



Agilent Biomass Solutions

SUSTAIN YOUR PRODUCT QUALITY AND COMPETITIVE EDGE

The Measure of Confidence



Agilent Technologies

Promote clean, sustainable fuel for our planet – and energy independence for its people

Global warming, trade deficits, environmental concerns, political instability, and other issues are driving dramatic changes in the energy and chemical industries. The world is looking for reliable, clean, and sustainable energy sources – and is turning to biomass as an answer.

Powering the future by taking a lesson from the past

Simply stated, biomass is any plant or animal material of *recent origin*, as opposed to plant or animal material that, over millennia, has transformed into oil, coal, tar sands, natural gas, or other petroleum products.

Biomass materials are remarkably versatile, and have been used throughout the history of civilization. Early humans, for example, used wood biomass as a fuel for fire, and clothes have been made from cotton fiber biomass for centuries.

Today, however, biomass is taking on a truly revolutionary role, inspiring new industries dedicated to providing the energy we need without harming the environment. Every year, biofuels are growing more attractive as viable supplements – or alternatives – to petroleum-based fuels, which continue to increase in price and rely on a dwindling supply of crude oil.

Although numerous technologies are under development for converting biomass to fuels and chemicals, they all follow the same basic procedure.

BIOMASS FEEDSTOCK

Examples

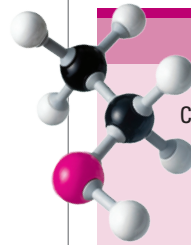
Algae
Corn
Sugar cane bagasse
Switch grass
Tallow
Wood



TRANSFORMATION PROCESS

Examples

Catalysis
Chemical extraction
Combustion
Enzymes
Fermentation
Pyrolysis



FINAL PRODUCT

Examples

Biodiesel
Butanol
Ethanol
Ethylene
Heat
Syngas

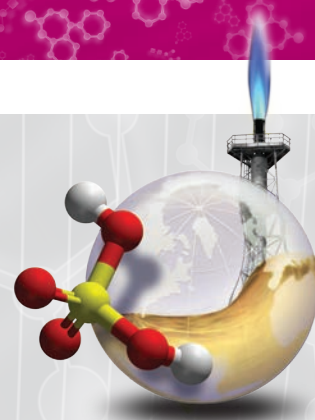


Meeting rigorous analytical requirements

For biomass fuels to be acceptable as replacements for petroleum, they must conform to industry requirements throughout the manufacturing chain. Testing protocols typically fall into four areas:

- 1. Raw material quality:** Carbohydrate, protein, and fat assays directly impact the market price of biomass feedstock.
- 2. Process control:** Measuring the conversion to fuel during plant production is critical for optimizing economics.
- 3. Fuel product certification:** Recognized quality standards must be met before the final product enters the fuel supply.
- 4. Field operations/monitoring:** The blending of biofuel into traditional petroleum products must be monitored at terminals – and advertised content must be enforced at the point of sale.

Since the majority of tests are routine and likely to be performed by non-scientific personnel, analytical instruments must be fast, accurate, safe, and easy to operate. You can count on Agilent for the technical capabilities and expertise you need to meet these difficult analytical challenges.



On the following pages, you'll find the Agilent technologies that can help usher in – *and sustain* – an era of clean, renewable, energy and chemical resources.

HPLC systems

Deliver ultimate resolution and sensitivity

4

GC analyzers

Fast results for confident certification

5

High-performing FTIR instruments

Suitable for routine and research analysis

6

MP-AES systems

A cost effective and efficient alternative to flame AA for elemental analysis of biofuels

7

ICP-MS systems

Monitor trace metals in organic matrices

8

Sample Prep WorkBench

Faster, more consistent sample prep

8

Columns and supplies

Reproducible results and trouble-free instrument performance

9

Service and support

Providing you with unparalleled expertise and service

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To learn more about Agilent biomass technologies and applications, visit agilent.com/chem/EnergyandFuels

