

APPLICATIONS

Determination of Aromatic Hydrocarbon Types in Aviation Fuels and Petroleum Middle Distillates by HPLC

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Tim is an avid outdoorsman who loves to hike and ski. His most recent exploration is tall ship sailing in our local Pacific Ocean. Tim loves history and everything about the stars and space.

Introduction

Jet fuel is a complex mixture of thousands of different types of hydrocarbons. The petroleum refining process separates the crude into the different boiling-point based streams and the kerosene jet fuel is sourced from the middle distillate cut. There are different compositional variations of crude oil depending on its geological source which will create a fluctuation in the kerosene's complex mixture of aliphatic, aromatic, and heteroatomic compounds, which are typically between 8 and 16 carbon numbers in length. Paraffins, naphthenes, olefins, and aromatics are the four main group types of hydrocarbon compound classifications. The most desired combustion characteristics come from the paraffins, then the naphthenes, and lastly the aromatics.

Compared to the paraffins and naphthenes, the aromatics tend to create a smoky flame and they will also release a greater proportion of undesired thermal radiation. The total level of paraffins, olefins, and aromatics in kerosene is important in the jet fuel's operational performance. They are also important in characterizing petroleum fractions and products from the various refinery process streams, such as catalytic reforming and from thermal and catalytic cracking, so that they can be used as a guide to blend different components for aviation jet fuel.

In order to ensure that the composition of jet fuel will meet the operational criteria to perform properly in the jet engines, universally accepted specifications have been created. The U.S. EPA and many other government regulatory authorities mandate that the finished jet fuel product meets ASTM D1655 testing requirements, which contains a long list of physical and analytical test methods.

Materials and Methods

One of the test methods listed in ASTM D1655 is D6379 (equivalent to IP 436) for the determination of mono- and di-aromatic hydrocarbon (MAH and DAH) content in aviation fuel and middle distillates with boiling points in the range of 50°C to 300°C. The accurate determination of the aromatic content in fuels is critical to assessing the finished product's quality relative to the combustion characteristics. These parameters are crucial to ensuring aviation safety and compliance with environmental regulations.

A fixed volume of sample with the mobile phase (heptane) is injected into a high-performance liquid chromatography (HPLC) device equipped with a polar HPLC column. The polar column has strong affinity for aromatic hydrocarbons; therefore, the aromatics are separated from the non-aromatics into distinct peaks based on their molecular structure. The refractive index detector connected to the column detects the components as they elute from the column. The amplitudes of the signals (peak areas) from the sample aromatics are compared with those obtained from previously run calibration standards in order to calculate the percent m/m MAHs and DAHs in the sample. The sum of the MAHs and DAHs is reported as the total aromatic content (percent m/m) of the sample.

Test method D6379 specifies that any stainless steel HPLC column(s) packed with an approved amino-bonded (or polar amino/cyano-bonded) silica stationary phase can be utilized, provided it meets the resolution requirements. The SRS-R1 sample demonstrates the three component peaks with surrogate analytes: Cyclohexane for saturated compounds, o-Xylene for monoaromatic hydrocarbons (MAHs), and 1-Methylnaphthalene for di-aromatic hydrocarbons (DAHs).

