Fast Distilled Spirit Analysis with an Agilent 8850 Gas Chromatograph and Long-Term Stability Test

Authors

Youjuan Zhang,
Jinqiang Zhang, and Shun Na
Agilent Technologies, Inc.
Shanghai, China

Abstract

Precise and rapid analysis of key compounds in distilled spirits is essential for ensuring product quality, streamlining production, and addressing quality issues efficiently. This study developed a fast analysis solution for alcohols, aldehydes, esters, and organic acids in distilled spirits using the Agilent 8850 gas chromatography (GC) system equipped with a flame ionization detector (FID). The high-speed analysis was performed on a 10-meter Agilent J&W DB-WAX UI column, leveraging the 8850 GC unique rapid oven heating and cooling capabilities, reducing the analysis cycle for a single sample to one-third of the time compared to traditional methods. Different carrier gases were studied, yielding excellent performance results that met the requirements of the quality control departments in the distilled spirits industry. The applicability of this rapid method, along with system ultra-high inertness and long-term stability, was verified through more than 2,000 injections of real samples.

Introduction

In the distilled spirits industry, compounds such as alcohols, esters, aldehydes, and acids directly influence the flavor, quality, and stability of the spirits. Therefore, precise quantitative analysis of these compounds is a critical step to ensure the product meets quality standards. Traditional analytical methods[1] are often time consuming, and quality control (QC) departments are eager to test a large number of samples in a short time to meet the real-time demands of production lines or quickly respond to quality issues. Rapid analytical solutions not only significantly improve work efficiency but also reduce wait times, ensuring smooth production processes and product stability. Additionally, fast and reliable analytical techniques can help identify potential process issues, thereby optimizing the production process.

The Agilent 8850 GC system is a compact, purpose-built, energy-efficient, and highly effective intelligent gas chromatograph designed specifically for laboratories requiring fast analysis. One of its standout features is the oven, which can heat up and cool down extremely quickly, making it ideal for rapid testing scenarios. In this study, an 8850 GC was used in combination with a highly inert, 10-meter DB-WAX column to conduct fast analysis of distilled spirits. The system performance was evaluated under different carrier gases, including nitrogen, helium, and hydrogen, to meet the varying needs of different laboratories. The results showed that the system could significantly reduce analysis time compared to 30-plus minute traditional methods, achieving a time savings of more than three-fold regardless of the carrier gas used. When hydrogen was used as the carrier gas, the performance was especially remarkable: all 17 key components in the distilled spirits were eluted within just 3 minutes, and the total cycle for a single sample only required 7 minutes. This represented a five-fold improvement in efficiency compared to conventional methods. The rapid analysis capabilities of this system provide a valuable solution for the distilled spirits industry, enabling faster and more efficient testing while maintaining the same level of accuracy and reliability as seen in traditional approaches.

Experimental

Fast spirit analyses were performed using an 8850 GC equipped with a flame ionization detector (FID). Sample introduction was done using an Agilent 7650A automatic liquid sampler with a 5 µL syringe. Data was acquired and processed using OpenLab CDS 2.7.

Table 1. Agilent 8850 GC configuration for the nitrogen, helium, and hydrogen carrier methods.

	Nitrogen Carrier	Helium Carrier	Hydrogen Carrier
GC System	Agilent 8850 GC/FID		
Inlet	Split/splitless, 250 °C, split ratio 200:1 Agilent inlet liner, Ultra Inert, low pressure drop, split, glass wool (p/n 5190-2295)		
Column	Agilent J&W DB-WAX Ultra Inert, 10 m × 0.18 mm, 0.18 µm (p/n 121-7012UI)		
Carrier	N_2, Ramped flow, 0.06 mL/min (0.5 min), then 20 mL/min/min to 0.5 mL/min	He, Ramped flow, 0.16 mL/min (0.2 min), then 20 mL/min/min to 0.8 mL/min	H_2, Ramped flow, 0.2 mL/min (0.1min), then 10 mL/min/min to 1 mL/min
Oven	35 °C (1.4 min), then 12 °C/min to 70 °C, then 150 °C/min to 210 °C (1 min); postrun: 240 °C (1 min)	35 °C (1 min), then 26 °C/min to 70 °C, then 130 °C/min to 240 °C (0.5 min); postrun: 245 °C (1 min)	35 °C (0.7 min), then 34.4 °C/min to 70 °C, then 172 °C/min to 240 °C (0.5 min); postrun: 245 °C (0.5 min)
FID	250 °C; hydrogen: 30 mL/min; air: 300 mL/min; Make up gas (N_2): 25 mL/min		
Injection	0.5 µL Agilent ALS syringe, Gold Standard, 23 to 26 s tapered needle (p/n 5181-1273)		

Note: The oven ramp rates in Table 1 are based on the 8850 240V fast oven.

