Capillary Flow Technology: GCxGC Flow Modulator

GET A SECOND DIMENSION OF INFORMATION ON COMPLEX MIXTURES

The Measure of Confidence

Agilent Technologies

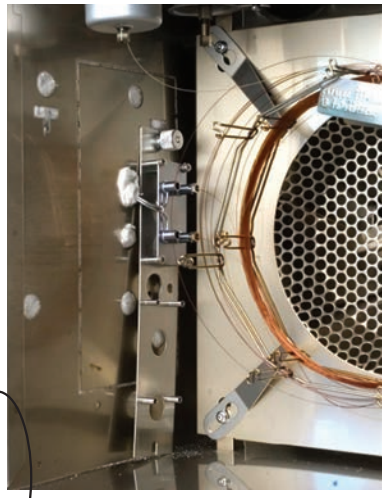
Maximize information while collecting and analyzing GC data

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

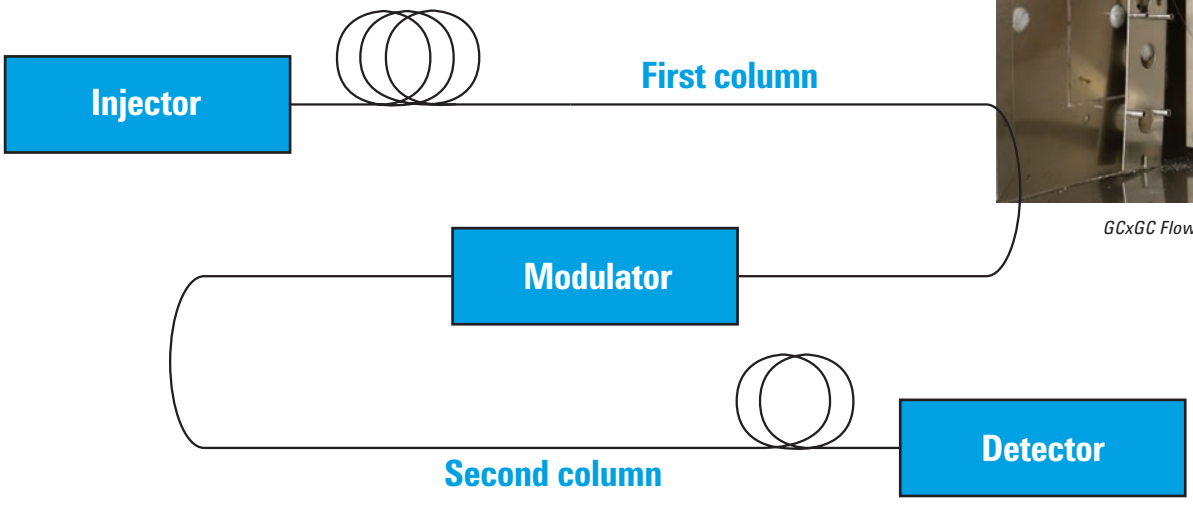


Figure 1. *GCxGC uses a primary column (conventional separation), a flow modulator, a second column (very fast separation), and a fast detector.*

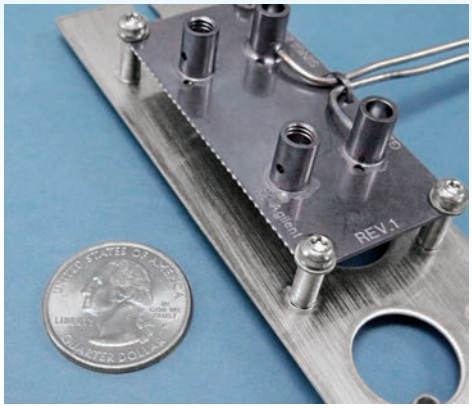
How it works...

