Технологии GC

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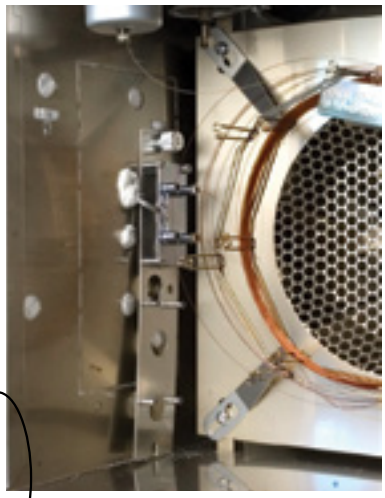
Maximize information while collecting and analyzing GC data

Comprehensive two-dimensional GC, or GCxGC, is a powerful technique that can be used to separate very complex mixtures – such as those found in the hydrocarbon processing, environmental, and food/fragrance industries.

Agilent's GCxGC method uses two columns, typically of very different polarities, installed in series with a differential flow modulator in between. The second column is much shorter than the first column to effect a fast separation, and the entire assembly is located inside the GC oven. The flow modulator performs three functions (**Figure 1**):

1. It collects effluent from the first column for a fraction of the time equal to peak width. For example, if a peak from column one is six seconds wide, the modulator will accumulate material every two to three seconds, thereby dividing the peak from the first column into two or three "cuts."
2. It focuses the material collected from each cut into a very narrow band.
3. It introduces the bands sequentially into the second column, resulting in additional separation for each band injected into the second column.

This technique provides a second dimension of information that can increase the peak resolution and capacity. In effect, its peak-generating ability is much greater than that of a single-column separation.



GCxGC Flow Modulator attachment

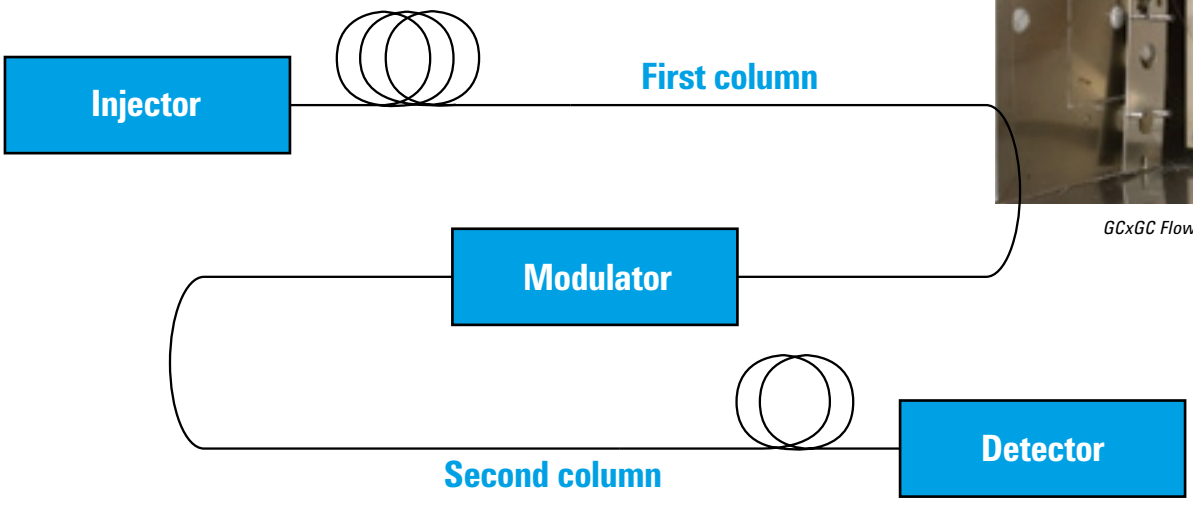


Figure 1. *GCxGC uses a primary column (conventional separation), a flow modulator, a second column (very fast separation), and a fast detector.*

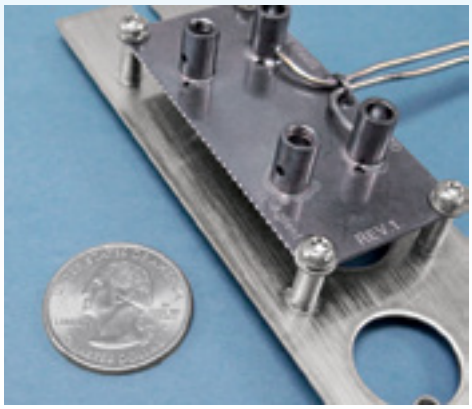
How it works...