Sample preparation

Seventeen target compound single standards and three internal standards (ISTD) were purchased from ANPEL Laboratory Technologies (Shanghai) Inc. Four real samples (Chinese liquor) were provided by customers.

The solvent used in this study was an ethanol/water solution with a volume ratio of 60:40. The mixed standard stock was prepared by adding defined amount of each single standard compound and diluting them with the solvent. Six different concentrations of standard solutions were prepared to establish the calibration curve, with the specific concentrations of each target compound detailed in Table 2.

The internal standard compounds are tert-pentanol, n-pentyl acetate, and 2-ethylbutyric acid. The ethanol/water solution (60:40) was also used as the solvent, with a final analysis concentration of 200 ppm for internal standard (ISTD) compounds. During quantitative calculations, alcohols and aldehydes were calculated using tert-pentanol as the internal standard, esters were calculated using n-pentyl acetate, and acetic acid and hexanoic acid were quantified using 2-ethylbutyric acid.

Results and discussion

Considering the varying needs of different laboratories, this study evaluated the performance of spirit analysis using nitrogen, helium, and hydrogen as carrier gases. For laboratories with cost-control requirements, the nitrogen method can be prioritized. For laboratories seeking high efficiency but unable to use hydrogen as a carrier gas, the helium method is a suitable choice. If ultra-fast analysis is desired, the hydrogen method can be selected.

Method optimization

During the early stages of method development, it was found that using the mid-frit liner (part number 5190-5105) under the same acquisition conditions resulted in sharper chromatographic peaks and better separation. However, compared to liners with glass wool, the area repeatability results based on the 5190-5105 liner were not as good. The absolute peak area repeatability for alcohols and esters exceeded 3%, and the repeatability for acids was even worse. After comparing multiple different liners, this study selected the 5190-2295 liner. Through method optimization, satisfactory peak shapes were achieved.

During the development of this fast method, it was also observed that when nitrogen was used as the carrier gas and the column operated in constant flow mode, the peak shape of the first eluting compound, acetaldehyde, was sharp by the mid-frit liner. However, when switched to a liner with glass wool, such as the 5190-2295 liner, the acetaldehyde peak became broader and even showed splitting (Figure 1). As previously described, the repeatability of the mid-frit liner is inferior to that of the liner with glass wool. Therefore, the 5190-2295 liner was ultimately used in this test. To optimize the peak shape of acetaldehyde, this study adopted a ramped flow mode. Initially, the column flow rate was set to a lower value and maintained for a short period, then rapidly increased to the normal flow rate. This approach resulted in a sharp peak for acetaldehyde.

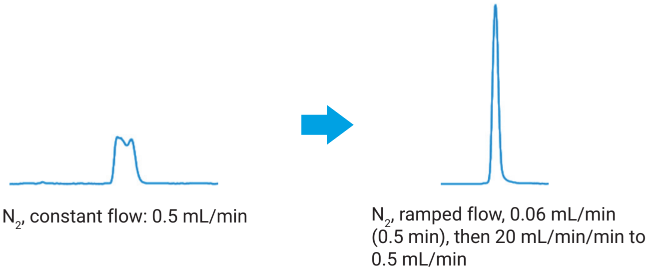


Figure 1. Optimize the peak shape of acetaldehyde.