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:

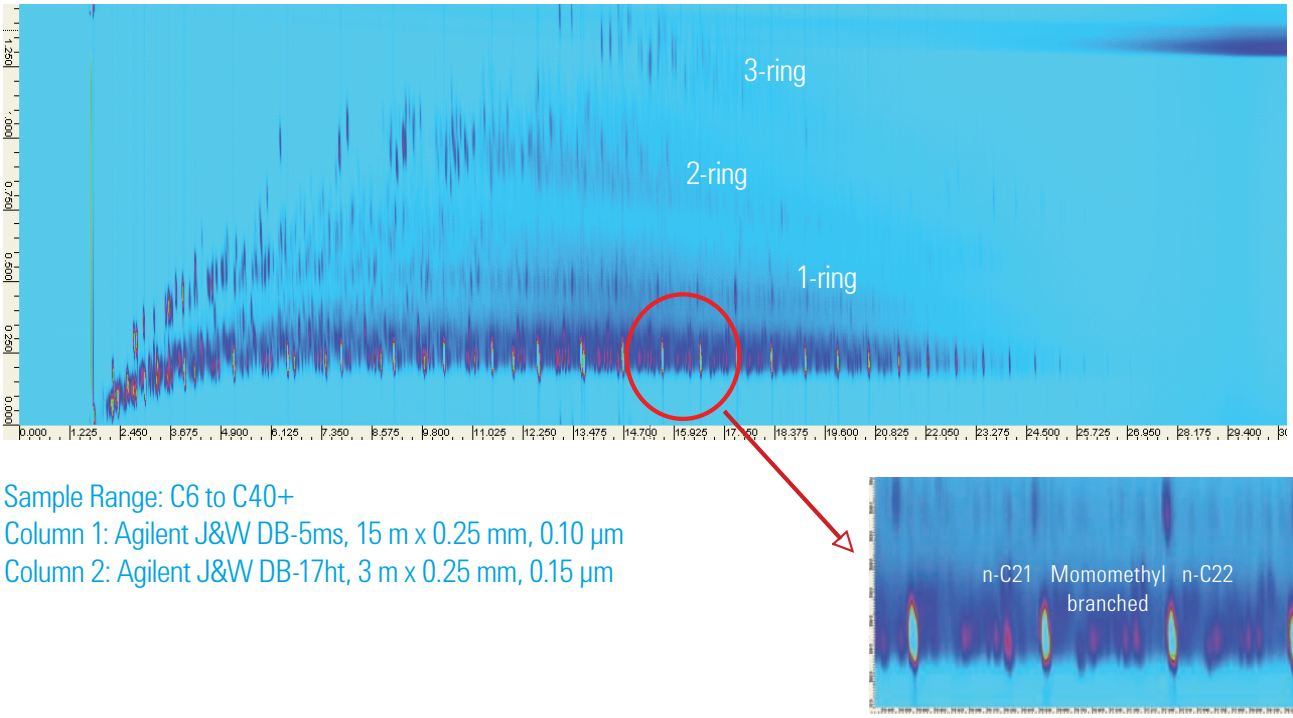
- Large usage of expensive cryogenic gases leading to a high cost of analysis
- Complexity of the hardware
- Longer analysis times

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

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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.