Agilent 1260 Infinity LC system

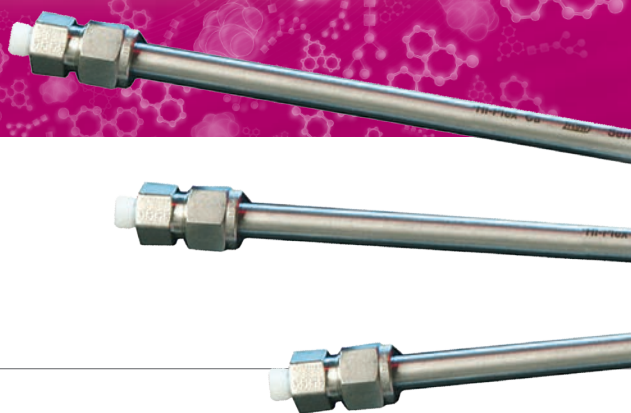
Infinitely better feedstock quality and process control

Agilent's 1260 Infinity LC system raises the standard of HPLC with new levels of productivity, data quality, and robustness.

- **600 bar standard pump pressure, 80 Hz standard detector speed and up to 10 times higher UV detection sensitivity** prepare you for today's challenges – and tomorrow's
- **100% compatible with your HPLC and RRLLC methods** – ensuring no-risk instrument replacement
- **Enhanced UHPLC capability** for HPLC price
- **Dramatically increased sensitivity** with flat baselines for DAD-based analyses



The 1260 Infinity LC lets you monitor process lines, ensure proper feed rates, and gather intelligence on competitive products.

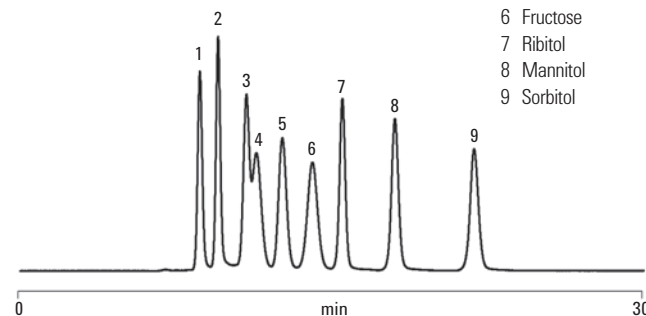


Conditions

Sample: Sugars and sugar alcohols
Column: Agilent Hi-Plex Ca,
7.7 × 300 mm, 8 μm (p/n PL1170-6810)
Sample size: 10 mg/mL
Mobile phase: 100% DI H₂O
Flow rate: 0.6 mL/min
Injection volume: 10 μL
Temperature: 85 °C
Detector: RI

Compound list

- 1 Raffinose
- 2 Sucrose
- 3 Lactulose
- 4 Glucose
- 5 Galactose
- 6 Fructose
- 7 Ribitol
- 8 Mannitol
- 9 Sorbitol



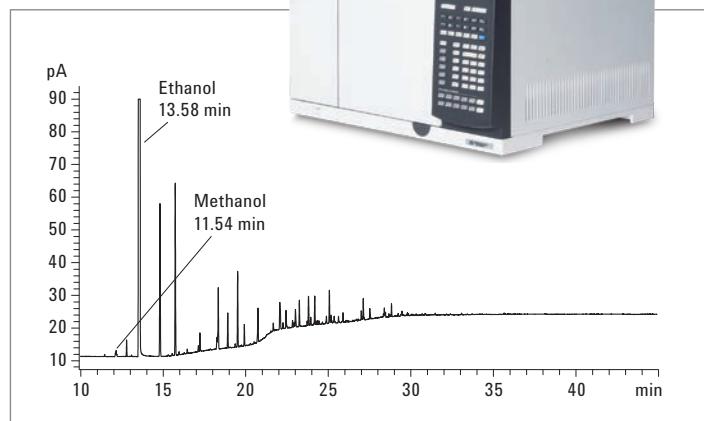
LC separation of a sugar/sugar alcohol mixture using an Agilent Hi-Plex Ca column. With a range of ligand counter ions for optimum selectivity – and with resolution and materials matched to USP definitions of media types L17, L19, L34, and L58 – the Hi-Plex column family is ideal for isocratic separations using water or dilute acid as the eluent.