Nitrogen carrier gas result

Based on the rapid heating and cooling characteristics of the 8850 GC and the use of a 10-meter short column, this system enables the rapid analysis of spirits. When nitrogen is used as the carrier gas, the GC runtime for a single injection is 6.25 minutes, followed by a 1-minute postrun. The cooling and equilibration time is approximately 3 minutes, bringing the total analysis time for one sample to 11 minutes. As illustrated in Figure 2, the traditional method requires over 35 minutes to analyze a single sample, including cooling and equilibration time. In contrast, the fast method takes only 11 minutes. This significant time reduction allows the fast method to boost laboratory efficiency by more than three-fold within the same time frame. Although the analysis time is reduced significantly, Figure 3 demonstrates that the separation and peak shape results are excellent. Key compound groups, such as ethyl acetate, acetal, and methanol, exhibit sharp and symmetrical peaks with baseline separation. Ethyl lactate and n-hexanol also achieve complete baseline separation. Symmetrical peak shapes and good separation are prerequisites for accurate quantification, and the results from this system provide an excellent demonstration of accuracy.

Through the optimization of method parameters, excellent peak shapes and separation were achieved. Next, we proceeded with method validation, which included assessments of linearity, repeatability, limit of detection (LOD), and other performance checks. Considering the varying concentrations of each target component in several types of real samples, the linear range for each compound was different in this study, as detailed in Table 2. A 6-point calibration curve was established for each compound, with correlation coefficients all greater than or equal to 0.9992. Figure 4 presents the calibration curves for key alcohols, aldehydes, esters, and acids.