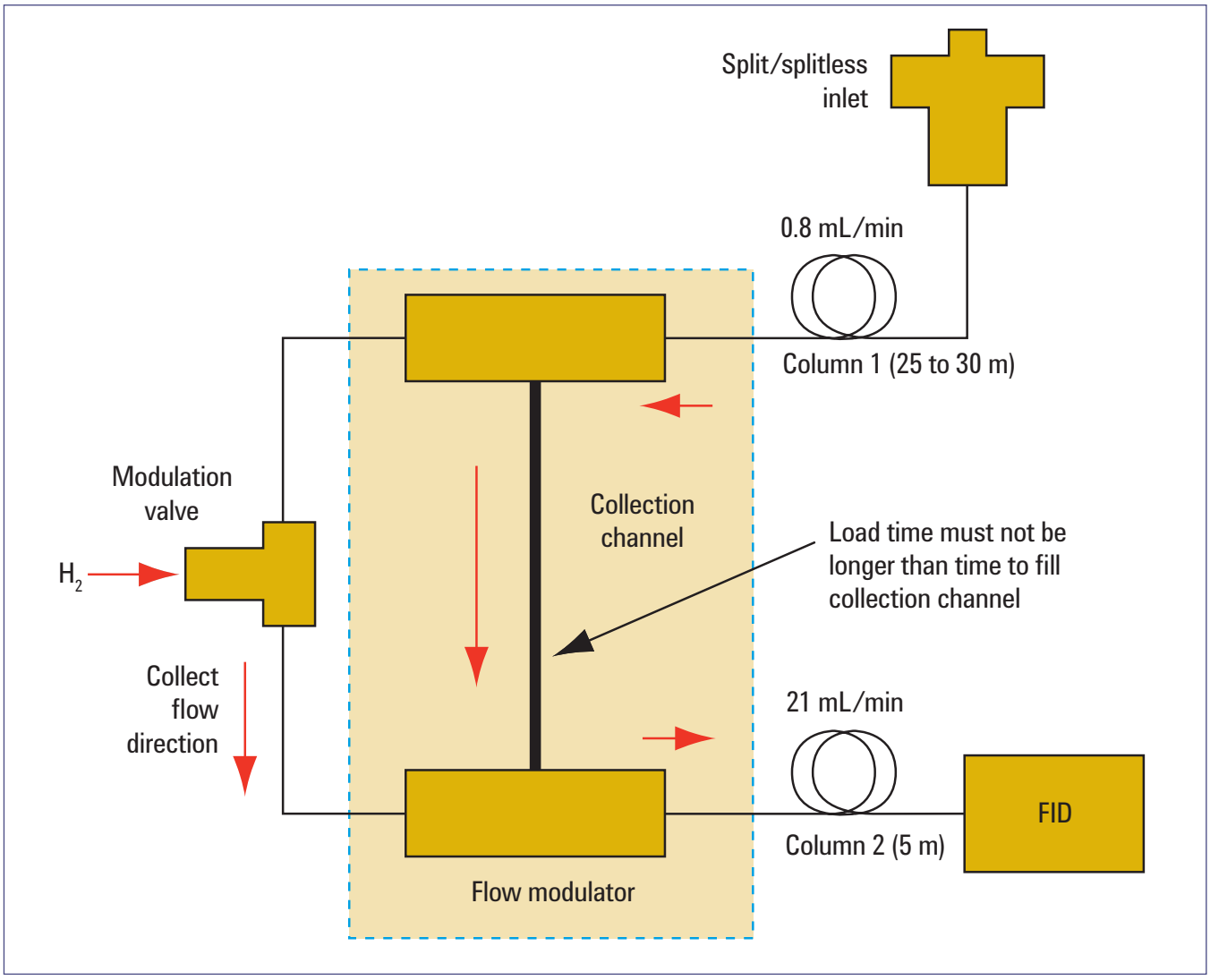

Figure 2. Load or collect state *(above): At the beginning of this state, the collection channel is filled with hydrogen gas from a previous injection cycle flush. The primary column effluent enters the modulator's top tee connection and flows into the collection channel. The analytes from this column 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.

