Application Note

Handheld Chemical Identification

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Fuel Detection Through Opaque Containers with Agilent Resolve – a Handheld SORS System

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Abstract

The Agilent Resolve Raman handheld through-barrier identification system identifies materials concealed behind barriers such as colored and opaque plastics, dark glass, paper, and fabric using Agilent proprietary spatially offset Raman spectroscopy (SORS) technology.

This application note details how the Resolve Raman system can easily differentiate specific petrochemical formulations inside opaque containers. With no need to open the containers, fast analysis times of less than two minutes were achieved enabling the rapid identification of fuels.

The Resolve is a powerful tool that can help authorities identify illicit petrochemicals. This capability is important due to the rise of illegal fuel imports and illicit blending of refined products, which pose a risk to consumers. Resolve can also help identify specific fuel formulations, facilitating the detection of the source of leaks during processing or transportation.

Introduction

Suppliers of illicit fuels avoid taxes by mislabeling fuel imports as they enter a country or by creating hazardous blends with lower-cost components like methanol, naphtha, and base oils.[1] The economic impacts from lost revenue due to illicit or smuggled goods can be significant. Also, non-legitimate fuels are unlikely to meet safety standards or regulations, posing a risk to the public and the environment.

The Agilent Resolve Handheld Raman Analyzer is a powerful tool that can help authorities identify contraband petrochemicals. It can also be used to find the source of leakages on a petrochemical platform, throughout processing, or during transportation. Fuels with different blends, formulations, and octane ratings will produce distinctive Raman spectra, making it possible to identify the fuel composition or type using Raman spectroscopy. Also, using Spatially Offset Raman Spectroscopy (SORS) through-barrier mode, the Resolve can perform measurements of fuels housed in a range of containers without the need to open them.

The spectra from four fuel samples of varying octane ratings were transferred to the Agilent Command Fleet Management Software to build a custom Resolve library for fuels. The library creation and deployment process is outlined in this application note.

Experimental

Instrumentation

To conduct a measurement using the portable Resolve system, simply select the container type from the three options shown in Figure 1. In this study, the tests were performed in the SORS through-barrier mode by selecting "Thick, Colored, or Opaque" on the Resolve screen (Figure 1, left).

Care and caution are needed when scanning suspected flammable materials. As shown in Figure 1, right, the Resolve system can be operated using a scan delay or the laser power can be reduced to help minimize any risk of accidental ignition. Resolve can also be operated via remote viewing (through the optional Wi-Fi connection) for increased operator safety. For the work described in this note, the Resolve handheld Raman analyzer was used with default acquisition settings and full laser power in the SORS through-barrier mode.

Samples

The samples used to create the Command fuels spectral library were all commercially available fuels, as follows and as shown in Figure 2:

- Diesel
- Gasoline 87 Octane
- Gasoline 89 Octane
- Gasoline 92 Octane

Figure 2. Fuels that are typically for sale at gas stations.

Each fuel sample was decanted into a full-sized plastic fuel container, as shown in Figure 3.

Figure 3. Fuels are frequently decanted into opaque colored plastic containers.

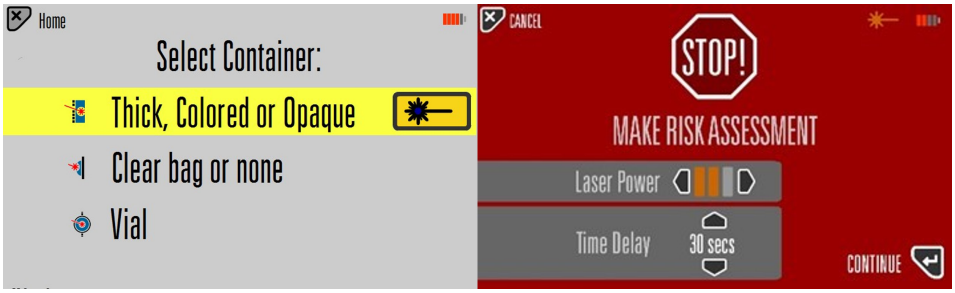

Figure 1. Left: Selection of Agilent Resolve handheld Raman analyzer operational mode; SORS through-barrier (Thick, Colored or Opaque), point-and-shoot (Clear bag or none), or glass vial measurements (Vial). Right: Risk assessment screen for reducing laser power or setting a scan delay time.