Agilent Biofuel GC Analyzers

Be confident that your final product conforms to industry quality standards


Finished biofuel must undergo extensive analysis before it can be sold. Agilent's factory-tested and pre-configured **biodiesel analyzers** conform to ASTM and CEN standard methods, helping you comply with stringent regulations for FAMES analysis, glycerin and glyceride determination, and trace methanol measurement.

- **Each analyzer arrives ready to run your application** with proven analysis methods and checkout samples that can reduce method development costs by up to 90%.
- **All columns and supplies you need for out-of-the-box setup and operation** are included, so you can get started quickly.
- **Optional Deans Switch** allows cost-effective 2-D GC analysis of biodiesel blends with no sample preparation. Compounds that might co-elute on the first column are separated from the analyte on the second column, which has a different stationary phase. This configuration conforms to the ISO EN 13132 method.



Analysis of a commercial denatured fuel ethanol sample using an Agilent 7890B GC system configured to run ASTM method D5501-09.

The system showed no inlet discrimination, allowing compounds with wide boiling ranges to be quantitatively transferred to the column.



Agilent biomass analyzers are engineered to meet or exceed these industry standards

ASTM D6584	EN 14103
ASTM D4815	EN 14106
ASTM D5501	EN 14110
ASTM D7754	EN 14105

To learn more about Agilent biomass technologies and applications, visit agilent.com/chem/EnergyandFuels

Agilent FTIR systems

Pushing the limits of monitoring for biodiesel and ethanol methods

Fourier Transform Infrared spectroscopy (FTIR) is the preferred technique for identifying unknown materials in the lab or in the field, because of its ability to analyze functional groups and produce a unique spectroscopic “fingerprint.”

Agilent’s FTIR portfolio complements our best-in-class GC analyzers for bioanalysis applications. Our **Cary 630 FTIR** makes complex calibrations simple, providing users with versatility for measurement of both EN and ASTM methods just by changing the sample interface. The rugged design of the **4500 and 5500 series FTIR** lets you take measurements in places you didn’t think possible – loading docks, out in the field, or even in the back of a truck. The mobile FTIR (4500 / 5500) and in-lab Cary 630 fuel analysis package includes an extended 0-100% range ethanol in gasoline measurement designed for very accurate E85 fuel testing.



Note: Aged Gasoline, EtOH, Light Aromatics, and Light Aliphatics Evaporated, Measured on the Multireflection 5500a Gasoline Method

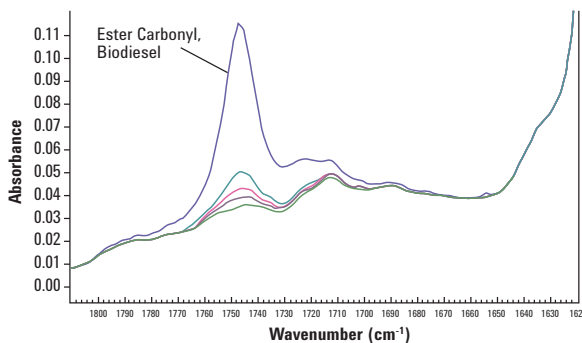
The **Cary 630, 4500 and 5500 FTIR** all run on MicroLab software. MicroLab displays and reports the quantitative results along with color-coded alerts if a sample is out of specification.



Versatile, innovative, and intuitive: The Cary 630 provides superior quantitative and qualitative information for routine analysis

A new method for quantifying biodiesel in diesel fuel using Agilent’s 5500t FTIR

We combined the transmission sample interface specified in EN 14078 with the algorithm and standards specified in ASTM D7371 to develop a method that accurately predicts the percentage of biodiesel in diesel fuel from 0.025% to 20%. The method accuracy was tested and found to be superior to other methods, especially for low levels of biodiesel, as you can see below. The 4500 / 5500 and Cary 630 series Dialpath and TumbllR FTIR systems also conform to the new ASTM D7806 transmission Mid-IR biodiesel in diesel standard.