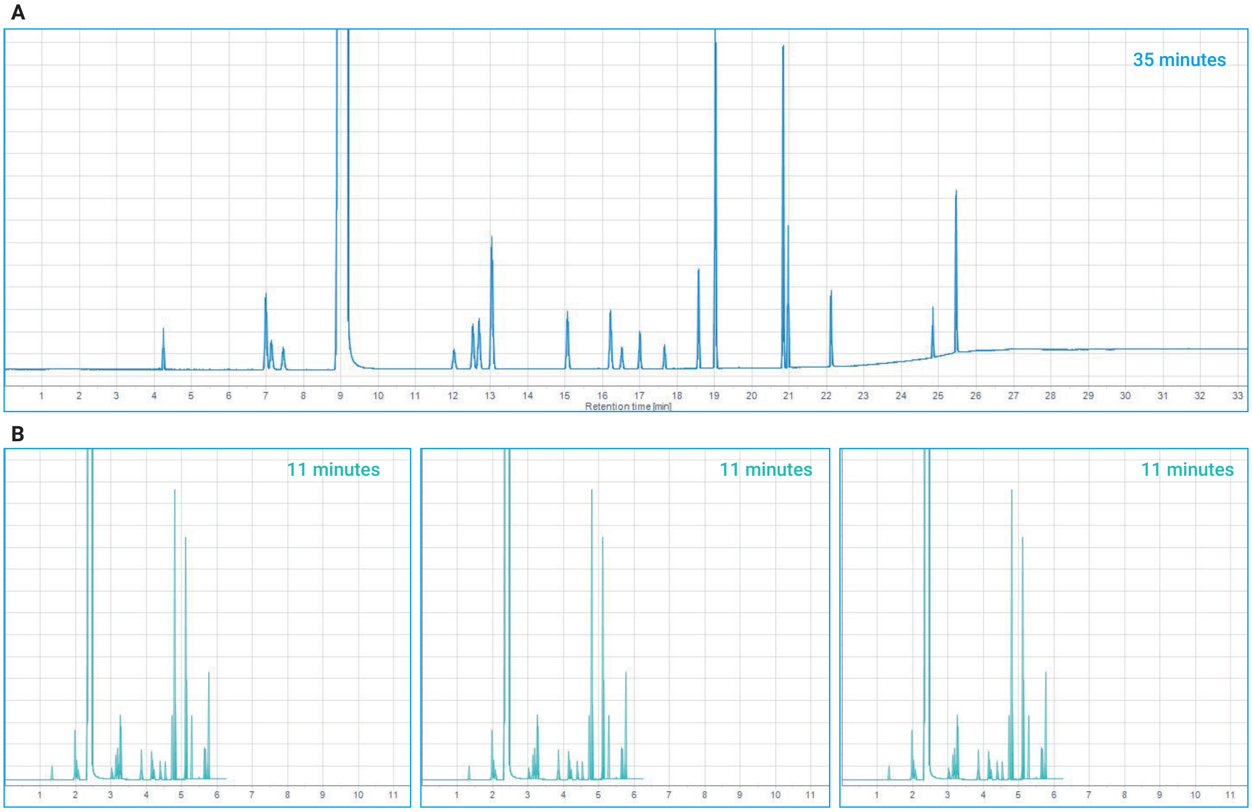
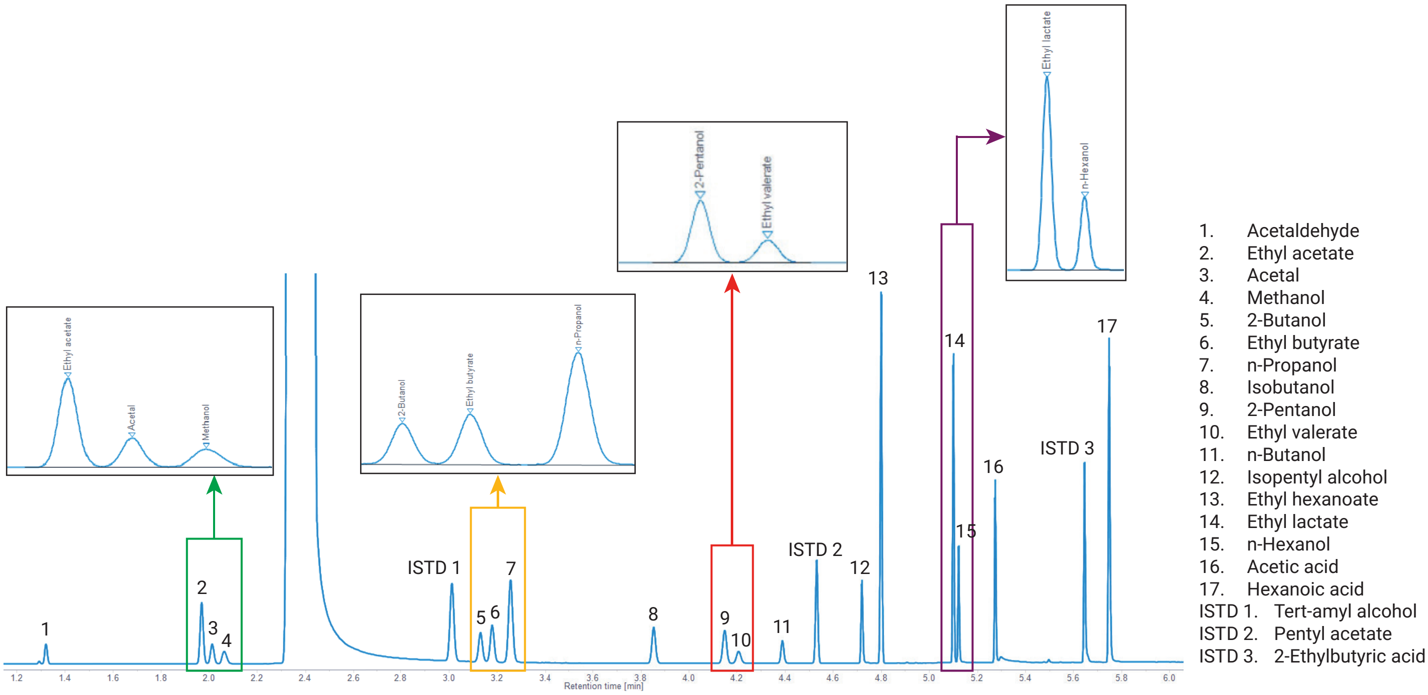


Figure 2. Total cycle comparison of traditional methods and fast analysis using N_2 carrier gas. The traditional method takes 35 minutes to run a single sample (A), whereas within the same time limit, this 11-minute fast method can analyze three samples (B).



1. Acetaldehyde
2. Ethyl acetate
3. Acetal
4. Methanol
5. 2-Butanol
6. Ethyl butyrate
7. n-Propanol
8. Isobutanol
9. 2-Pentanol
10. Ethyl valerate
11. n-Butanol
12. Isopentyl alcohol
13. Ethyl hexanoate
14. Ethyl lactate
15. n-Hexanol
16. Acetic acid
17. Hexanoic acid

ISTD 1. Tert-amyl alcohol
ISTD 2. Pentyl acetate
ISTD 3. 2-Ethylbutyric acid

Figure 3. GC/FID chromatogram of 17 target compounds at the concentration of L2 using N_2 carrier gas.

