C180-E102A

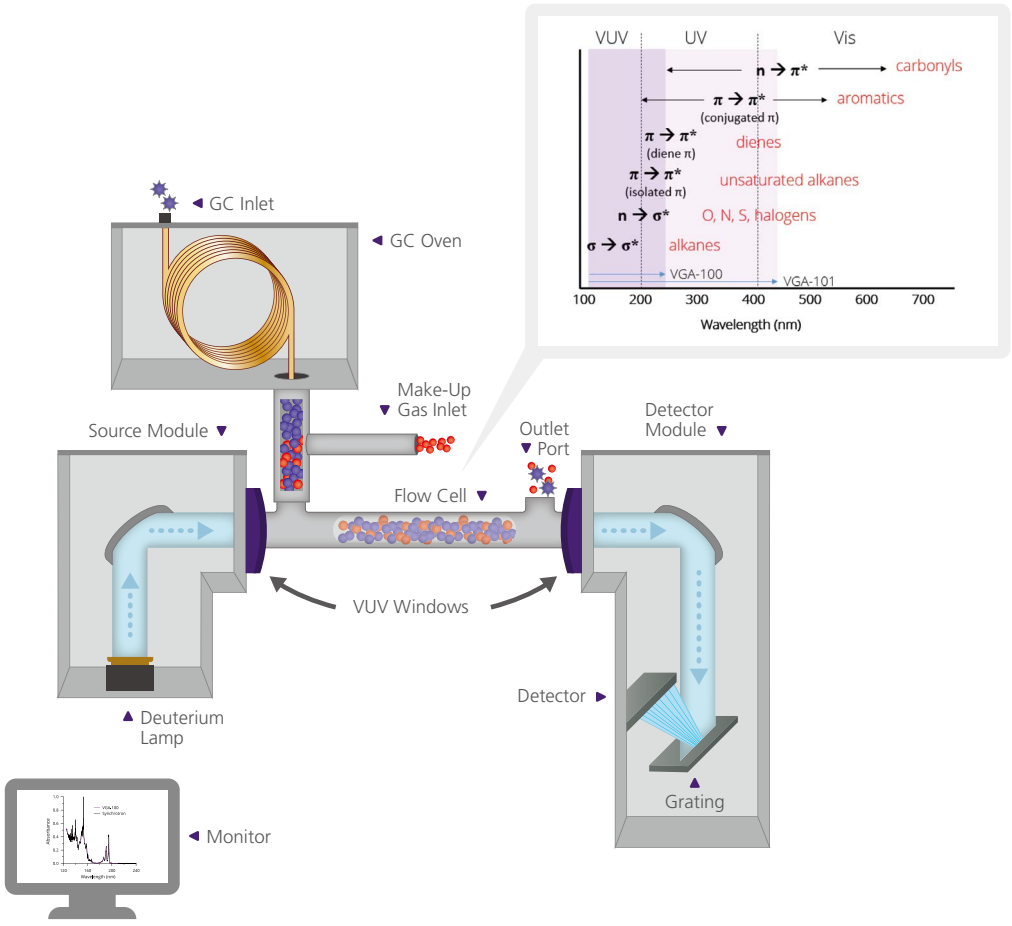
SHIMADZU
Excellence in Science

Gas Chromatography Detector

VGA-100/VGA-101

VUV ANALYTICS

Meet the alternative with a vacuum ultraviolet (VUV) detector for Gas Chromatography



The VUV (Vacuum Ultraviolet) detector is designed to collect absorption spectrum of compounds eluted from GC in the wavelength range of 120 nm to 240 nm (vacuum ultraviolet region). It consists of a deuterium lamp, flow cell, grating device and detection device. Hydrocarbons, such as fuels, have strong absorption in the range of 115 nm to 185 nm (due to σ→σ* and π→→π* transitions), making the VUV detector an ideal choice for fuel analysis.

The VUV wavelength region is typically characterized by significant background absorption. Traditionally, very high-energy photons generated by a synchrotron facilities were used to obtain VUV spectrum. The VGA-100/101 VUV detector minimizes background absorption to an exceptional degree, enabling easy acquisition of VUV spectrum.

Gas Chromatography detection in a whole new light

VUV provides Powerful Identification Performance for Petroleum and Petrochemical Analysis.

VUV analysis system offers...

Identification performance specialized for fuel analysis

- Full spectrum detection in the vacuum ultraviolet (VUV) wavelength region enhances identification performance of various hydrocarbon compounds.
- Excellent oven performance of the Nexis GC-2060 improves identification performance with retention index.