SEPARATE COMPLEX MIXTURES WITHOUT COMPLEX HARDWARE

A number of different modulator designs exist, most relying on thermal cycling to focus the bands from the first column and release them into the second column. There are some disadvantages to this approach:

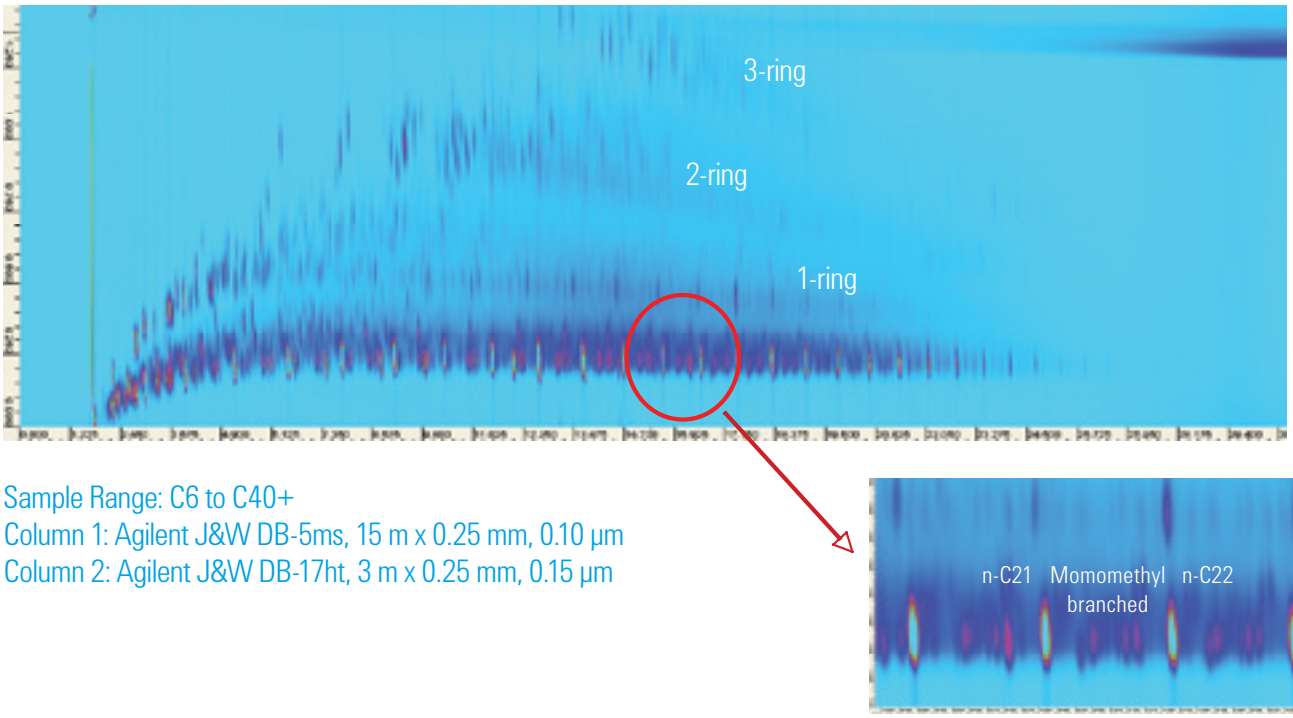
- Large usage of expensive cryogenic gases leading to a high cost of analysis
- Complexity of the hardware
- Longer analysis times

Agilent's proprietary Capillary Flow Technology and fourth generation Electronic Pneumatics Control (EPC) enable the use of a differential flow modulator to conduct comprehensive GCxGC without the use of cryogenic gases or complex hardware.



Compact design simplifies GCxGC without the need for expensive cryo gases by using flow modulation.

Gas Oil Feedstock



Sample Range: C6 to C40+
Column 1: Agilent J&W DB-5ms, 15 m x 0.25 mm, 0.10 µm
Column 2: Agilent J&W DB-17ht, 3 m x 0.25 mm, 0.15 µm

Flow Modulation Applied to a Gas Oil Feedstock

The modulator is key

The Capillary Flow Technology modulator uses a deactivated, stainless steel structure with all flow splitters and the collector channel incorporated internally in the device. With its low thermal mass, it can track the oven temperature very closely, while its GC oven location allows precise temperature control without lag during programmed runs. All external connections are made using Agilent's Ultimate Union technology for leak-free operation and extremely small, well-swept volumes.