Table 2. The linear range and linearity results for each target compound using N_2 carrier gas.

No.	Name	L1 (ppm)	L2 (ppm)	L3 (ppm)	L4 (ppm)	L5 (ppm)	L6 (ppm)	R^2
1	Acetaldehyde	50	100	250	500	800	1000	0.9995
2	Ethyl acetate	150	300	750	1500	2400	3000	0.9998
3	Acetal	50	100	250	500	800	1000	0.9992
4	Methanol	50	100	250	500	800	1000	0.9999
5	2-Butanol	50	100	250	500	800	1000	0.9999
6	Ethyl butyrate	75	150	375	750	1200	1500	0.9999
7	n-Propanol	150	300	750	1500	2400	3000	0.9999
8	Isobutanol	50	100	250	500	800	1000	1
9	2-Pentanol	50	100	250	500	800	1000	0.9999
10	Ethyl valerate	25	50	125	250	400	500	0.9999
11	n-Butanol	25	50	125	250	400	500	0.9999
12	Isopentyl alcohol	50	100	250	500	800	1000	0.9999
13	Ethyl hexanoate	250	500	1250	2500	4000	5000	1
14	Ethyl lactate	250	500	1250	2500	4000	5000	0.9999
15	n-Hexanol	50	100	250	500	800	1000	0.9998
16	Acetic acid	300	500	800	1000	1600	2000	0.9993
17	Hexanoic acid	225	375	600	750	1200	1500	0.9998

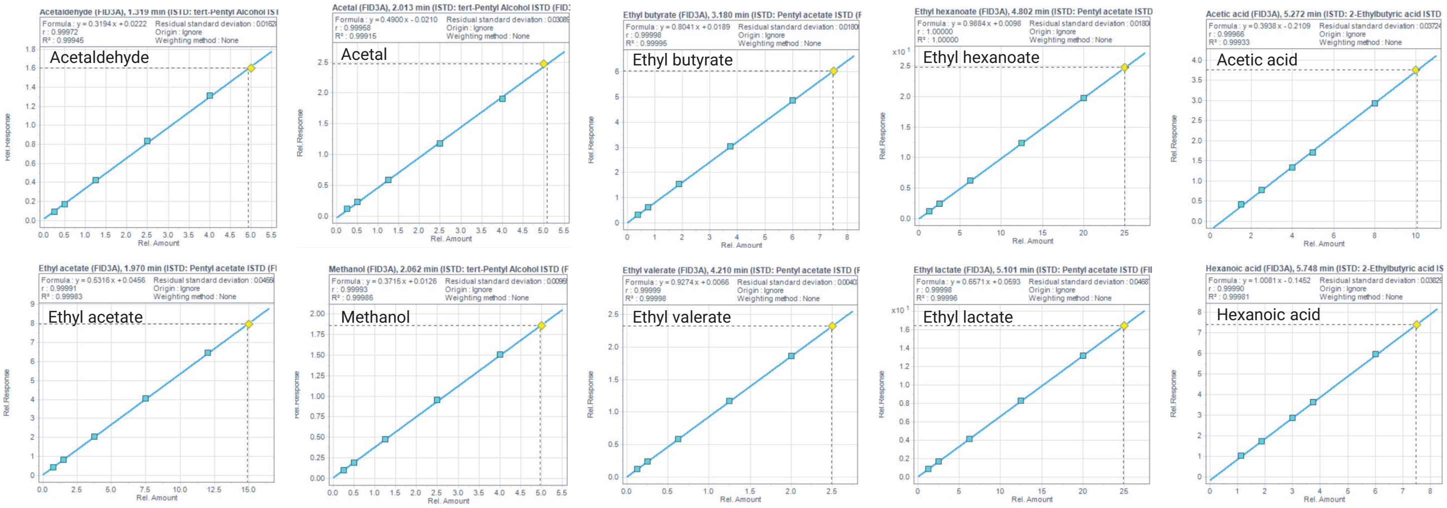


Figure 4. The calibration curves of some representative compounds using N_2 carrier gas.