Full compliance with ASTM official standards

- A multi-method architecture that allows testing of different fuels and methods on the same analyzer without changing hardware.
- Dedicated spectral libraries for various ASTM official methods

Enhanced analysis support functions

- Time Interval Deconvolution™ (TID™) to easily deconvolve co-eluting analytes.
- Push-button, automated data analysis and reporting using VUV Analyze™ Software.

Voice from KOL

"The VUV detector will be used as a universal, calibration-free tool that provides the relative quantitative values of distinct molecules in mixtures in a rapid manner."

LUIGI MONDELLO

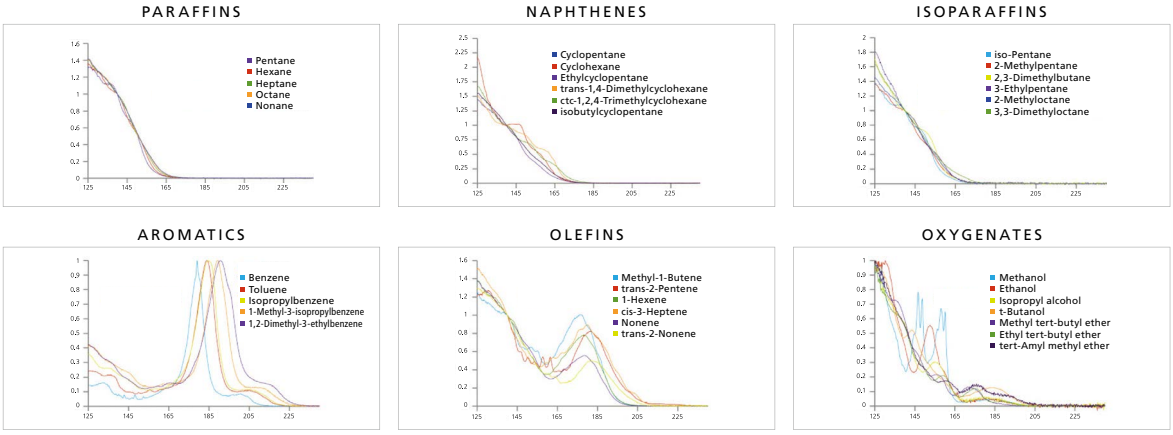
Chair of ISCC and GCxGC Conference in Riva del Garda and
Professor, University of Messina, Italy

Market-leading solutions to deliver superior fuels analysis results

Vacuum Ultraviolet Spectroscopy

Universal and Unambiguous

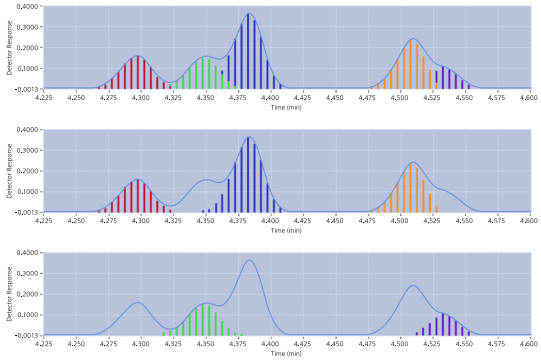
Characterized by very short wavelengths of light, VUV spectroscopy is a universal, mass-sensitive detection technique that provides both quantitative and qualitative data. Because almost all gas phase molecules absorb strongly in the vacuum ultraviolet region, VUV spectroscopy is well-suited for analysis of fuels. It is possible to obtain a specific spectrum even for hydrocarbons which are subtly different such as structural isomers, and to easily and accurately identify them.



Fast and Precise Analysis

Automatically Deconvolve Co-eluting Compounds

Let's face it: Even with good chromatographic separation, compounds can coelute—especially with complex samples. The VUV Analyzer for Fuels provides a powerful and automated solution: Time Interval Deconvolution (TID). TID works by slicing a chromatogram into regularly spaced time intervals, each with a unique summed absorbance spectrum. Each slice is then automatically analyzed to determine the contribution of each compound to the measured spectra. This means complex chromatograms can be easily, reliably deconvolved and analyzed, without the need for a fixed peak table.



Voice from KOL

"One thing that I really like about VUV is that it can be considered a universal detector but with the advantage of being familiar to us. We all used UV spectrometers in school."

