Global Analyser Solution

VUV ANALYTICS

Total aromatic, monoaromatic and diaromatic content of jet fuel

- Fully compliant with ASTM D8267.
- 5-10 x better results compared to FIA and HPLC
- 2.5–16 times lower total cost compared to FIA and HPLC
- No sample preparation or calibration curves

Get ready for ***tomorrow's analytics***

AN19-4WA0124B

Global Analyser Solutions

GAS offers custom configured GC analysers for many application fields for over 50 years. GAS analysers are designed to meet many standardised methods from GPA, ASTM, UOP, ISO, EN and others. The efficient configurations are based on proven GC technology, resulting in robust, highly productive instruments with an optimal return on investment.

Aromatic hydrocarbons in jet fuel are restricted to a maximum of 25% volume due to their negative impact on jet engine performance, safety, environmental emissions, elastomer compatibility, and energy density. Established standards such as ASTM D1655 and DEF STAN 91091 regulate aromatic content in jet fuel. Traditional methods for analysing aromatics include Fluorescence Indicator Absorption (FIA) and High-Performance Liquid Chromatography (HPLC). FIA, dating back to the 1950s, is considered manual, laborious, and prone to human error. HPLC, a newer method, requires sample preparation, calibration standards, and the use of hazardous solvents. Despite improvements over FIA, HPLC is time-intensive and demands a skilled analyst. The application note introduces a new approach for analysing aromatic content in jet fuel.

A simple five-step analytical workflow (Figure 1) is employed to compounds of interest present in a variety of jet fuel samples. The jet fuel samples does not require any special sample preparation and are run on a VUV Analyser Platform for Fuels consisting of a VGA-100™ Spectrometer coupled with a Gas Chromatograph using both VUVision™ Software and VUV Analyze™ Software configured to run ASTM D8267.

SYSTEM VALIDATION	Single standard is used to check split linearity and baseline. Automated RI file generation and reporting.
SAMPLE PREPARATION	No sample preparation is required with this application.
DATA ACQUISITION	All data is acquired using VUVision Software and is automated. No calibration curve required.
SPECTRAL MATCHING	Automated with VUV Analyze Software running the Jet Fuel Application for ASTM D8267.
QUANTITATION	Automated with VUV Analyze Software. Relative Response Factors > mass %. Densities > volume %.

Figure 1 - Analytical workflow

Saturate, mono-aromatic and di-aromatic content are easily visible using specific portions of the acquired wavelength range, referred to as spectral filters. However, the entire wavelength range is used when performing spectral matching and quantitation (figure 2)..

