrometer to achieve higher sensitivity.



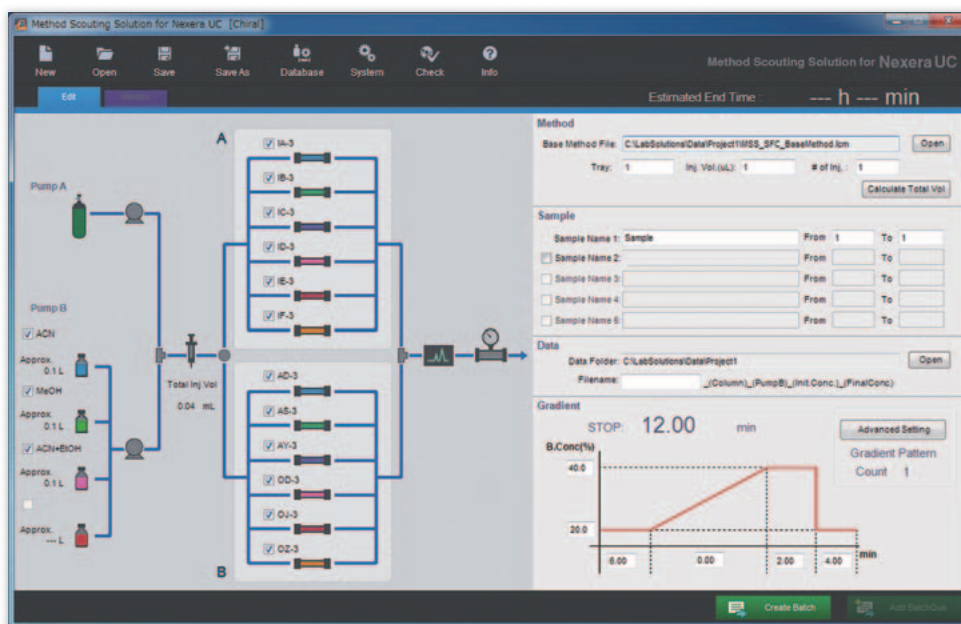
Comparison of intensity of two peaks detected by the same MS detector.
(Sample: Reserpine 10 pg)

Easy and efficient method scouting for separating chiral compounds

Automatically performs a variety of method scouting processes

The high-speed performance of SFC can shorten the time required for method scouting.

It automatically generates a large number of methods by utilizing combinations of up to 12 columns, four modifiers, and different ratios of modifiers to mobile phase.

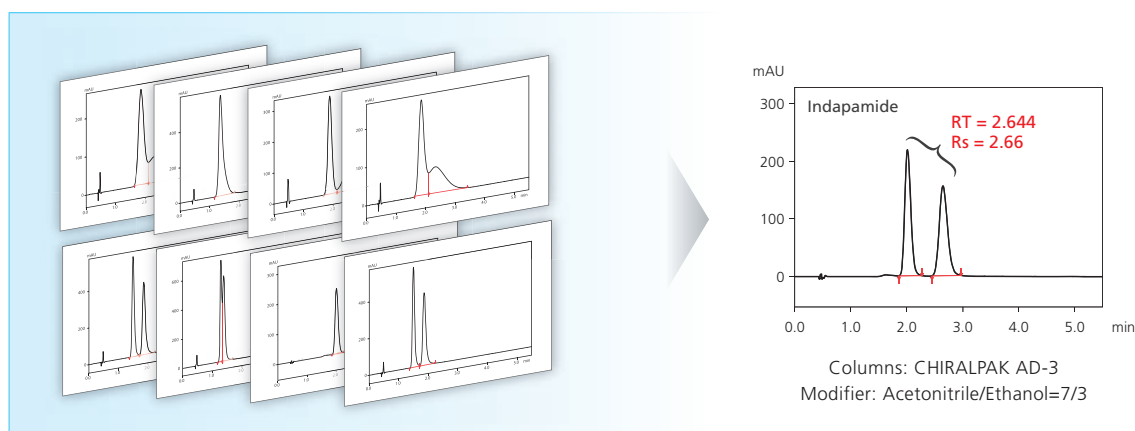


A screen shot of Method Scouting Solution for Nexera UC user interface.

Chiral analysis with “Nexera UC Chiral Screening System”

CHIRALPAK® Series and CHIRALCEL® Series columns (Daicel Corporation) for chiral analysis are capable of resolving a wide variety of compounds by showing complementary separation targets.

The combination of the Nexera UC Chiral Screening System and these columns simplifies method scouting for chiral analysis.



CHIRALPAK® and CHIRALCEL® are registered trademarks of Daicel Corporation.

Innovative technologies packaged into robust modules

Customized modules for Nexera UC based on Nexera technology

Supercritical Fluid Extraction Unit SFE-30A

This unit operates at a maximum temperature of 80°C to allow faster and more complete extractions.

Two sizes of extraction vessels (5 mL and 0.2 mL) can be chosen based on the sample amount.