A micro three-way solenoid valve, installed on the side of the gas chromatograph, connects to a pneumatics control module (PCM) to accurately and precisely control flow through the modulator.

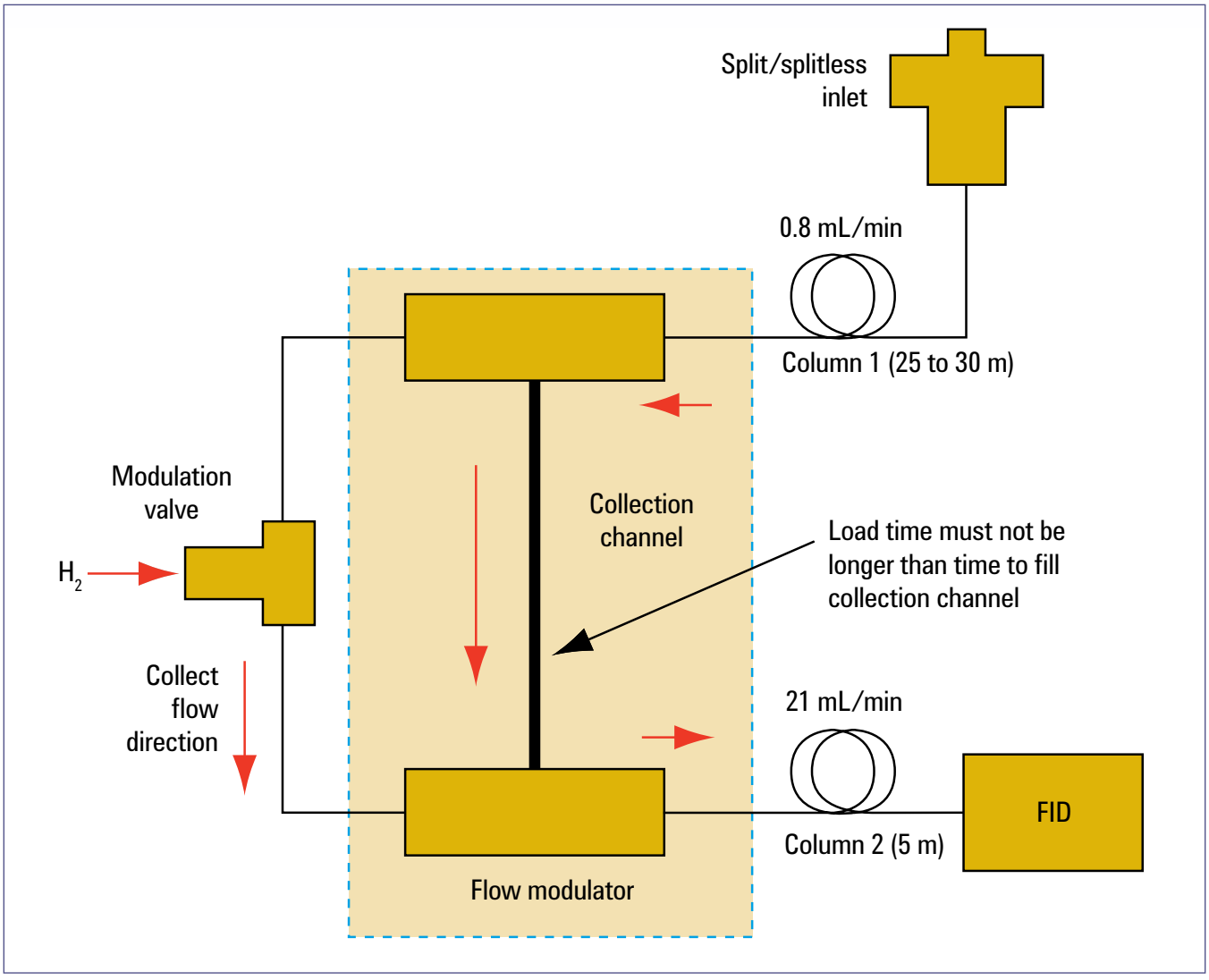


Figure 2. Load or collect state *(above): At the beginning of this state, the collection channel is filled with hydrogen gas from a previous injection cycle flush. The primary column effluent enters the modulator's top tee connection and flows into the collection channel. The analytes from this column enter one end of the collection channel. Hydrogen flow from the PCM/three-way micro valve exits the modulator at the bottom tee and is sent to the second column.*