Library generation

After data collection using the Resolve, the scans of the four fuel samples were exported onto a desktop computer via a USB memory stick. The Agilent Command Fleet Management software was used to open the file and create a custom library for fuels based on the spectral data. The library creation process in Command is fast and simple, as outlined in Figure 4. Command allows the user to use the average of data acquired from repeated measurements, perform small corrections, and add metadata, if desired. Once the library has been created, a Command library file can be generated for uploading from the PC onto the Resolve or onto multiple Resolve analyzers.

After the Command custom fuels library had been installed on the Resolve, a new set of measurements were performed on the fuel containers to confirm the performance of the method. The Resolve was operated in SORS through-barrier mode using full laser power.

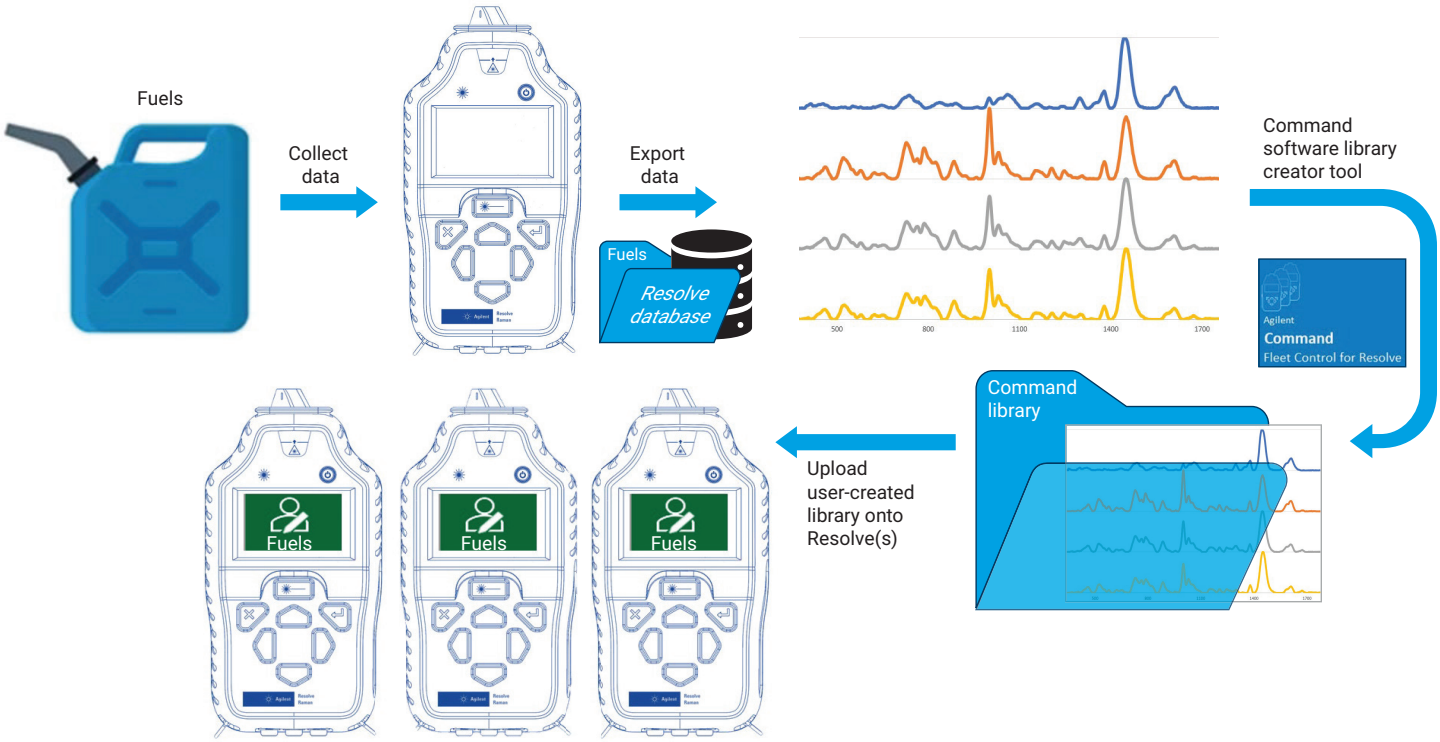

Figure 4. Workflow of data collection, library creation, and uploading of the user created fuel library from Agilent Command software to one or a fleet of Agilent Resolve handheld Raman analyzers.

Results and discussion

The fully automated SORS measurement of each fuel in its opaque colored plastic container took less than two minutes using the Resolve analyzer. The through-barrier Raman spectra of the different fuels are plotted in Figure 5. While there are distinct differences between the spectra of the diesel and gasoline samples, distinguishing between the three gasoline samples by eye is more challenging.