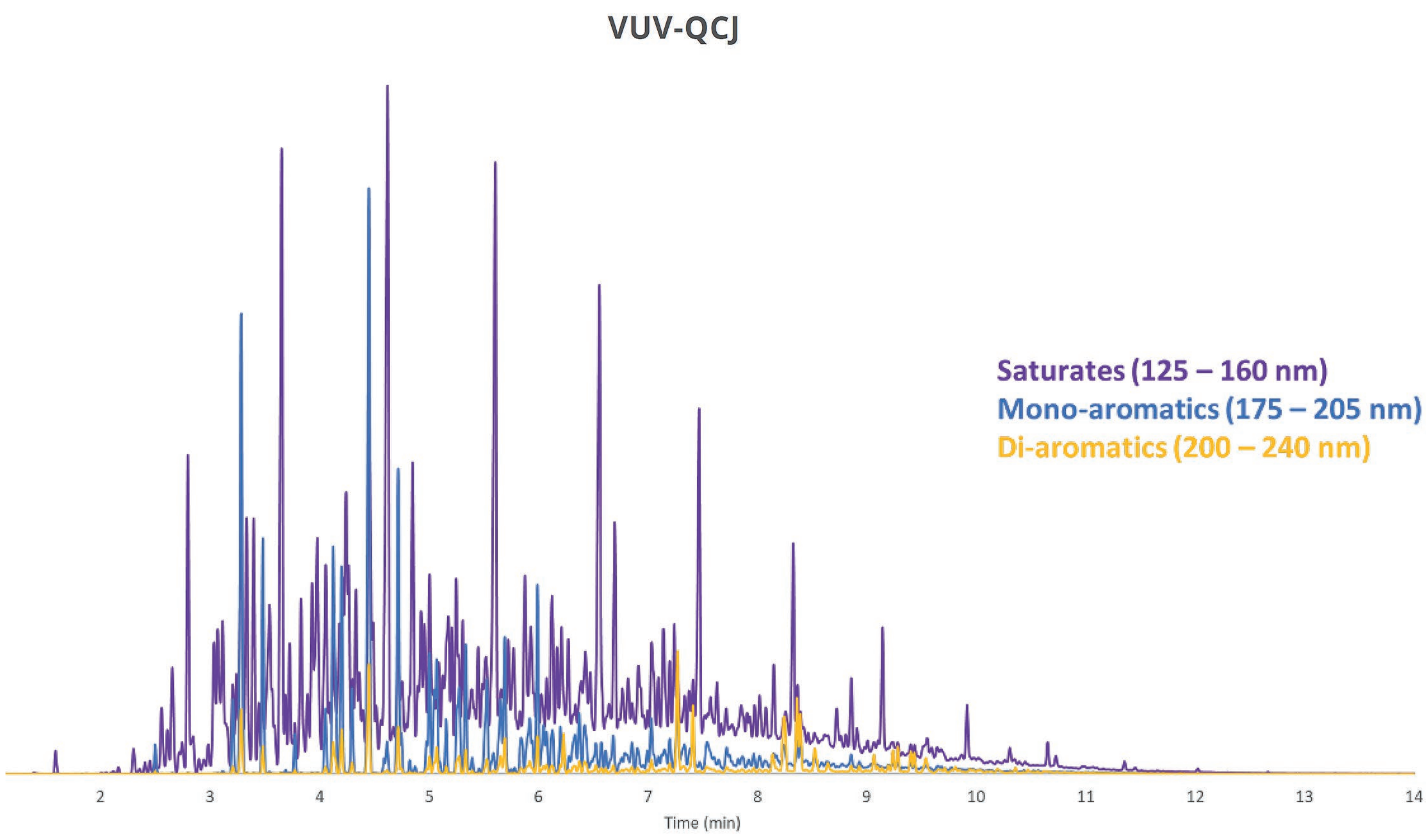


Figure 2 - Conventional jet fuel sample with spectral filters overlaid for Saturates (125 – 160 nm), Mono-aromatics (175 – 205 nm), and Di-aromatics (200 – 240 nm).

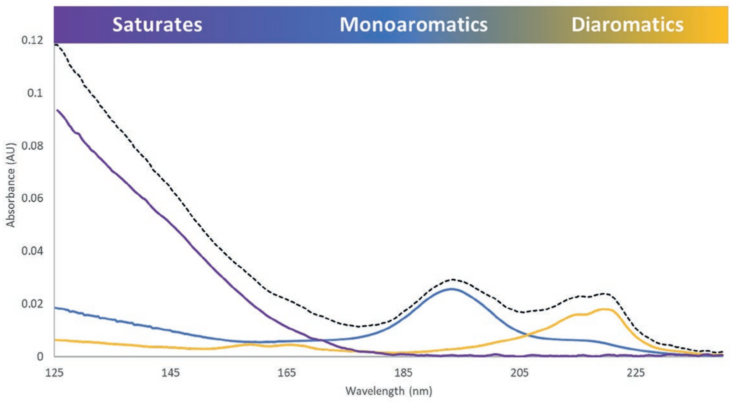


Figure 3 - Spectral matching to deconvolve

In GC-VUV analysis, unlike traditional chromatography, where components are identified and quantified using peak retention time and integration, data analysis relies on spectral validation with a compound library. Saturate, mono-aromatic, and di-aromatic compounds exhibit distinct spectral shapes, ensuring reliable quantification with spectral confirmation. Compound classes with similar spectra can be combined for accurate class-based reporting. Time Interval Deconvolution™ (TID™) enables the spectral distinction of coeluting compounds. Using TID, chromatograms are divided into time intervals, and each interval's spectrum is matched against the library. Figure 2 illustrates a spectrum revealing a clear coelution. TID leverages the unique spectral shapes of each class to determine the best multi-analyte fit, as demonstrated in Figure 3.