Overlaid IR spectra of diesel fuels with ultra-low concentrations of biodiesel: 0.50% (blue), 0.10% (light green), 0.05% (red), 0.025% (maroon), and 0.00% (dark green).

Range	SECV	R ²	#Validation Samples	Avg. Relative Error
0.025-1%	0.0016%	0.9999	29	1.37%
1%-10%	0.0164%	0.9999	12	0.06%
10%-20%	0.04%	0.9999	8	0.57%

Here, we used cross validation data to calculate the standard error of cross validation (SECV) and to prepare an actual versus predicted plot.

The correlation of the actual versus predicted plot was also calculated.



Compact and Powerful: Agilent’s 4500 and 5500 series FTIR let you make real-time, on-site decisions.

Agilent 4200 MP-AES

Analyze a broader range of samples while benefiting from the lowest cost of ownership

The Agilent MP-AES is a suitable cost effective and efficient alternative to flame AA for elemental analysis of biofuels. Simple "dilute and shoot" methods using this instrument are applicable for both biodiesel and ethanol analyses.

The Agilent 4200 MP-AES delivers:

- **Lowest cost of ownership** – the Agilent 4200 MP-AES runs unattended without flammable or expensive gas supply, dramatically reducing your operating costs.
- **Improved laboratory safety** – in addition to eliminating flammable and oxidizing gases, the 4200 MP-AES eliminates the need to plumb multiple gases into the laboratory, or manually transport and handle gas cylinders.
- **High-performance** – the microwave plasma source provides superior detection limits to flame AA.

- **Ease of use** – application-specific software applets plus plug-and-play hardware ensure any user can set up quickly without method development or alignment, and with minimal training.
- **Robustness and reliability** – ideal for chemicals, petrochemicals, and manufacturing industries, and for use in remote locations .



Figures of merit for Cr, Ni, Pb, V, and Si determination by MP-AES technology.

Element	LOD* (µg/L)	LOQ* (µg/L)	LOD in the sample† (µg/kg)
Cr	0.7	2.2	9
Ni	16	52	200
Pb	40	130	490
V	0.3	0.9	4

* Instrumental limits of detection and quantification.

† Limit of detection considering sample dilution (1:9 v/v ethanol fuel in HNO₃ 1% v/v).

From Application Note: 5991-0771EN

	HNO ₃ 1% v/v			Micro-emulsion		
	LOD (µg/L)	LDR ^a (Decades)	RSD ^b (%)	LOD (µg/L)	LDR ^a (Decades)	RSD ^b (%)
Si (251.611 nm)	20	2.3	1.6	5	2.6	1.6
Si (288.158 nm)	240	0.9	1.3	5	2.5	0.4

a = Linear dynamic range starting at the limit of detection.

b = Repeatability presented as the relative standard deviation for a 2 mg/L Si solution (n = 10).

From Application Note: 5991-0490EN

To learn more about Agilent biomass technologies and applications, visit agilent.com/chem/EnergyandFuels

Agilent 7900 ICP-MS

Streamlined technology that simplifies your measurement of trace elements

From feedstock process monitoring to quality control, ICP-MS is an excellent tool for the elemental analysis of biofuels. Specifically, it can help you meet requirements for:

- **Detecting contaminants**, such as sulfur, catalyst residues (usually Na and K), and catalyst poisons (typically lead, vanadium, and mercury).
- **Monitoring the levels of common fuel additives**, such as silicon (anti-foaming agent), manganese (burn improver), and chromium, iron, and nickel (for marine applications).

Agilent's 7900 ICP-MS delivers accurate elemental concentrations from ppt to % levels with minimal sample preparation. Interferences from complex, carbon-based samples are removed reliably by the revolutionary 4th generation collision/reaction cell – the ORS⁴.