Figure 1.
Separation of D-6379 SRS-R1 Mix

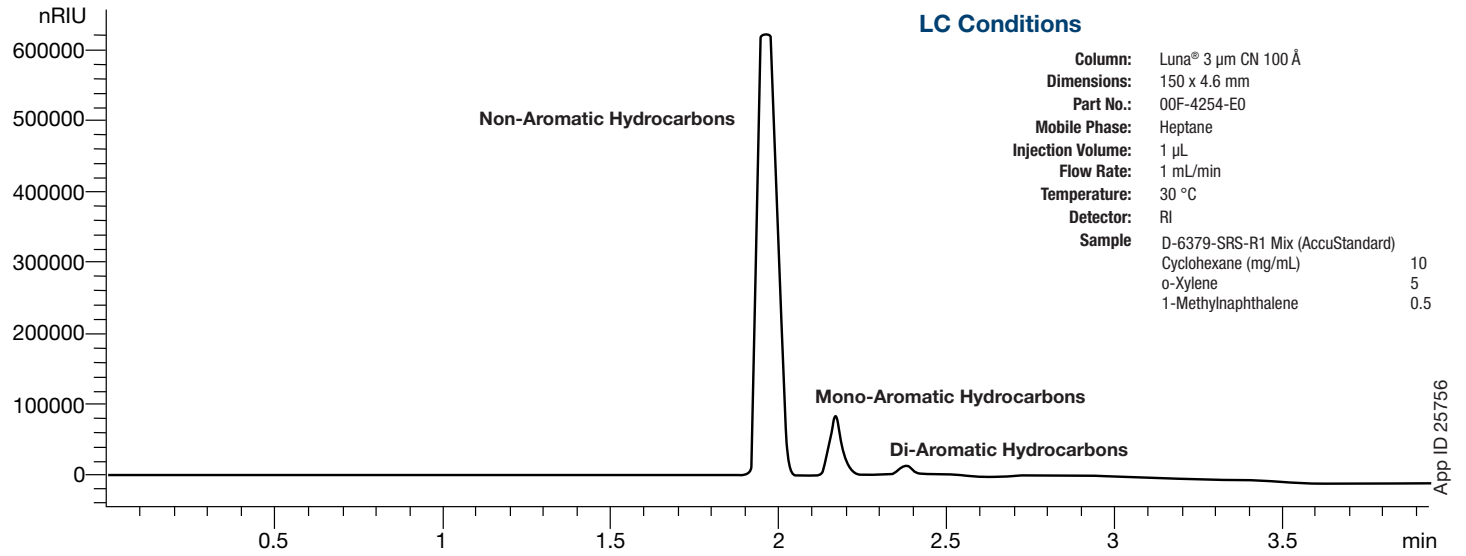
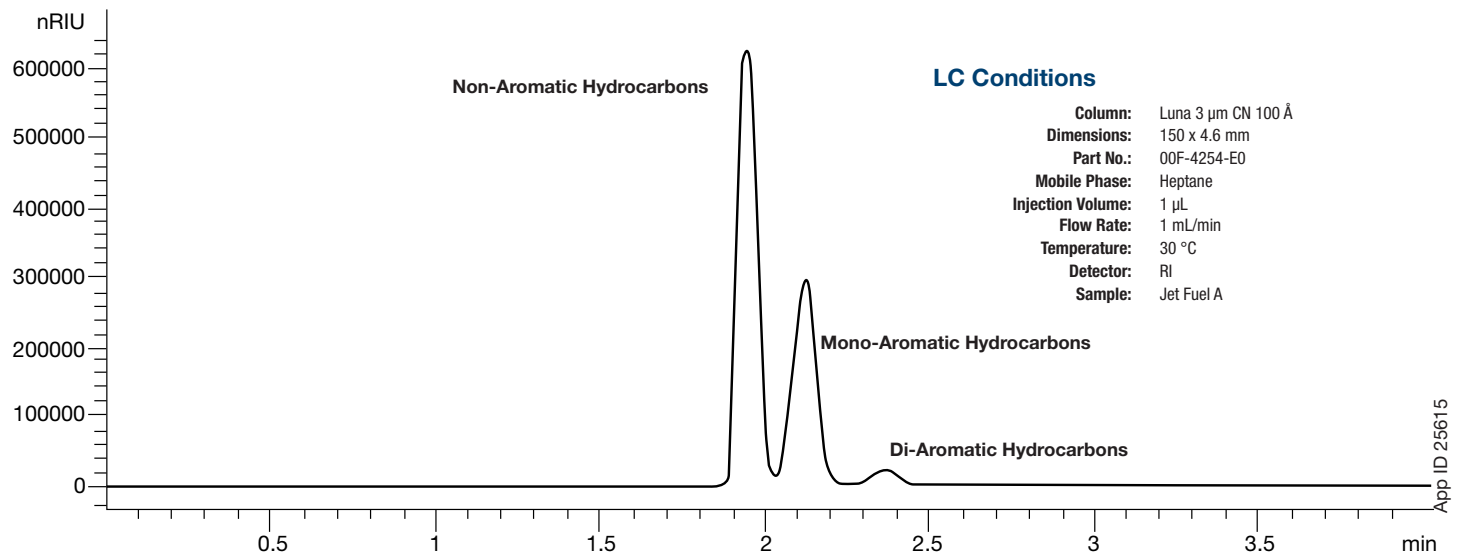
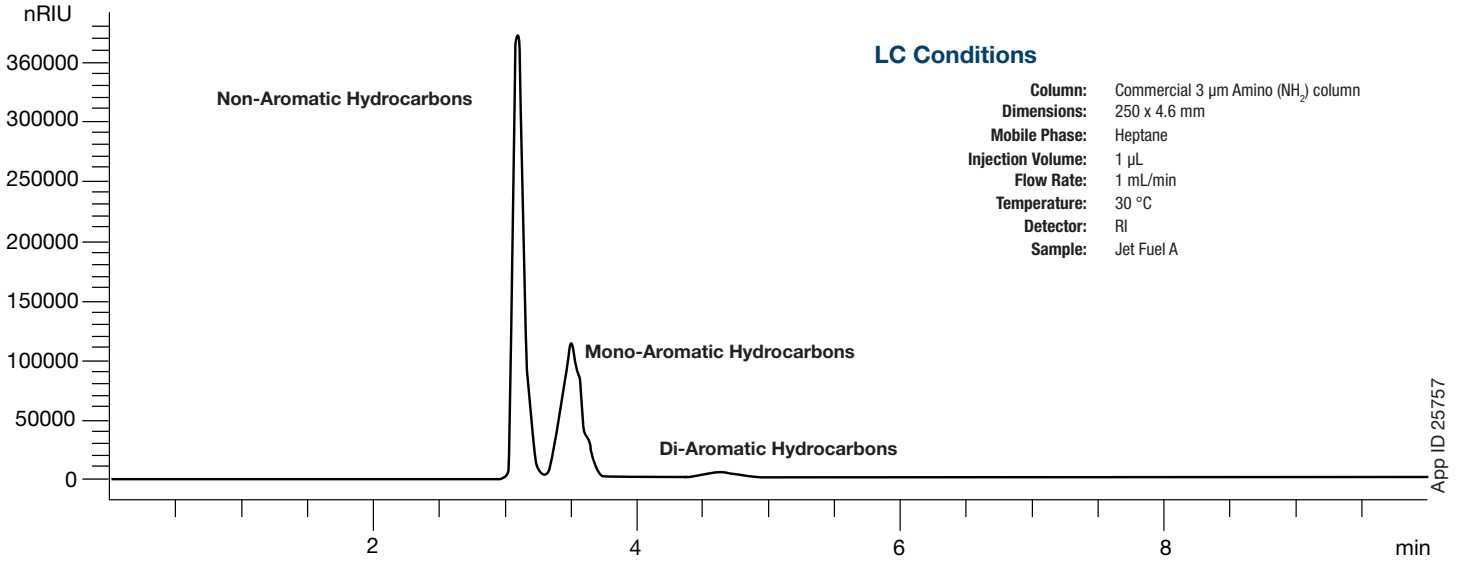