Figures 2 and **3** illustrate the modulator. A three-way solenoid valve receives a controlled supply of hydrogen gas from a PCM. The periodic switching of this three-way valve drives the modulator. The precisely timed and synchronized switching between the *collect* and *inject* states directs discrete sample pulses continuously to the second column for additional fast separation throughout the chromatographic run.

Inject or *flush state* (below): Hydrogen gas flow from the three-way solenoid valve is directed to the top tee. A high flow of typically 20 mL/min for about 0.1 second rapidly flushes the collection channel, transferring material in a very narrow band onto the second column where any analytes collected in the channel undergo rapid separation.

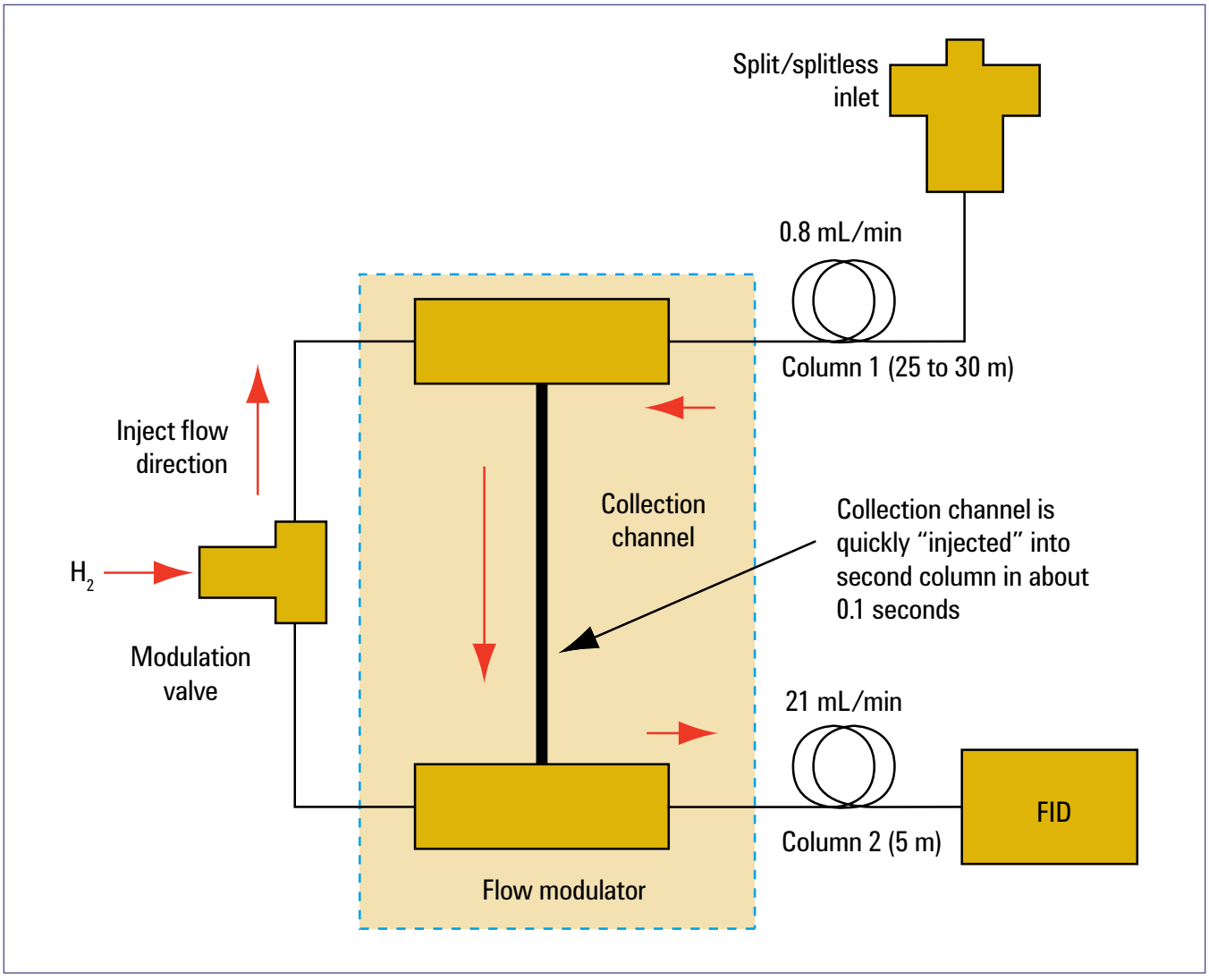


Figure 3. *Flow rates and flow directions during the transfer or inject portion of the modulation cycle.*

Two Ways to Benefit from Agilent's Capillary Flow Technology

GCxGC using a flow modulator based on Agilent's Capillary Flow Technology in **Figures 4** and **5** is used to show different classes of hydrocarbons in a kerosene sample and separation of C16 and C18 FAMEs in a biodiesel sample.

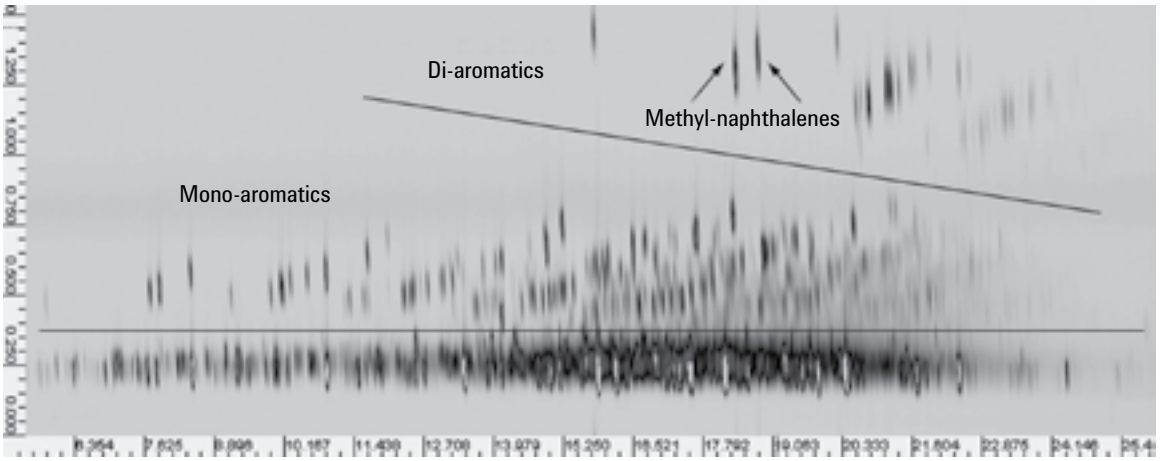


Figure 4. *GCxGC image of No. 2 Kerosene*

Comprehensive Flow Modulated Two-Dimensional Gas Chromatography System

Agilent Application Note 5989-6078EN

Industries: Hydrocarbon Processing

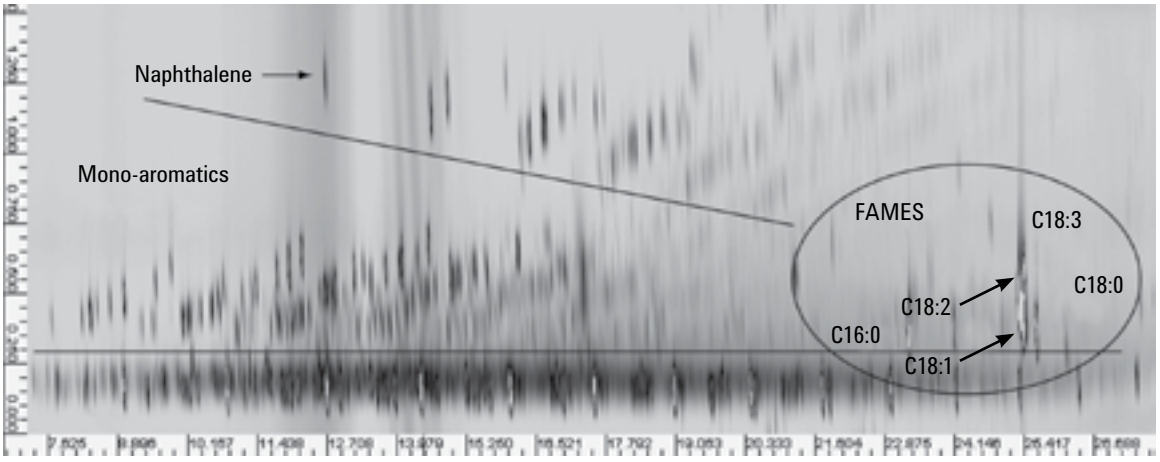


Figure 5. *GCxGC image of a B20 soy-based biodiesel (20% methyl ester, 80% diesel)*