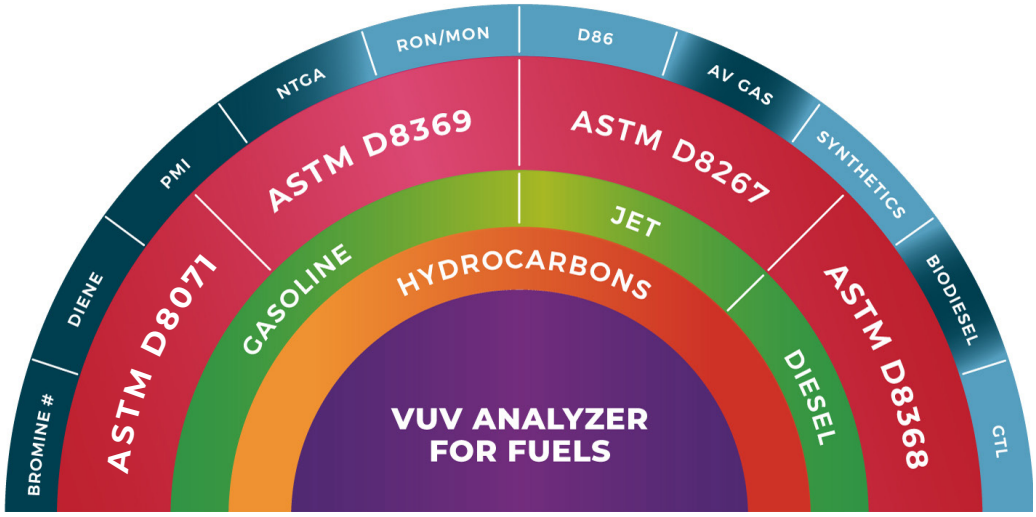
NICHOLAS SNOW

Professor, Seton Hall University,
New Jersey, USA

Multi-Method Platform Architecture

Maximize the Value of Your Investment by Running Numerous Methods on One Analyzer

The VUV Analyzer for Fuels is a platform developed with value, ease-of-use, and flexibility in mind. Running multiple methods on one VUV Analyzer for Fuels allows you to rapidly switch between different analyses using the same GC, detector, and software. This simplifies operation for the analyst and accelerates analysis time across methods, including: ASTM D8071/ASTM D8369 (gasoline), ASTM D8267 (jet fuel), ASTM D8368 (diesel) and ASTM D8519 (pyrolysis oil).



ASTM D8519 (Determination of Hydrocarbon Types in Waste Plastic Process Oil) is also registered for Pyrolysis Oil Analysis

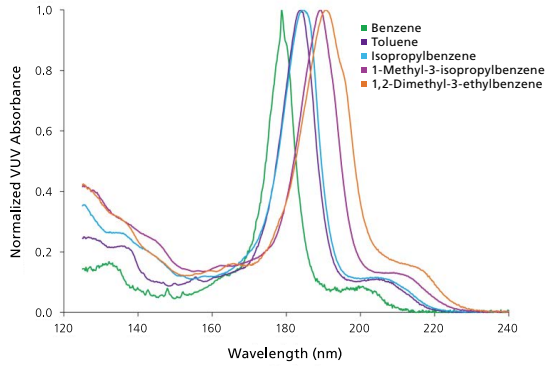
Application-Specific Spectral Libraries

Unique and Comprehensive Spectral Libraries for Unambiguous Identification

Each application developed to run on the VUV Analyzer for Fuels includes a comprehensive spectral library specific to the method being run. The high-resolution spectra contained in these libraries provide unambiguous identification and reduce the need for baseline-resolved chromatography, ensuring accurate results every time. For added flexibility, the VUV Analyzer for Fuels makes it easy to extend these libraries or to create new ones with your own user-defined spectra.

The following dedicated spectral libraries are provided by VUV.

- ASTM D8071 770 compounds (Gasoline)
- ASTM D8369 1033 compounds (Gasoline)
- EN 18015 699 compounds (Gasoline)
- ASTM D8267 734 compounds (Jet Fuel)
- ASTM D8368 1496 compounds (Diesel)
- ASTM D8519 10461 compounds (Pyrolysis Oil)



Voice from KOL

"VUV spectroscopy adds a dimension that is complementary to mass spectrometry, offering selectivity that is difficult to otherwise obtain."

HANS-GERD JANSSEN

Professor, University of Amsterdam and
Science leader, Unilever Research Vlaardingen, the Netherlands