Figure 2.
Separation of a 1 μL injection of undiluted Jet Fuel



A sample of Jet Fuel A from a refinery was run with the same column and conditions showing separation of the non-aromatics, MAH's, and DAH's.

Figure 3.
Separation of a 1 µL injection of undiluted Jet Fuel



Then, a comparison was run on a popular commercially available amino (NH₂) column showing that there is an improved performance with the Luna CN (cyano) stationary phase. There is a noticeable co-elution between the MAH and DAH components.

Results and Discussion

The Luna[®] CN column provides excellent polar selectivity and good peak shapes with both the SRS-R1 and Jet Fuel A samples. The Luna CN has a modified silica surface to ensure improved resistance to bonded phase hydrolysis providing one of the most stable CN phases.

**Luna HPLC Column
Ordering Information**

3 µm MidBore™ and Analytical Columns (mm)								SecurityGuard™ Cartridges (mm)	
Phases	50 x 3.0	150 x 3.0	30 x 4.6	50 x 4.6	75 x 4.6	100 x 4.6	150 x 4.6	4 x 2.0*	4 x 3.0*
CN	00B-4254-Y0	00F-4254-Y0	00A-4254-E0	00B-4254-E0	00C-4254-E0	00D-4254-E0	00F-4254-E0	/10pk AJ0-4304	/10pk AJ0-4305
								for ID: 2.0-3.0 mm 3.2-8.0 mm	

5 µm MidBore and Analytical Columns (mm)							SecurityGuard Cartridges (mm)	
Phases	50 x 3.0	150 x 3.0	250 x 3.0	30 x 4.6	50 x 4.6	75 x 4.6	4 x 2.0*	4 x 3.0*
CN	00B-4255-Y0	00F-4255-Y0	00G-4255-Y0	00A-4255-E0	00B-4255-E0	00C-4255-E0	/10pk AJ0-4304	/10pk AJ0-4305
							for ID: 2.0-3.0 mm 3.2-8.0 mm	

*HPLC Guard Cartridge Holders (one-time purchase only)	/kit
Reusable Holder	KJ0-4282



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Luna is a registered trademark, and SecurityGuard, BE-HAPPY, and MidBore are trademarks of Phenomenex.

Disclaimer

Comparative separations may not be representative of all applications.

SecurityGuard is patented by Phenomenex. U.S. Patent No. 6,162,362

CAUTION: this patent only applies to the analytical-sized guard cartridge holder, and does not apply to SemiPrep, PREP or ULTRA holders, or to any cartridges.

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