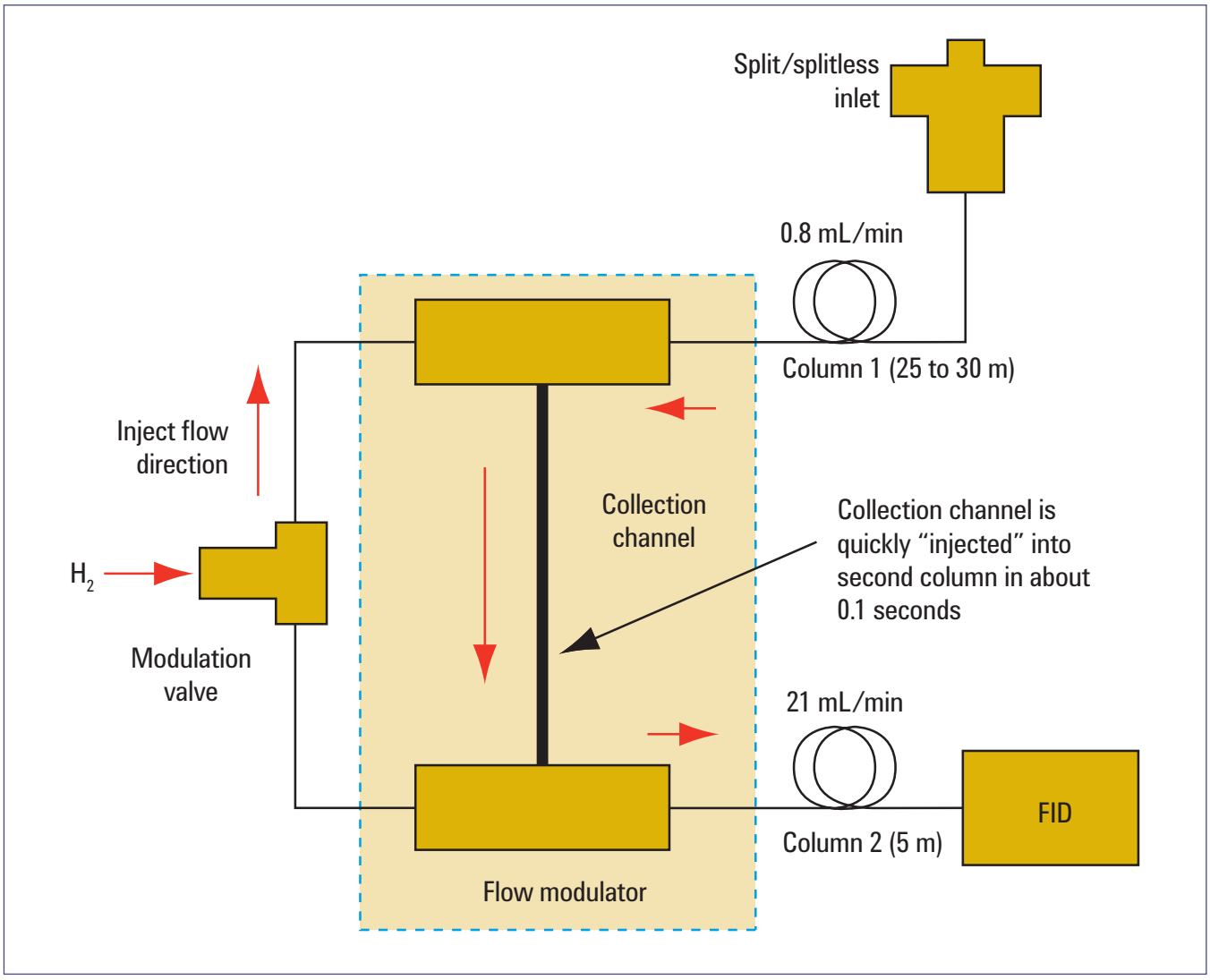

Figure 3. *Flow rates and flow directions during the transfer or inject portion of the modulation cycle.*

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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.