With automated setup, faster analysis, better interference removal, and a simplified MassHunter software interface, the Agilent 7900 ICP-MS blends high performance with unprecedented ease-of-use.

Agilent 7696A Sample Prep WorkBench

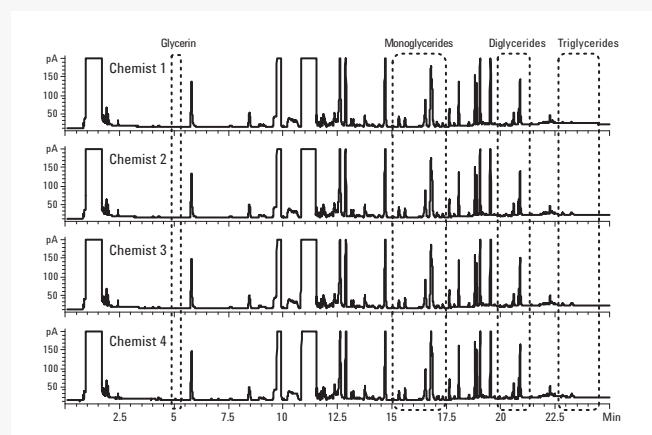
Automate GC and LC sample and standards prep

Manual sample prep can be time-consuming and inconsistent, leading to rework and wasted supplies. **Agilent's 7696A Sample Prep WorkBench** eases these frustrations by:

- Decreasing sample carryover
- Minimizing variability between analysts
- Reducing the need for costly rework
- Lowering safety risks
- Reducing solvent, reagent, and glassware costs by performing all operations in a 2 mL vial
- Reducing costs over time



Best of all, the 7696A Sample Prep WorkBench can actually pay for itself through reduced analyst time and labor costs.



A comparison of data from a soybean biodiesel sample prepared by using ASTM method D6584 on the Agilent Sample Prep WorkBench.

The right columns and supplies help you produce the right numbers under demanding deadlines

Agilent-engineered columns and supplies keep your methods safe, your workflow running smoothly, and contamination to a minimum. They are registered to ISO 9001 standards to ensure maximum instrument performance and reproducible results.

Agilent LC columns

Agilent LC columns are optimized for high throughput analysis (Fast LC), and feature the sensitivity, accuracy, and reliability that demanding applications require. Agilent ZORBAX and Poroshell columns give you:

- **The productivity you need to increase lab throughput:** Technological advances like sub-2 μm particles and superficially porous Poroshell 120 columns increase speed and resolution.
- **Unbeatable chromatographic performance:** ZORBAX silica – the base silica used for all ZORBAX and Poroshell 120 columns – is ultra-pure, very strong, and highly uniform for ultimate reliability.
- **Assured selectivity to suit your separation,** via the broadest range of chemistries and column configurations.

You will find that **Poroshell 120 columns** provide exceptional efficiency for standard HPLC and UHPLC instruments.

Poroshell 120 family highlights:

- **Extraordinary lot-to-lot reproducibility:** manufactured using a proprietary single-step porous shell process that dramatically reduces minute differences between columns and lots.
- **Comparable speed and resolution to sub-2 μm columns with up to 50% less backpressure:** take HPLC and UHPLC performance to a new level of flexibility and efficiency.
- **Superior peak shape:** for faster, more accurate results.
- **Long column life:** a standard 2 μm frit is used and resists plugging with dirty samples.
- **TWELVE chemistries,** including SB-C18 and SB-C8 for low pH applications and HPH-C18 and HPH-C8 for high pH applications.
- **Easy method transfer and scalability** to ZORBAX bonded phases, for highest productivity.
- **Reduced operating expenses** with Fast Guards for UHPLC.

Find the best column for your separation with the Agilent LC Column Navigator:
agilent.com/chem/navigator



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Agilent J&W GC columns

These columns give you excellent performance for benign and difficult samples. With the best inertness, lowest bleed levels, and the tightest column-to-column reproducibility, they outperform any other column on the market.