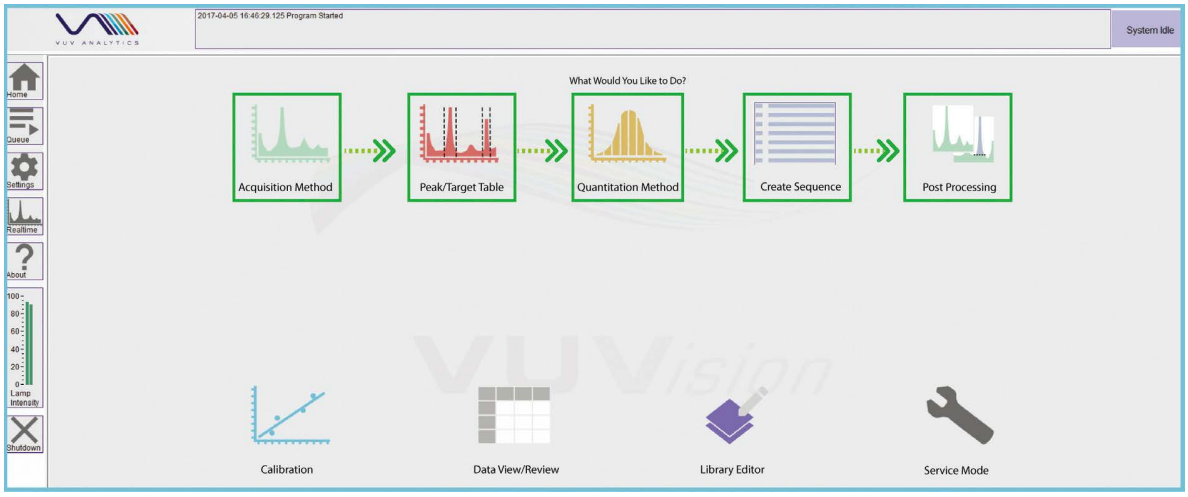
Easy to set up, easy to use

Intuitive Chromatography Software Written by Chromatographers for Chromatographers

VUVision™ software simplifies GC analysis by providing an intuitive interface for analyte characterization by VUV spectroscopy. VUVision delivers straightforward workflows for acquiring and processing data, resulting in high automation confidence and low risk of analytical error.

VUVision is the base software for system control, data acquisition, library searching, qualitative analysis, calibration, and quantitative analysis by external or internal standard methods. It is intended for both manual post-processing and automated analysis driven by VUV Analyze which is the powerful post-acquisition software to support ASTM methods.

This robust software solution delivers standard chromatographic capabilities and data analysis while providing spectral information that is unique to VUV spectroscopy.



Home Screen Workflow: *VUVision™ software provides a straightforward workflow for processing and analyzing data.*

Voice from KOL

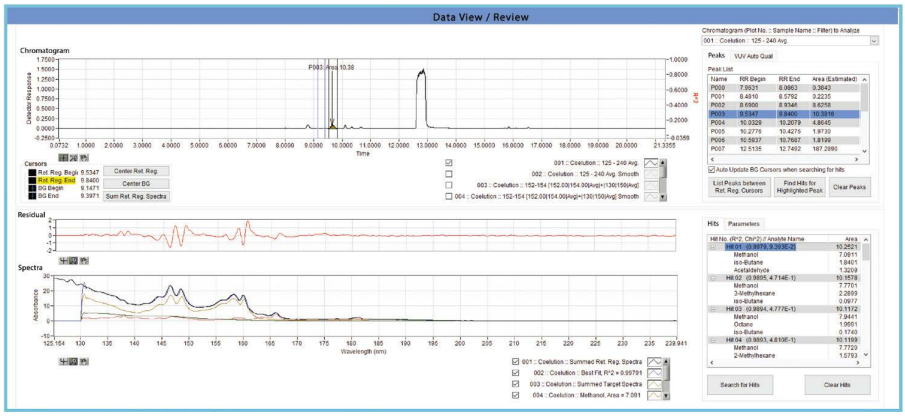
"The VUV detector is a powerful new tool in the GC toolbox."

KEVIN SCHUG
Distinguished Professor of Analytical Chemistry,
University of Texas at Arlington

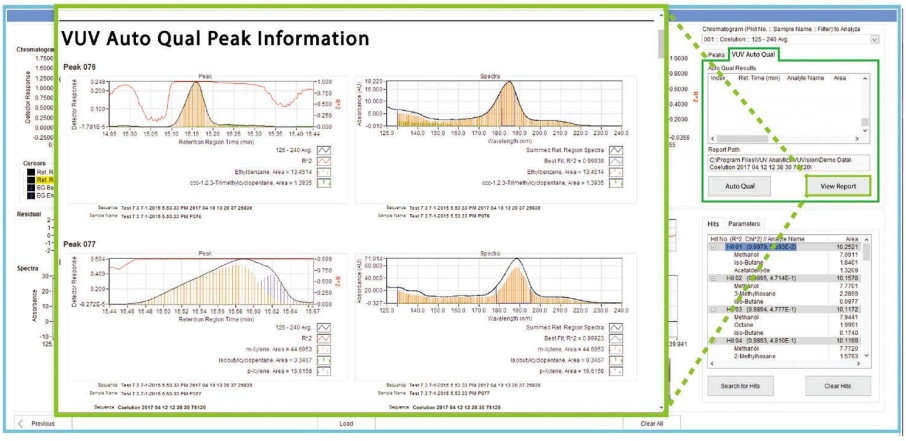
Powerful and easy-to-understand analysis tools

Data View / Review

Data View / Review performs qualitative analysis of either currently running acquisitions or previously acquired runs. It is especially useful in analyzing unknown samples using the VUV Auto Qual feature, which provides best-fit identification based on VUV library compound matching. Specific peaks or areas of interest can be highlighted for compound identification through VUV spectral library fitting.