For standards with low, medium, and high concentrations, 8 consecutive injections were performed for each concentration. The first injection was discarded, and the repeatability results of retention time and peak area for the remaining 7 injections are shown in Table 3 and Figure 5. The %RSD of the retention time did not exceed 0.02%, and the repeatability of the peak area was within 2.5%, demonstrating the excellent stability and inertness of the system. Even acetic acid and hexanoic acid exhibited stable results on this system. If the repeatability of acetic acid and hexanoic acid starts to deteriorate, it is suggested to check if liner is contaminated. Try replacing it with a new liner to see if the results improve.

A standard solution with a concentration lower than L1 was prepared for the limit of detection (LOD) testing. Using a signal-to-noise ratio (S/N = 3), the LOD values for each compound were calculated, as shown in Table 4 and Figure 6.

Table 3. Repeatability results of 17 target compounds using N_2 carrier gas.

No.	Name	RT	Area %RSD (n = 7)			RT %RSD (n = 7)		
			L1	L3	L6	L1	L3	L6
1	Acetaldehyde	1.32	1.857	0.387	0.428	0.011	0.008	0.004
2	Ethyl acetate	1.969	0.7	0.332	0.46	0.017	0.006	0.005
3	Acetal	2.013	0.835	0.468	0.399	0.014	0.008	0.006
4	Methanol	2.062	1.141	0.564	0.36	0.02	0.01	0.008
5	2-Butanol	3.13	1.018	0.406	0.362	0.009	0.009	0.007
6	Ethyl butyrate	3.178	1.022	0.459	0.439	0.008	0.005	0.006
7	n-Propanol	3.255	0.788	0.42	0.361	0.008	0.007	0.007
8	Isobutanol	3.852	1.065	0.469	0.204	0.013	0.007	0.006
9	2-Pentanol	4.148	0.543	0.389	0.37	0.02	0.012	0.005
10	Ethyl valerate	4.206	1.574	0.461	0.367	0.01	0.011	0.008
11	n-Butanol	4.387	2.004	0.85	0.325	0.012	0.007	0.005
12	Isopentyl alcohol	4.72	0.847	0.384	0.376	0.005	0.004	0.006
13	Ethyl hexanoate	4.8	0.459	0.343	0.361	0.008	0.002	0.004
14	Ethyl lactate	5.1	0.585	0.317	0.418	0.005	0.004	0.006
15	n-Hexanol	5.122	1.178	0.559	0.417	0.006	0.003	0.004
16	Acetic acid	5.274	2.1	0.682	0.702	0.007	0.005	0.007
17	Hexanoic acid	5.749	1.134	2.476	0.679	0.012	0.006	0.018