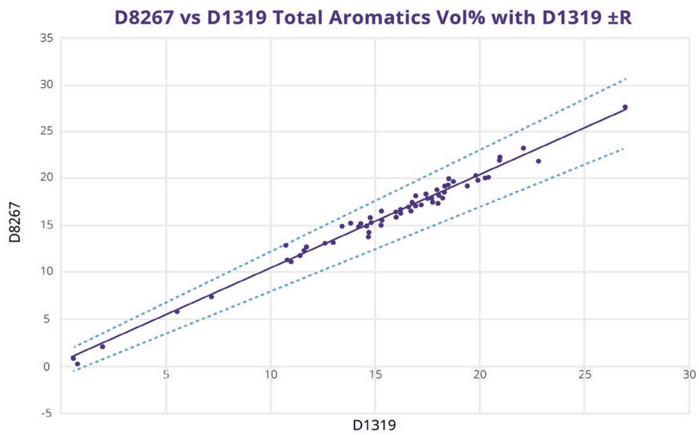


Figure 4 - Consolidated study comparing ASTM D8267 reproducibility (solid line) with ASTM D1319 (dotted lines).

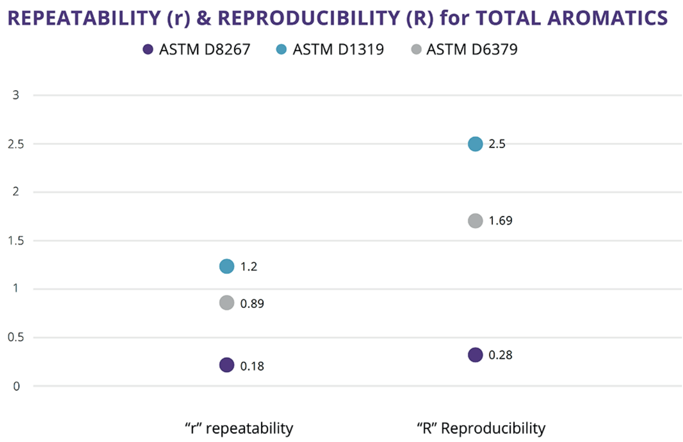
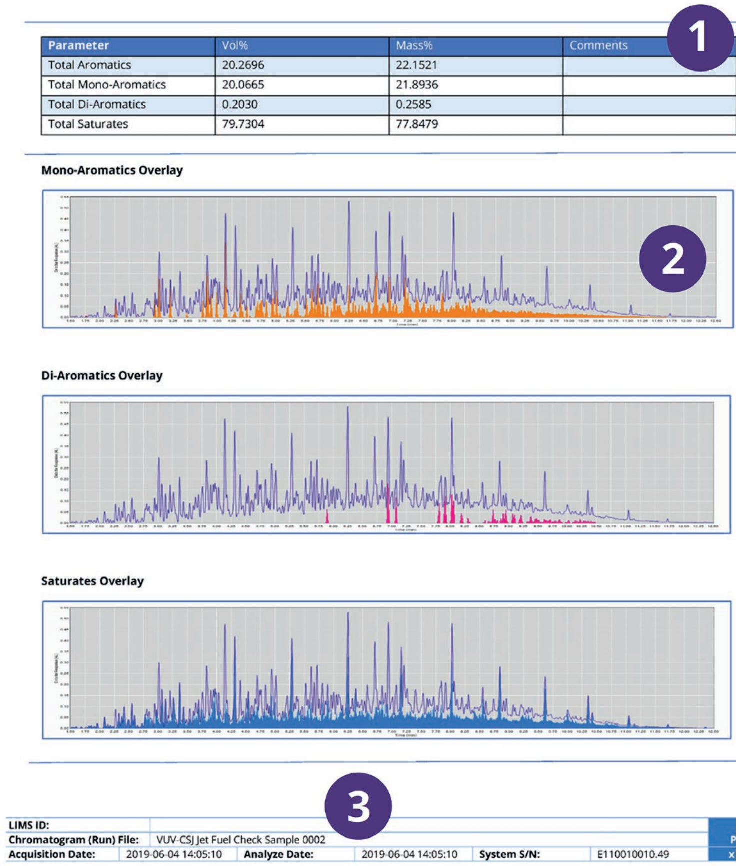


Figure 5 - Comparison of method precision.