Data View / Review: *Regions of interest can be selected and analyte spectra fit with VUV library compounds.*



Auto Qual Report: *Auto Qual provides best-guess compound identification of unknowns using VUV library compound fitting. A report is generated detailing the chromatographic, spectral, and closest compound match for each peak detected.*

Voice from KOL

"An amazingly simple concept extended into a powerful spectral region."

TIM HOSSAIN, PH.D.
Chief Scientist,
Cerium Laboratories

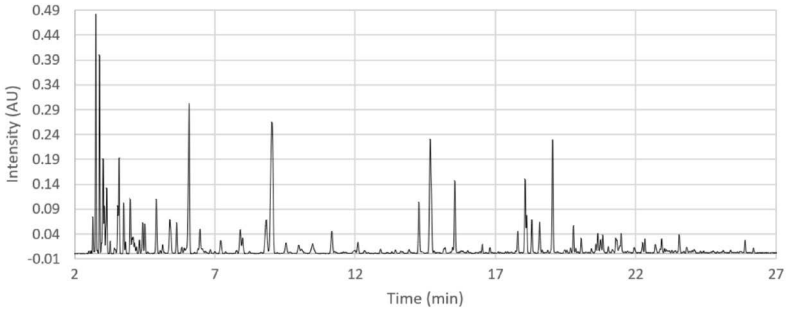
PIONA analysis based on ASTM D8071

Reduced Analysis Time

The chromatogram below was obtained by a reformulated gasoline sample that contains over 300 individual compounds. This sample was acquired using a 30-meter, non-polar PDMS column with a runtime of 34 minutes. While it is not obvious by looking at the chromatogram, there are several co-eluting compounds that make it difficult to analyze using traditional retention time approaches.

Powerful Deconvolution Function

GC-VUV is a three-dimensional technique, where data is acquired on three axes – time, absorbance, and wavelength. As a result, each compound has a unique spectral shape. Additionally, the individual spectra from compounds in a given class share similar shapes. This is significant because the class-based spectra can be combined to provide accurate class-based analysis that is required for PIONA.



After VUV Analyze Software completes the carbon number and class categorization of the components within the sample, an automated calculation determines the mass percent and volume percent makeup. The result is a carbon number breakdown table based on compound class.

CLASS-BASED DATA ANALYSIS (cont.)

MASS %

C. No.	P	I	O	N	A	Total
C1						
C2						
C3						
C4	1.1144	0.1064	0.0450			1.2657
C5	2.9113	6.0742	3.7817	0.2446		13.0118
C6	2.0138	6.9951	2.2886	1.6600	0.8034	13.7610
C7	1.2529	5.5536	0.8038	2.0491	3.8278	13.4871
C8	0.5290	17.2473	0.7076	2.0670	5.7730	26.3239
C9	0.3473	3.2496	0.1982	0.9024	5.9828	10.6802
C10	0.2080	0.8515	0.6075	0.9567	3.1507	5.7743
C11	0.1045	0.9554	0.3179	0.5486	1.3512	3.2776
C12		0.1992	0.1638	0.0571	0.3897	0.8098
C13		0.1849	0.0491		0.2292	0.4633
C14		0.0445				0.0445
C15		0.0028				0.0028
C16						
C17						
C18						
C19						
Total	8.4811	41.4645	8.9633	8.4855	21.5077	

VOLUME %

C. No.	P	I	O	N	A	Total
C1						
C2						
C3						
C4	1.4101	0.1398	0.0538			1.6037
C5	3.4051	7.1802	4.1864	0.2404		15.0121
C6	2.2368	7.7921	2.3616	1.6090	0.6695	14.6690
C7	1.3422	5.9535	0.8039	1.9908	3.2336	13.3239
C8	0.5515	17.9972	0.7041	1.9749	4.8632	26.0909
C9	0.3545	3.3225	0.1979	0.8451	5.0351	9.7550
C10	0.2087	0.8459	0.5969	0.8663	2.6164	5.1341
C11	0.1034	0.9195	0.3101	0.4966	1.1072	2.9368
C12		0.1892	0.1581	0.0511	0.3162	0.7147
C13		0.1741	0.0469		0.1925	0.4135
C14		0.0416				0.0416
C15		0.0026				0.0026
C16						
C17						
C18						
C19						
Total	9.6122	44.5583	9.4195	8.0742	18.0337	