A TOTAL PORTFOLIO OF SOLUTIONS FROM THE LEADER IN GC AND GC/MS TECHNOLOGY

When you buy instruments and systems from Agilent, you get more than just reliability

You also get:

- **Over 40 years** of chromatography expertise and industry leadership.
- **Agilent J&W GC columns, calibration kits, mix cylinders, and filters** that conform to the industry's most stringent specifications, so you know they will deliver unbeatable precision, performance, and sensitivity.
- **Application solutions** that let you maintain stringent practices from sample preparation to analysis. So you can achieve rapid, reliable results that stand up to scrutiny.
- **Informatics software** for managing large quantities of data and preserving the integrity and security of your results.
- **World-class, global service and support** – on the Web, by phone or in person – that can save your lab time, optimize instrument use, and increase productivity.

What you need to get started with GCxGC

- Agilent 7890B GC with firmware version A.04.06 or higher
- FID with 200 Hz data collection rate
- Split/splitless inlet of Multimode Inlet
- Capillary Flow Technology modulator option or accessory
- Capillary Flow Technology modulator checkout kit
- Pneumatics control module (PCM)
- Agilent GC ChemStation B.03.02 or other data collection and analysis system that can control the flow modulator cycle
- 30 m x 0.25 mm, 0.25 µm DB-5ms column (included with option or accessory)
- 5 m x 0.25 mm, 0.15 µm INNOWax column (included with option or accessory)
- GCxGC data analysis software (not provided by Agilent)
- Internal column nuts and SilTite ferrules

Inert Flow Path Split/Splitless inlet

Using Agilent Ultra Inert (UI) deactivation technology, the optional Inert Flow Path version of the split/splitless (S/SL) inlet prevents adsorption of active compounds for increased levels of sensitivity, accuracy, and precision.

The inlet and its associated consumables (UI inlet liner, UI check-out column, UI gold seal, and UltiMetal Flexible Metal ferrules) all contribute to an inert flow path that gives improved performance for sensitive analytes at very low concentration levels, extending the range and confidence of quantification and detection.

Features

- Ultra Inert deactivation for S/SL inlet and liner
- Ultra Inert deactivation for UI gold seal and UltiMetal flexible ferrules
- Provides increased levels of accuracy, precision and sensitivity for active compounds

Multimode Inlet

The Multimode Inlet (MMI) increases GC capabilities. It performs large-volume injection (LVI) that dramatically increases sensitivity, cool on-column injection that protects thermally labile sample components and improves accuracy, pulsed injections that eliminate inlet liner overload and backflash, and direct injection.

The injection technique that is used for a method can be tailored to the compounds in your samples. Using the MMI, the gas chromatograph can meet current analytical needs and provide flexibility to meet future requirements.

Features

- Large volume injection (LVI) capabilities
- Other injection modes include hot and cold split and splitless, pulsed split and splitless, solvent vent, and direct inject mode
- Agilent Turn Top inlet for easier maintenance
- Temperature range of -160 °C to 450 °C
- Agilent Solvent Elimination Calculator assists user in setting large-volume injection parameters
- Cooling options include air, liquid nitrogen, and liquid carbon dioxide
- Compatible with Merlin Microseal for GC

Data Sheet

Agilent

Trusted Answers

Agilent Low Thermal Mass (LTM) Series II System for Gas Chromatography

Overview

Agilent Low Thermal Mass (LTM) technology addresses the demand for greater productivity required for many gas chromatography (GC) applications. This technology uses an LTM column module combining a fused silica capillary column with heating and temperature-sensing components wound around it. The LTM Series II system is designed to work with the LTM column module components to heat and cool the column very efficiently for significantly shorter analytical cycle times compared to conventional air bath GC oven techniques involving much higher thermal mass.