This unit has the internal capacity to run up to four samples automatically; with the addition of an optional rack changer, it can accommodate unattended operation for up to 48 samples.



Rack changer: max. 48 samples



Two sizes of extraction vessels

CO₂ Solvent Delivery Unit LC-30AD_{SF} / Back Pressure Regulator Unit SFC-30A

Stable baseline with low pulsation is realized by LC-30AD_{SF} with a built-in cooler for pump heads, which delivers mobile phases up to 5 mL/min at pressures up to 66 MPa. The low dead volume of SFC-30A (0.7 μL) allows a mass spectrometer to be directly connected to the SFC system without splitting so that higher sensitivity can be achieved.



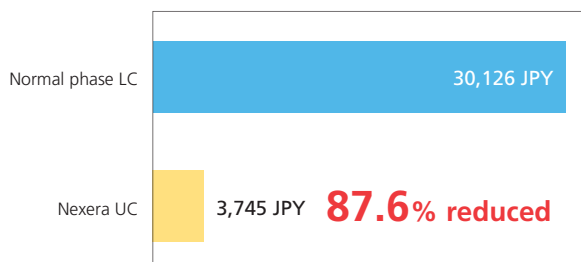
LC-30AD_{SF}



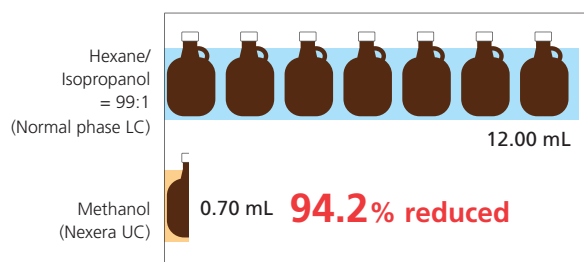
SFC-30A

Nexera UC reduces environmental impact

Comparison of costs and consumption of organic solvent for a single analysis by conventional normal-phase LC vs. SFC is shown below. By using SFC, the total cost of analysis is reduced by 87.6% and the consumption of organic solvent is reduced by 94.2%.



Comparison of costs



Comparison of organic solvent consumption

System configuration examples

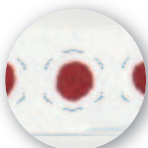
On-line SFE-SFC-MS System

In this system, solid samples are extracted by supercritical fluid and introduced to SFC on-line. The time for pretreatment of samples is drastically shortened. In addition, samples are extracted under light-shielding and anaerobic conditions in order to protect labile analytes from degradation.



Simultaneous analysis of pesticides over a wide range of polarity

With conventional methods, both LC (LC/MS/MS) and GC (GC/MS/MS) are needed to analyze pesticides. In contrast, the Nexera UC On-line SFE-SFC system can extract and analyze the full range of pesticides automatically. Pretreatment requires only homogenization and dehydration, which takes 1/7 the time of the QuEChERS method. Adding the optional Rack Changer enables automated analysis of up to 48 samples.



Extraction and analysis of labile samples without degradation

Samples are extracted under light-shielding and anaerobic conditions so that labile compounds can be analyzed without degradation.



Quick start of cleaning validation in pharmaceutical industry

Regardless of the sample polarity, the only required preparation step is enclosing the sample swab in an extraction vessel. The Nexera UC On-line SFE-SFC-MS system automatically starts extraction for analysis.



Analysis of polymer additives where other analytical instruments struggle

Polymer additives are insoluble in THF or chloroform and hard to sublime; therefore, GPC and GC are not applicable. The Nexera UC On-line SFE-SFC system easily extracts and analyzes them.

UFMS System

This system realizes high speed and high resolution by using supercritical fluid. The low volume of the SFC-30A back pressure regulator unit transfers all eluate from the column to a mass spectrometer in order to achieve high-sensitivity analysis.



Off-line simultaneous analysis of trace pesticides in foods

The Nexera UC UFMS system is able to reduce analysis times while maintaining high sensitivity. Combining the low volume of the SFC-30A back pressure regulator unit with supercritical fluid provides sensitivity six times higher than conventional LC-MS and requires 1/3 the time.



Analysis of fatty acids and phospholipids that have many analogues

Phospholipids have many analogues. Since their UV spectra are very similar, MS detection is more suitable for analysis. The Nexera UC UFMS system can analyze these compounds accurately and with high separation.



Analysis of synthetic compounds

Finding a suitable analytical method for the analysis of synthetic compounds is often a time consuming task, requiring the user to manually change columns and mobile phases to test different combinations. Nexera UC UFMS simplifies this task by automatically screening different combinations of columns and mobile phases to find the most suitable conditions. Additionally, the polarity of the mobile phase can be adjusted by the addition of modifiers, allowing a greater number of possibilities to be evaluated.