ASTM D8071 results are presented in an easy-to read table showing carbon number and class breakdown

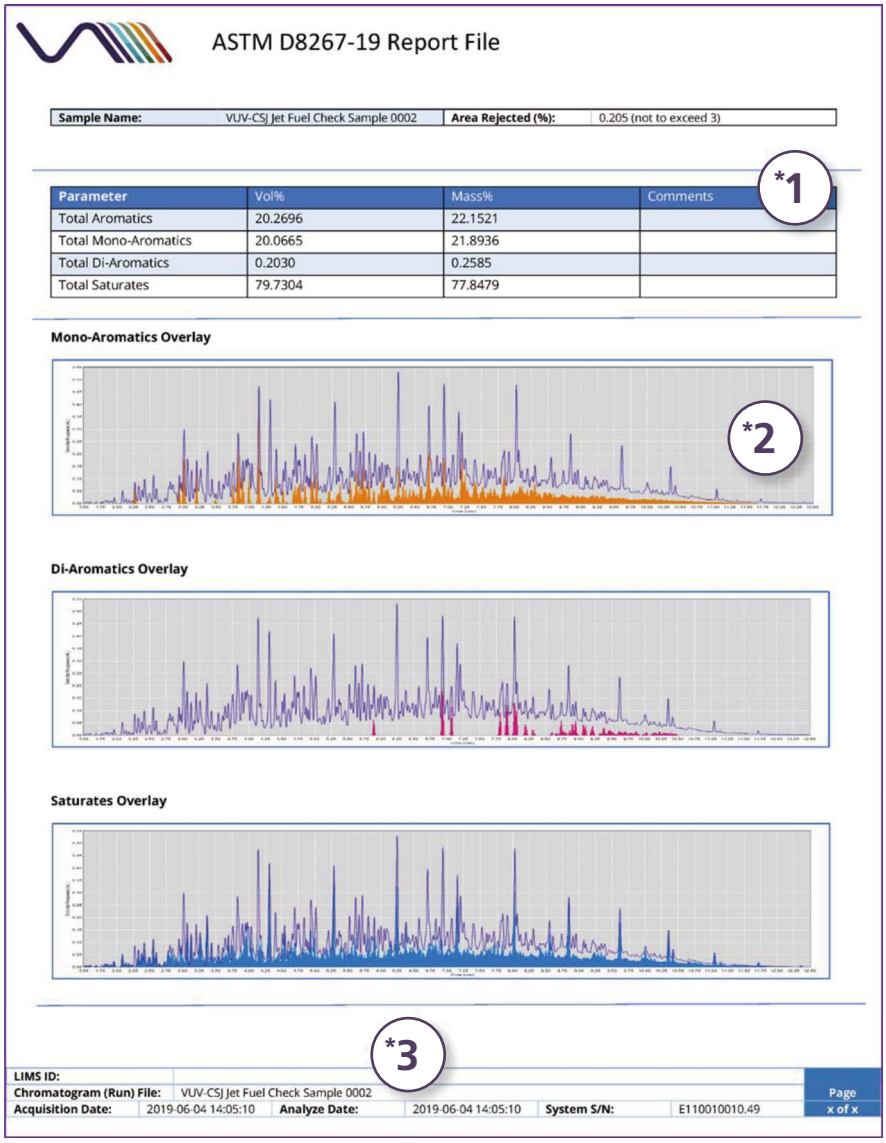
Aromatics analysis in jet fuels based on ASTM D8267

Simultaneous Analysis of Saturates and Aromatics

This method can be used to quantify total saturates and total aromatics; additionally, monoaromatics and diaromatics are distinguished and quantified.

No Sample Preparation, No Calibration Curve

No sample preparation or system calibration is required for analysis. Samples are characterized in a simple 14-minute run, and fully automated data processing is achieved using spectral matching.



ASTM D8267-19 Report File

Sample Name:	VUV-CSJ Jet Fuel Check Sample 0002	Area Rejected (%):	0.205 (not to exceed 3)

*1

Parameter	Vol%	Mass%	Comments
Total Aromatics	20.2696	22.1521	
Total Mono-Aromatics	20.0665	21.8936	
Total Di-Aromatics	0.2030	0.2585	
Total Saturates	79.7304	77.8479	

Mono-Aromatics Overlay

*2

Di-Aromatics Overlay

Saturates Overlay

*3

LIMS ID:						
Chromatogram (Run) File:	VUV-CSJ Jet Fuel Check Sample 0002					Page
Acquisition Date:	2019-06-04 14:05:10	Analyze Date:	2019-06-04 14:05:10	System S/N:	E110010010.49	x of x

Note: *1. Results are easy to interpret with no room for ambiguity.