Ruggedness and reliability to meet your lab's demands

From product quality and safety... to price-driven efficiency improvements... to environmental stewardship... the pressure to stay productive, profitable, and compliant is more intense than ever. You simply do not have room in your day for downtime caused by problems with your analytical column. Porous layer open tubular (PLOT) columns are the GC columns of choice for the analysis of light gases and volatile compounds because of their high retentive character, and therefore, have been widely adopted in the hydrocarbon processing industry. However, the stationary phase layer in many PLOT columns is not mechanically stable – resulting in particle shedding – which can adversely affect your analysis.

Likewise, if you use Sulfur Chemiluminescence Detection (SCD) to analyze sulfur compounds in natural gas, petroleum products, and process streams, you may have experienced detector sensitivity issues. Column bleed from thick film polydimethylsiloxane (PDMS) phases, which are commonly used, can contribute to “fouling” phenomena on SCD ceramic burner tubes. This leads to frequent and costly tube replacement and associated downtime. In addition, since light sulfur gases are reactive, flow path inertness is critical to avoiding peak tailing.

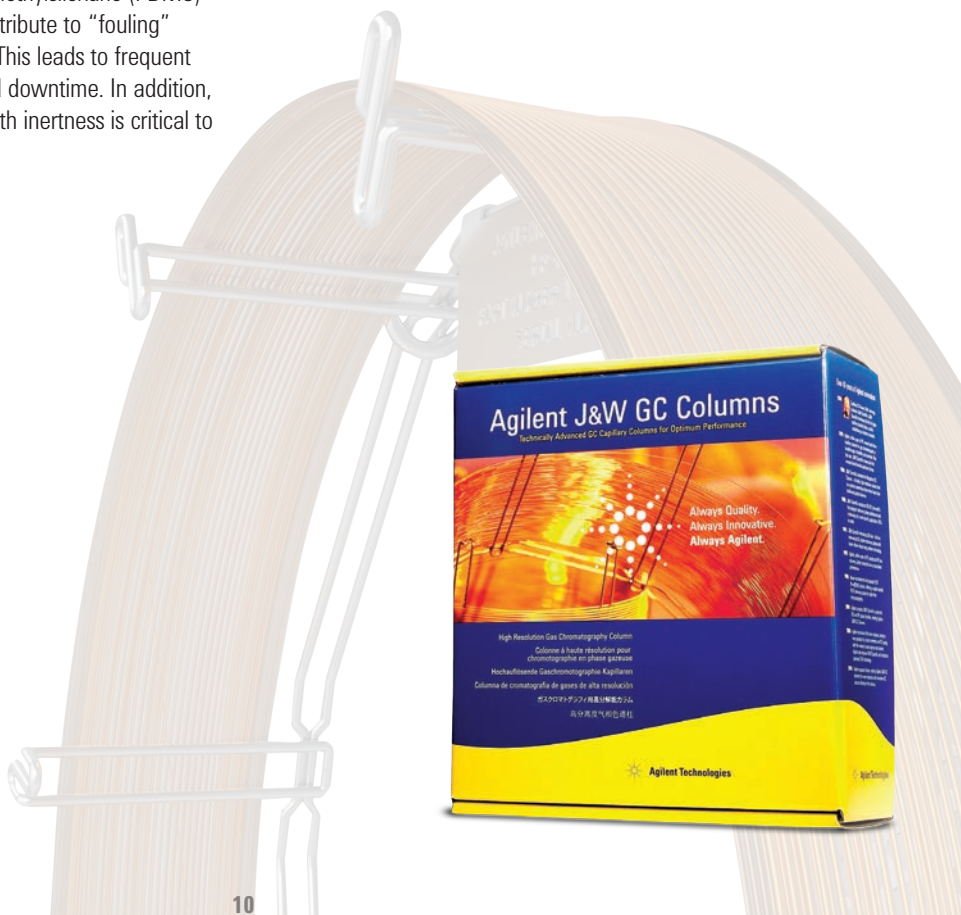
*But the **good news is...** Agilent has developed two new column technologies specifically designed to reduce GC system downtime and maintenance, while expanding your lab's analytical capabilities.*

Reduce maintenance costs and extend your capabilities with Agilent J&W PLOT PT GC columns

New integrated particle-trapping technology on *both ends* of **Agilent J&W PLOT PT GC columns** minimizes particle shedding in all applications. That means you can worry less about signal spiking – and unnecessary downtime. Our particle-trapping design also takes the worry out of performing GC or GC/MS analysis with PLOT columns for more confident identification of unknowns.