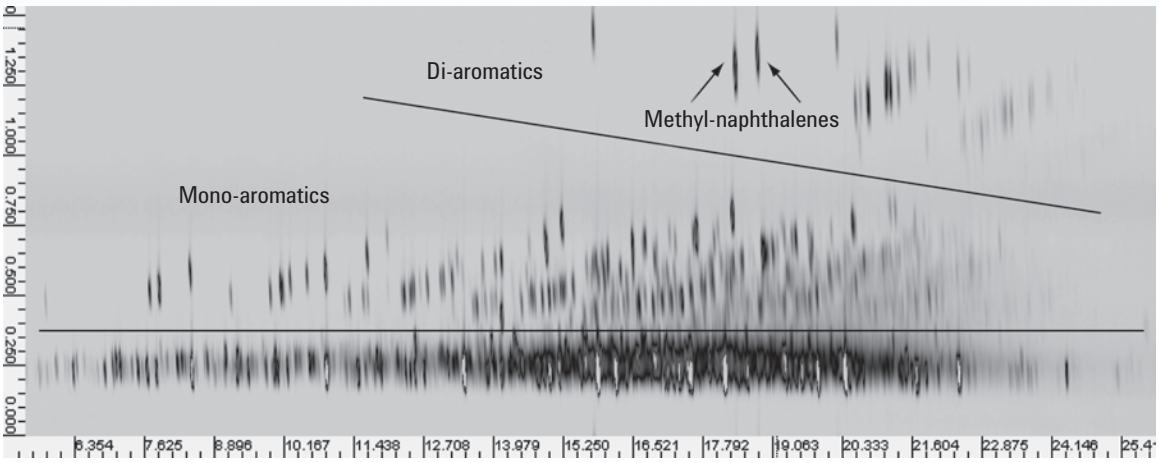

Figure 4. *GCxGC image of No. 2 Kerosene*

Comprehensive Flow Modulated Two-Dimensional Gas Chromatography System

Agilent Application Note 5989-6078EN

Industries: Hydrocarbon Processing

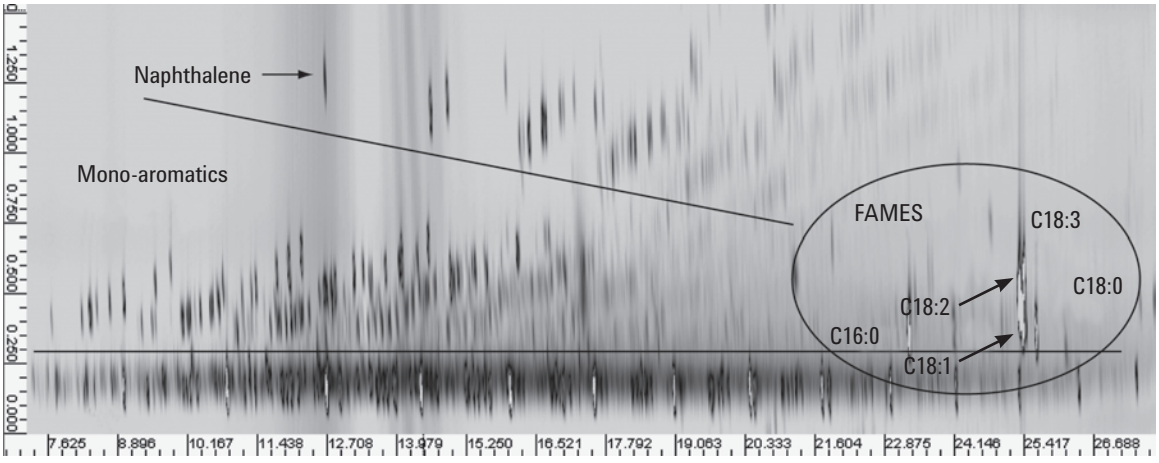

Figure 5. *GCxGC image of a B20 soy-based biodiesel (20% methyl ester, 80% diesel)*

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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

For more information

Read: **Agilent G3486A Capillary Flow Technology Modulator User Guide Agilent Manual, Publication Number G3486-90010**

Learn more about Agilent's Capillary Flow Technology at **agilent.com/chem/CapillaryFlowTechnology**

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Printed in the USA May xx, 2013
5989-9889EN

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