*2. Chromatogram overlays are provided for visual distinction of saturate, monoaromatic, and diaromatic content.

*3. Detailed acquisition information is provided for analysis traceability.

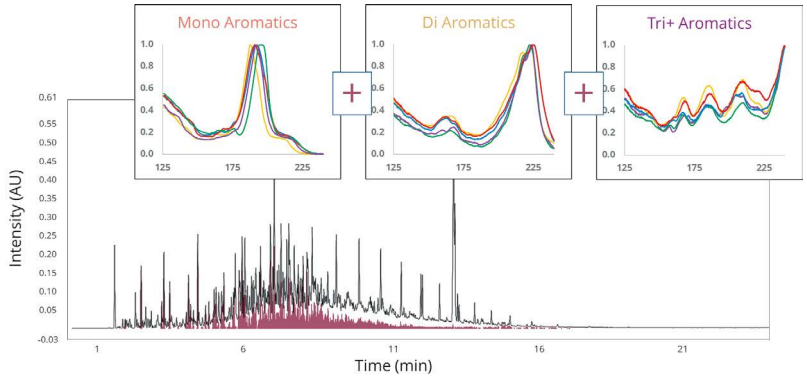
PAHs, FAME analysis in diesel fuels based on ASTM D8368

Simultaneous Analysis of PAHs and FAME

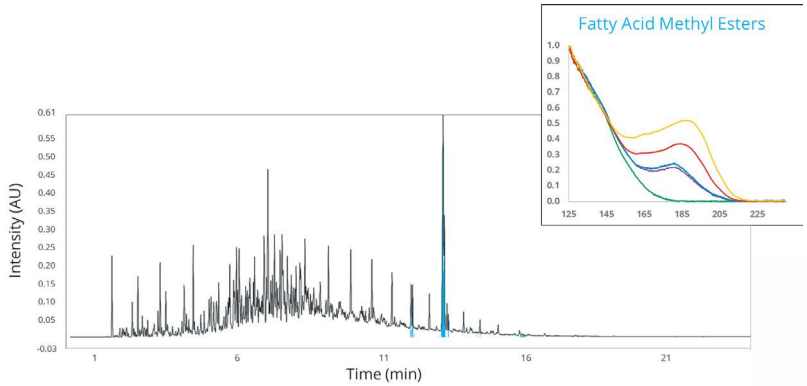
The combustion properties of diesel fuel and the resulting emissions from their consumption is greatly influenced by the percentage of aromatic hydrocarbons that are present in the diesel fuels. As a result, measuring the aromatic content of diesel fuels is important not only to determine the quality of the fuel from a manufacturing standpoint, but also to comply with environmental regulations for air quality and emissions.

While it is important to measure aromatic hydrocarbons, modern diesel fuels are often blended with as much as 20% (B20) biodiesel. As a result, it is also important to measure the fatty acid methyl esters (FAMEs) content to ensure compliance with current diesel fuel specifications.

The VUV Analyzer Platform achieves both qualitative and quantitative analysis of total aromatics, polyaromatic hydrocarbons (PAHs), and fatty acid methyl esters (FAMEs) using a single-injection, automated technique.



Chromatogram of a conventional biodiesel blend with the total aromatic spectral filter applied



Chromatogram of a conventional biodiesel blend with the FAMEs spectral filter applied.
The inset shows the VUV absorbance spectra of several common FAMEs found in diesel fuel.

CATEGORY	VOLUME %	MASS %
Total Saturates	71.8156	69.4367
Total Aromatics	23.2108	25.0496
Total Mono-Aromatics	21.8406	23.3264
Total PAHs	1.3702	1.7233
Total Di-Aromatics	1.1082	1.3803
Total Tri(+)-Aromatics	0.2620	0.3430
Total FAMEs	4.9736	5.5136

Results of the diesel analysis using GC-VUV and the Diesel Analyze Application are shown. All parameters are reported in volume percent and mass percent.