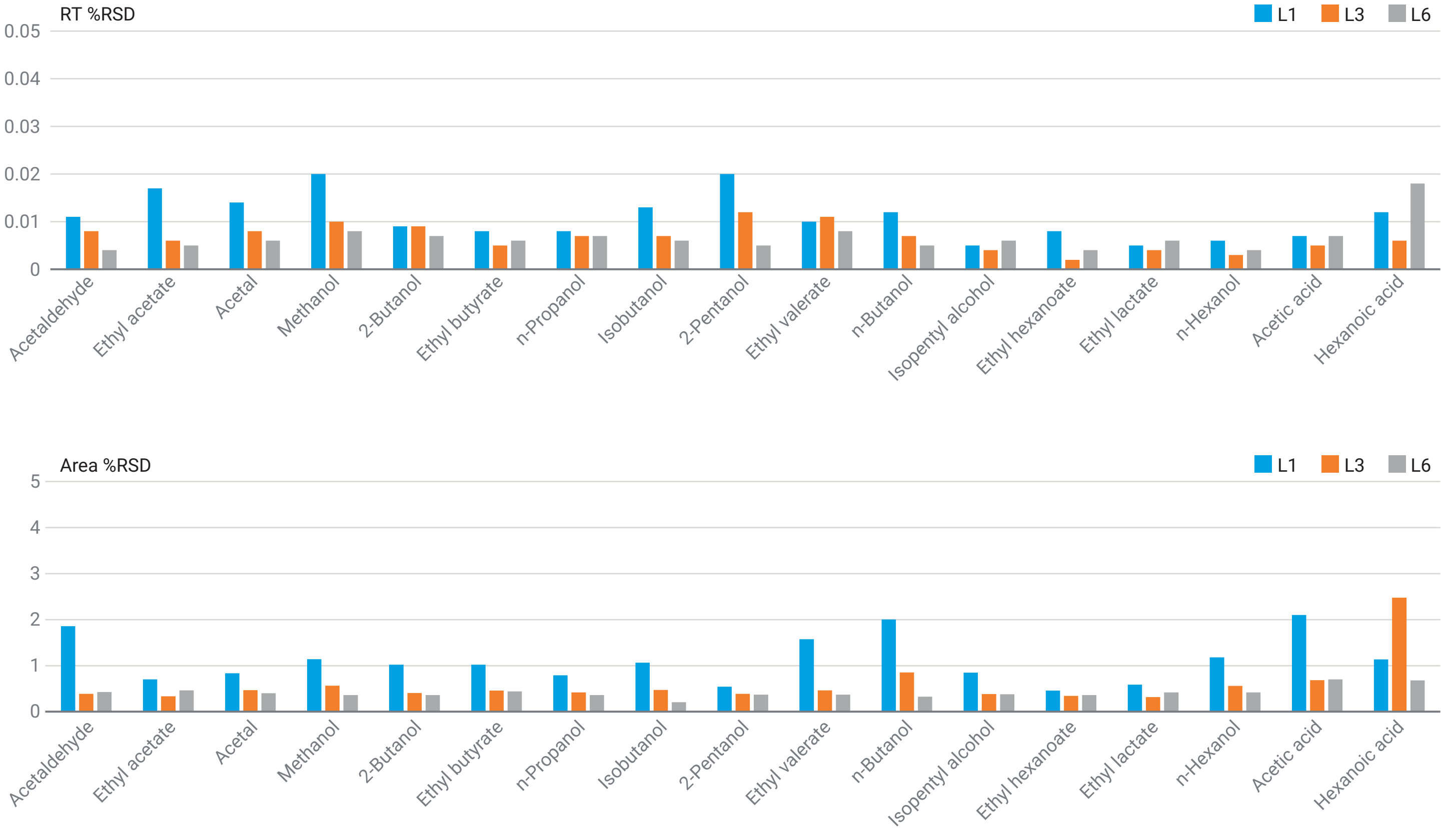


Figure 5. Repeatability results for target compounds using N_2 carrier gas.

Table 4. Calculated LOD for 17 compounds using N_2 carrier gas.

Peak Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Concentration of Standard Solution (ppm)	11	33	11	11	11	17	33	11	11	6	6	11	56	56	11	60	45
S/N (P2P)	12.7	30.3	10.8	6.9	15.8	17.4	44.0	18.9	18.4	5.6	13.1	44.2	163.1	167.5	63.6	45.0	92.1
LOD (ppm)	2.6	3.3	3.1	4.8	2.1	2.9	2.3	1.8	1.8	3.0	1.3	0.8	1.0	1.0	0.5	4.0	1.5