Once the Command fuels library based on these four spectra had been loaded onto the Resolve analyzer, the samples were rescanned. Figure 6 shows that the Resolve correctly identified the content of each of the opaque colored plastic fuel containers against the library spectra, with match values of 100%.

The screen of the Resolve analyzer shows the single best match result (87 Octane, 89 Octane, 92 Octane, and Diesel) to the spectra in the Command library. Users can also view lower match results, sample and reference (library) spectra, and metadata on the screen.

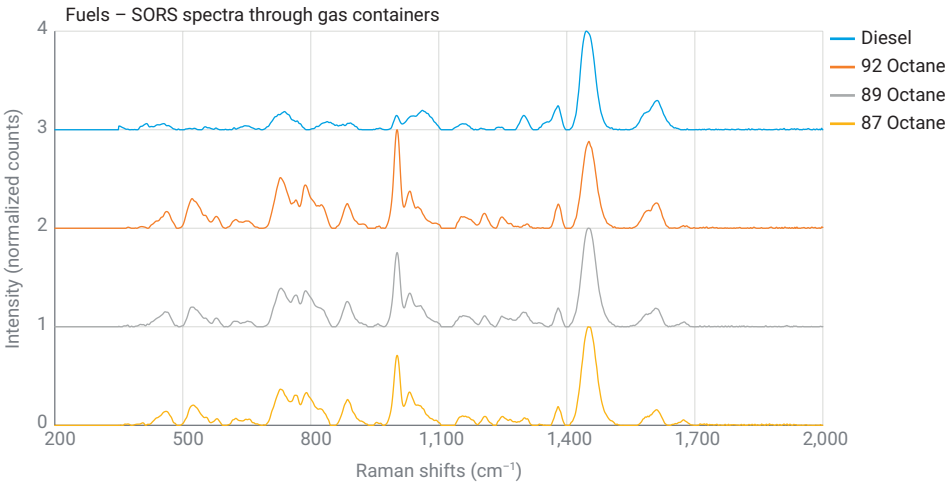

Figure 5. Raman spectra of four commercial fuels obtained using the Agilent Resolve handheld Raman analyzer in SORS through-barrier mode.

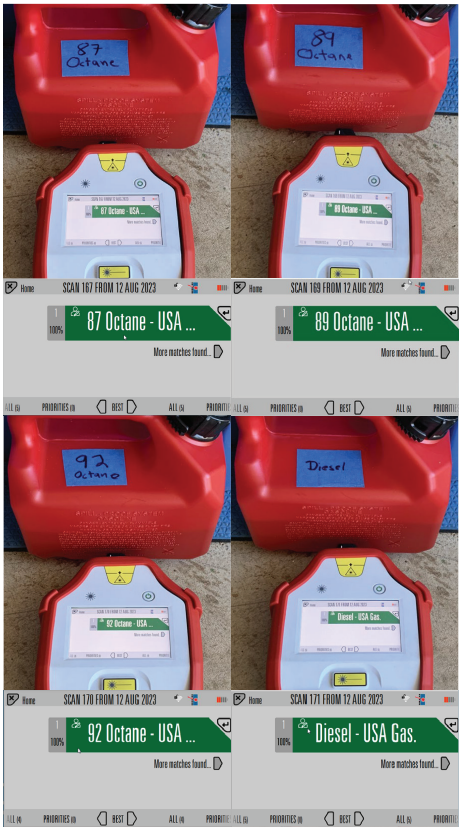

Figure 6. 100% match values for the four fuel sample measurements conducted through thick, red plastic containers using the Agilent Resolve and the custom "Fuels" library.

Conclusion

The study has shown the effectiveness of the Agilent Resolve handheld Raman analyzer in SORS through-barrier mode for the identification of fuels.

- Agilent SORS technology makes it possible to collect high-quality data directly, through opaque containers.
- Resolve features are designed to minimize the operator's risk and exposure to chemicals during measurements. There is no need to open containers to analyze samples, laser power can be adjusted, and measurements can be performed remotely using remote view.
- New sample spectra can be easily added to Resolve libraries using the Agilent Command Fleet Management Software.

In this study, the Resolve easily identified the concealed fuel material in all four tests. In each case, the measured spectrum produced a high-quality match with the library spectrum, despite being measured through a thick red plastic container.

Reference

1. Oil Price Information Service (OPIS), Mexico 101: Illegal Fuel Imports and Blends, April **2023**, accessed September 2023, https://blog.opisnet.com/mexico-101-illegal-fuel-imports-and-blends

Further information

Resolve Handheld Raman Analyzer

Command Fleet Management Software

Resolve Handheld Raman Analyzer FAQs

Raman Spectroscopy FAQs

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