The Agilent LTM Series II system (except external power supply) is built into a replacement Agilent 7890/8890 GC System oven door, which is mounted as an add-on to a 7890/8890 GC. The LTM Series II system is neither available nor supported for operation with an Agilent 5890 GC, 6850 GC, 6890 GC, 8860 GC, or other GCs.

The LTM Series II system takes LTM technology to the next level via integrated control directly by the 7890/8890 GC and Agilent GC and GC/MS data systems as well as improvements to ease LTM column installation. Support for constant flow mode and real-time display of temperatures and flows/pressures is available via the 7890/8890 GC display and Agilent data systems.

Temperature control

- **LTM column module heating:** direct resistive heating using a ceramic-insulated heating wire.
- **Temperature sensing:** high-precision temperature sensor combined with capillary GC column.
- **Temperature accuracy:** each column module is factory calibrated to heat within 0.1 °C of a reference; real-time error fluctuations between temperature setpoint and column module temperature are typically less than 1 °C over the entire temperature range at a programming rate of 120 °C/min.
- **Operating temperature:** 4 °C above ambient to the maximum operating temperature of the GC capillary column; maximum programmable temperature is 400 °C.
- **Maximum LTM column length:** 30 m
- **Maximum temperature ramp rate:** 700 °C/min (achievable ramp rate is dependent on column dimensions and configuration).
- **Negative temperature ramping:** uses heating to achieve a controlled cooling rate that is slower than the convection cooling rate.
- Simultaneous, synchronous operation of one to two 5-inch format column modules can be operated simultaneously with different temperature programs. The operation of multiple modules requires a matching number of fan brackets and transfer line modules.
- An 8890 GC can only support (one or two) LTM 5-inch format column modules.
- Simultaneous operation of two methods may require a second external power supply. Simultaneous use of two 30 m 5-inch format LTM columns requires two power supplies.
- Asynchronous operation is not allowed.
- Up to two external power supplies maximum allowed per LTM Series II system. The use of two power supplies will allow a maximum of two 5-inch modules to be run. The 8890 GC version of the LTM II does not support 3-inch modules.
- 7890A GC requires firmware revision A.01.12.1 or higher. The 8890 GC requires firmware revision 2.0.2.8 or higher.

7890/8890 GC configuration with LTM Series II System

The 7890/8890 GC allows up to 10 communications channels for various GC and LTM Series II components. The following is an example 7890/8890 GC configuration (dual SSL/dual FID with Aux EPC) and an LTM Series II system:

- Two (one for each inlet)
- Four (two for each detector)
  Note: DFPD requires three channels
- One (one for each PCM or Aux EPC module)
- One (one LTM Series II electronics module, for one or two 5-in format LTM column modules)
- One (one for an optional second electronics LTM Series II Power PCB and power supply

In this example, nine total GC communication channels are used.

Dimensions and Average Weight of LTM Series II Replacement Door	
Height	36.8 cm (14.5 in)
Width	43.2 cm (17.0 in)
Depth	25.4 cm (10.0 in); unit project 18.4 cm (7.2 in) forward from original door with modules installed
Average Weight	6.7 kg (14.7 lb)

Dimensions and Average Weight of LTM Series II External Power Supply	
Height	4.6 cm (1.8 in)
Width	8.5 cm (3.3 in)
Depth	21 cm (8.3 in); allow 5 cm (2 in) in front and behind for cable and line cord connections
Average Weight	1.1 kg (2.4 lb)

Environmental Conditions	
Ambient Operating Temperature	15 to 35 °C
Ambient Operating Humidity	5 to 85% (noncondensing)
Storage Extremes	–30 to 70 °C
Line Voltage Requirements	100 to 240 V, ±10%

Safety and regulatory certifications

Conforms to the following safety standards:

- Canadian Standards Association (CSA): C22.2 No. 61010-1
- International Electromechanical Commission (IEC): 61010-1, 61010-2-010, 61010-2-081
- EuroNorm (EN): 61010-1
- Nationally Recognized Test Laboratory (NRTL): ANSI/UL US 61010-1.

Conforms to the following standards on electromagnetic compatibility (EMC) and radio frequency interference (RFI):

- IEC/EN 61326-1
- ICES-001/NMB-001
- AS/NZS CISPR 11

Conforms to the following standard for the restriction of hazardous substances:

- EN 50581

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