Greatly improve SCD stability with Agilent J&W DB-Sulfur SCD columns

These new columns are optimized for low bleed, which reduces fouling of SCD ceramic tubes – minimizing instrument downtime and operational costs. In addition, **Agilent J&W DB-Sulfur SCD columns** provide excellent peak shape and extended detector stability for all GC SCD methods that utilize PDMS stationary phases – such as ASTM D 5623 and 5504.



Agilent liners, vials, septa, ferrules, and other supplies

All Agilent supplies are engineered or selected by our experienced instrument design teams, manufactured to our demanding specifications, and tested under the strictest conditions.



MS-certified split and splitless liners

Tested with FID and MSD to ensure inertness, purity, and consistency; deactivated using a proprietary Agilent liquid deactivation process



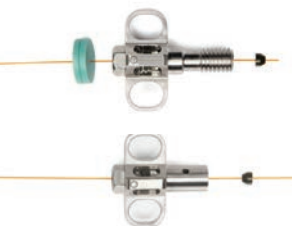
Certified vials

Work flawlessly with your autosampler's gripping and injection mechanisms – eliminating breakage and leaks that can cause unnecessary downtime, expensive repairs, and sample loss



Premium non-stick septa

Plasma coated to eliminate chemical bleed and contamination, so your GC system will stay cleaner and require less maintenance



Self Tightening Column Nut

- Leak-free seal, even at high temperatures
- Easy finger-tight design – no retightening needed
- Available for the inlet, detector and the MS transfer line



Vespel/graphite ferrules

Manufactured to the ideal hardness for GC/MS applications to prevent contamination caused by flaking



Renewable Gas Purification System

Prevents bleed and sustains column performance by improving the quality of gas that enters the column



PEEK or stainless steel LC tubing

Eliminates dead volumes while making sure your connections are inert, tight, and leak-free



ICP-MS sampling and skimmer cones

From our proprietary ICP torch to our skimmer cones, Agilent ICP-MS parts and supplies are rigorously tested to ensure that you'll always get the best performance from your instrument

To learn more about Agilent biomass technologies and applications, visit agilent.com/chem/EnergyandFuels

Agilent is uniquely equipped to support your Biofuels efforts with unmatched expertise, training, and services

For more information

Learn more

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Agilent Advantage Service and Support

Whether you need support for a single instrument or a multi-lab, multi-vendor operation, Agilent helps you solve problems quickly, increase your uptime, and optimize your resources – from installation and upgrade to operation and repair.

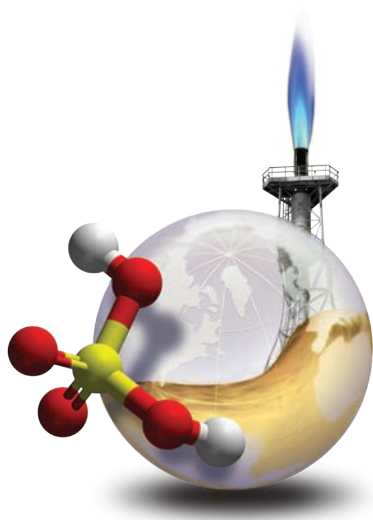


Agilent Value Promise

We *guarantee* you at least 10 years of instrument use from your date of purchase, or we will credit you with the residual value of the system toward an upgraded model.

Agilent Service Guarantee

If your Agilent instrument requires service while covered by an Agilent service agreement, we guarantee repair or we will replace your instrument for free. No other manufacturer or service provider offers this level of commitment to keeping your laboratory running at maximum productivity.



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