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	

Figure 6 - Typical report for GC-VUV running ASTM D8267. Compound classes are reported in the table (1) while chromatographic overlays (2) are provided for visual distinction of mono-aromatic, di-aromatic, and saturate content. Detailed acquisition information (3) is provided for analysis traceability.

All results are reported using the VUV Analyze Software based on compound class. Figure 6 shows the report for the VUV-QCJ sample discussed above. The table (1) provides reported values in both mass % and volume % for total aromatic, mono-aromatic, di-aromatic, and saturate content. Chromatographic overlays (2) are provided for easy visual distinction of mono-aromatic, di-aromatic, and saturate content. Additionally detailed acquisition information (3) is provided for analysis traceability. Precision for ASTM D8267 was determined by an interlaboratory study (ILS) that included 10 laboratories and 24 samples. This ILS included a variety of jet fuel types including JA, JA1 and F24 along with samples generated from different refining processes and sustainable alternative jet fuels. Supporting data for this ILS may be obtained from ASTM by requesting Research Report RR:D02-D1911. Additionally, other studies have been conducted as further validation of the precision, repeatability and reproducibility claims. Specific studies include 65 samples from various institutes. The data from these samples is summarized in Figure 4. The consolidated graph shows the ASTM D8267/D1319 data pairs and linear trendline all of which are well within the reproducibility of ASTM D1319 indicated by the upper and lower dotted lines (blue).

Jet fuel analysis using the VUV Analyzer™ for Fuels running ASTM D8267 demonstrates up to 10 times better repeatability and reproducibility compared to the referee method (D1319) and the HPLC alternative method (D6379). Figure 5 compares the precision across these methods for a conventional jet fuel with approximately 18% total aromatics.

Specification

METHOD SCOPE

The scope of ASTM D8267 is shown in the following (Table 1):

MATRIX	PROPERTY	MIN VOL %	MAX VOL %	REPLACES METHODS	APPROVALS
JET FUEL	TOTAL AROMATIC COMPOUNDS	0.487	27.876	ASTM D1319, ASTM D6379	ASTM D1655, DEFSTAN 91091
SAF	TOTAL MONOAROMATIC COMPOUNDS	0.49	27.537		
nC6 (68 °C) and nC21 (356 °C)	TOTAL DIAROMATIC COMPOUNDS	0.027	2.523	ASTM D1840	PENDING

Figure 7. ASTM D8267 Method Scope

Standardised method:	ASTM D8267
Application:	Automated analysis of the total aromatic, monoaromatic and diaromatic content of aviation turbine fuels using GC-VUV and ASTM D8267
Analysis Time:	14 minutes

GC conditions:

Column type:	Restek Rtx-1, 30m*0.25mm, df=0.25u
GC oven temperature program :	50 °C (0.1 min) - 15 °C/min - 260 °C
Column flow rate:	2 ml/min (He)
Injector:	Split/Splitless
Injection volume:	1 ul

VGA conditions:

Makeup gas pressure:	N_2 (pressure determined on instrument)
Flow cell temperature:	275 °C
Transfer line temperature	275 °C
Acquisition frequency:	7 Hz
Acquisition range:	125-240 nm

Total cost per sample: $ 3.07 for ASTM D8267-VUV (ASTM D6379-HPLC: $8.98; ASTM D1319-FIA: $51.49)

Figure 8. VUV Analytics VGA-100 with GC1610

The content of the application note is obtained from VUV application note VUV_Jet_App_Note_VUV-000272_Rev_3.0