SFE Pretreatment System

This system allows the pretreatment of samples using supercritical fluid. An extraction operation that changes the types of modifiers (up to four types, including eluate from a trap column, etc.) and concentrations to mix with supercritical carbon dioxide can be performed on each sample. After being held in the trap column, the extracted material is eluted and then collected in a vial using a fraction collector. In addition to analysis by SFC, the system is ideal for measurements using other analytical systems such as GCMS and NMR.



SFC/UHPLC Switching System

This system can switch automatically between SFC analysis and UHPLC analysis and make measurements on a single sample in each separation mode. It enhances user-friendliness and operability by allowing the investigation of separation conditions and performing reverse-phase high-speed analysis in a single system.



Chiral Screening System

This system is best for developing methods to separate chiral compounds. It automatically generates a large number of methods by utilizing combinations of up to 12 columns, four modifiers, and a different ratio of modifiers to mobile phase.



SFC-UV System

This is the minimum setup of Nexera UC and is suitable to replace both normal phase and reverse phase LCs. A wide range of analyte polarity can be covered by the combination of supercritical fluid and modifiers (for example, MeOH). Hazardous organic solvents such as hexane or chloroform are eliminated. This system reduces environmental impact by utilizing low-toxicity mobile phases and completing analyses in a shorter time.



Shim-pack UC-X Series

In the analysis with supercritical fluid chromatograph system Nexera UC, because diffusion of the sample band in mobile phase is high compared with liquid chromatography, separation behavior changes significantly due to different types of columns.

Shim-pack UC-X series was designed with variety types of stationary phases which making it suitable for the mobile phase of high diffusion and low viscosity liquid carbon dioxide.

- Achieve high speed and high performance by utilizing the features of Nexera UC
- Wide range of stationary phases meets diverse needs
- High durability and stable reproducibility

Specification

	Shim-pack UC-X RP	Shim-pack UC-X GIS II	Shim-pack UC-X Phenyl	Shim-pack UC-X CN
Bonded Phase	Octadecyl Groups + Polar Functional Group	Octadecyl Groups	Phenyl Groups	Cyanopropyl Groups
Analysis Mode	Reversed Phase	Reversed Phase	Reversed Phase	Normal Phase, Reversed Phase
Features	Unique selectivity	High inertness	Strong π - π interactions	Suitable in either reversed phase or normal phase mode
Particle Size	3 μ m, 5 μ m	3 μ m, 5 μ m	3 μ m, 5 μ m	3 μ m, 5 μ m
I.D.	2.1 mm, 4.6 mm	2.1 mm, 4.6 mm	2.1 mm, 4.6 mm	2.1 mm, 4.6 mm
Length	150 mm, 250 mm	150 mm, 250 mm	150 mm, 250 mm	150 mm, 250 mm
Max. Operating Pressure	20 MPa	20 MPa	20 Mpa	20 Mpa
Pore Size	10 nm	10 nm	10 nm	10 nm
Surface Area	450 m ² /g	450 m ² /g	450 m ² /g	450 m ² /g
Carbon Loading	9%	11%	9.5%	14%
Pore Volume	1.05 mL/g	1.05 mL/g	1.05 mL/g	1.05 mL/g
End Cap	—	✓	—	—
pH Range	2–7.5	2–7.5	2–7.5	2–7.5
USP Code	L1	L1	L11	L10

	Shim-pack UC-X Diol	Shim-pack UC-X Sil	Shim-pack UC-X Amide	Shim-pack UC-X NH ₂
Bonded Phase	Diol Group	—	Carbamoyl Groups	Aminopropyl Groups
Analysis Mode	Normal Phase	Normal Phase	HILIC	HILIC, Normal Phase
Features	High retentive in normal phase mode	Ultra-pure silica gel	Strong retention of highly polar compounds	Sugar analysis
Particle Size	3 μ m, 5 μ m	3 μ m, 5 μ m	3 μ m, 5 μ m	3 μ m, 5 μ m
I.D.	2.1 mm, 4.6 mm	2.1 mm, 4.6 mm	2.1 mm, 4.6 mm	2.1 mm, 4.6 mm
Length	150 mm, 250 mm	150 mm, 250 mm	150 mm, 250 mm	150 mm, 250 mm
Max. Operating Pressure	20 Mpa	20 Mpa	20 Mpa	20 Mpa
Pore Size	10 nm	10 nm	10 nm	10 nm
Surface Area	450 m ² /g	450 m ² /g	450 m ² /g	450 m ² /g
Carbon Loading	20%	—	18%	8%
Pore Volume	1.05 mL/g	1.05 mL/g	1.05 mL/g	1.05 mL/g
End Cap	—	—	—	—
pH Range	2–7.5	2–7.5	2–7.5	2–7.5
USP Code	L20	L3	—	L8

This product was co-developed with Osaka University, Kobe University, and Miyazaki Agricultural Research Institute in the program "JST-SENTAN" (Development of Systems and Technology for Advanced Measurement and Analysis) by Japan Science and Technology Agency (JST).



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