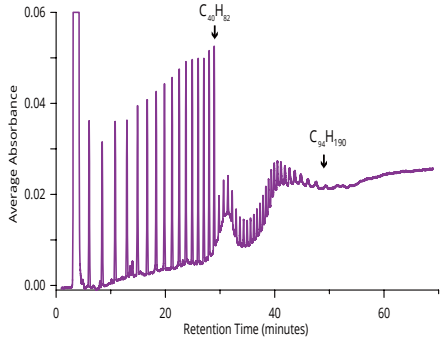
Expanded operating parameters widen the application spectrum

VGA-101 Enables More Applications

The VGA-101 offers additional capabilities to the VUV absorbance detection platform pioneered by the VGA-100. Analysis requiring temperatures exceeding 400 °C and measurement between 120 – 430 nm can now be routinely performed. Using spectral filters in a targeted wavelength region increases analyte sensitivity, ensuring quantitation at very low concentration levels.

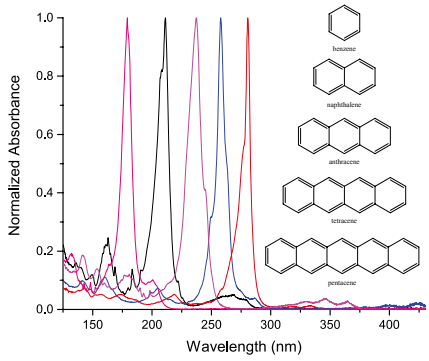
Routine identification and quantitation of high boiling point compounds

VUV absorbance spectrum of a complex hydrocarbon mixture analyzed at 430 °C



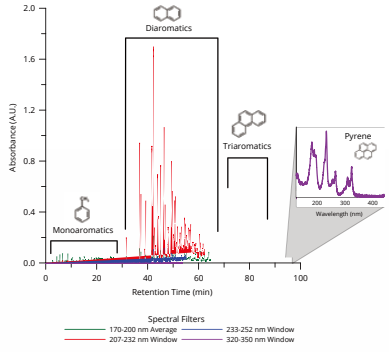
A wider wavelength detection range provides new spectroscopic data

A VUV spectrum comparison of acene compounds with increasing benzene ring count



Spectral filters improve analyte sensitivity throughout the VUV spectrum

Spectral filter comparison of diesel fuel fraction analyzed from 120 – 350nm



Specification

PARAMETER	VUV ANALYTICS™ VGA-100	VUV ANALYTICS VGA-101	NOTES
Light Source	Deuterium lamp	Deuterium lamp	
Wavelength Range	120 - 240 nm	120 - 430 nm	
Wavelength Accuracy	±0.2 nm	±0.2 nm	
Wavelength Reproducibility	0.05 nm	0.05 nm	
Type of Response	Universal	Universal	H_2, He, Ar are transparent
Spectral Bandwidth	<1 nm	<1 nm	
Maximum Acquisition Rate	>75 Hz	>75 Hz	
Response Characteristic	Absorption versus Wavelength	Absorption versus Wavelength	
Measurement Output	Identity, Concentration	Identity, Concentration	H_2, He, Ar are transparent
Detected Species	All compounds and classes	All compounds and classes	
Typical IDLs (pg on Column)	alpha-Pinene: 30 Methyl Decanoate: 30 Fluorene: 35 Coumarin: 35 n-Decane (C10): 40 Phenylacetaldehyde: 40 Citronellol: 65	Benzene: 15 Nicotine: 20 Naphthol: 30 Derivatized β-estradiol: 30 Octane: 60 Methanol: 170 Water: 246	
Linear Range	3-4 orders	3-4 orders**	
Temperature Range	Ambient - 300 ˚C	Ambient - 430 ˚C	
Carrier Gases	H_2, N_2, or He	H_2, N_2, or He	
Makeup Gas	Ar, He, N_2	Ar, He, N_2	
Flow Cell Dimensions	10 cm pathlength, <80 µL cell volume	10 cm pathlength, <40 µL cell volume	
Instrument Dimensions	30" × 13" × 17", or 76.2 × 33 × 43.2 cm	30" × 13" × 17", or 76.2 × 33 × 43.2 cm	
Deuterium Lamp Lifetime (hours)	>2000	>2000	Lamp intensity half life at 250 nm
Weight	120 lbs, or 54.4 kg	120 lbs, or 54.4 kg	
Power Input Voltage	100 / 240V	100 / 240V	
Power Consumption	<700 VA	<700 VA	
Operating System Requirements	Quad Core processor, 1080 × 1920 Monitor, Minimum Memory 8G, Hard Drive Min 250G, Windows 7, 8, or 10 (64 bit)	Quad Core processor, 1080 × 1920 Monitor, Minimum Memory 8G, Hard Drive Min 250G, Windows 7, 8, or 10 (64 bit)	
Additional Facilities Requirements	CDA connection 99.999% N_2 connection, typical 40 mL/min purge requirement	CDA connection 99.999% N_2 connection, typical 40 mL/min purge requirement	

Application Specific GC Systems
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