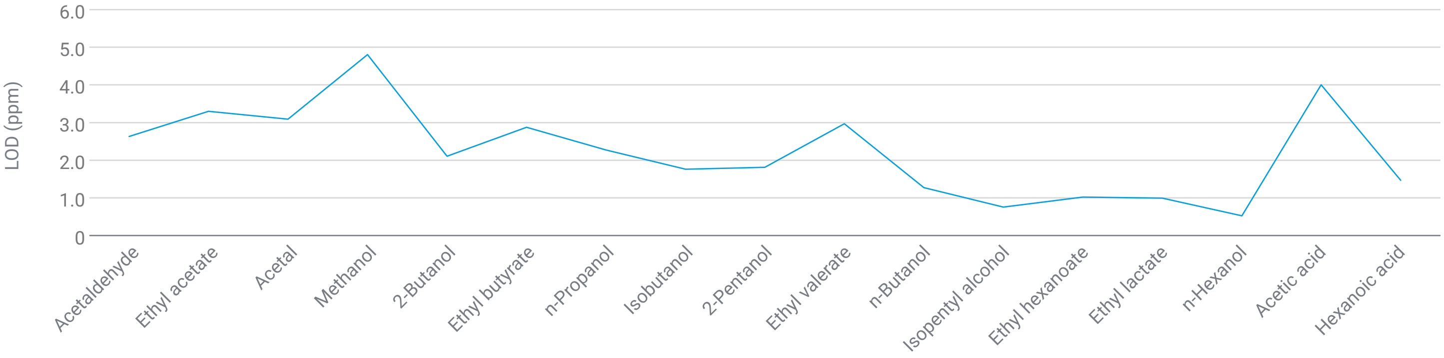


Figure 6. LODs for target compounds using N_2 carrier gas.

Carryover of organic acids

Acids in distilled spirits are often prone to causing carryover, which often originates from the inlet liner. The residue of hexanoic acid is more noticeable compared to that of acetic acid. The carryover of acids was investigated in this study. Before starting the carryover experiment, the septum and liner were replaced with new ones. Deionized water and ethanol were used as washing solvents for syringe. After sample injection, the syringe was washed twice with deionized water and twice with ethanol. Before the next sample injection, the same procedure was repeated, washing twice with deionized water and twice with ethanol to ensure no residue remains on the injection needle. After a very high-concentration standard (L6) was injected, multiple injections of ethanol/water (v/v 40:60) blanks were consecutively run. The peak areas of acetic acid and hexanoic acid in the blanks were compared to the peak areas of these acids in concentration levels L1 and L6. From Figure 7, it can be observed that following the injection of the high-concentration standard, the carryover of acetic acid in the first blank accounted for 1.05% of the acetic acid in L6, while the carryover of hexanoic acid accounted for 2.37% of the hexanoic acid in L6. Figure 7 also shows the percentage of carryover relative to the acids in L1. This allowed us to assess whether the system was clean enough to avoid affecting low-concentration samples. After running two blank injections, the carryover of hexanoic acid was less than 10% of L1, indicating that the effect on the analysis of low-concentration samples was negligible. If it was found that the residue of hexanoic acid remained high even after running multiple blank injections, it would be necessary to replace the liner with a new one.

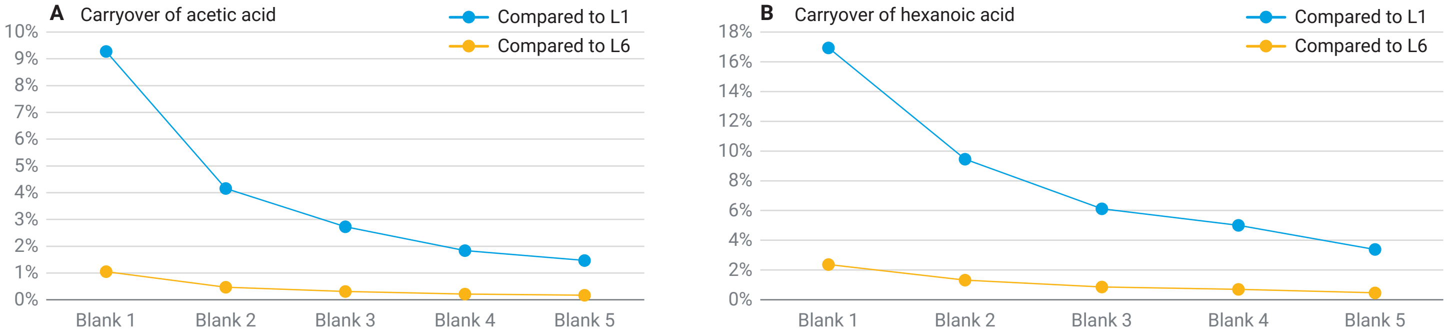


Figure 7. Carryover of acetic acid (A) and hexanoic acid (B). The blue line represents the percentage of the peak area of the residual acid in the blank relative to the peak area of the acid in the L1 concentration level. The orange line represents the percentage of the peak area of the residual acid in the blank relative to the peak area of the acid in the L6 concentration level.

Real sample analysis

To better understand how well this method performs in practical scenarios, this study analyzed four different samples of Chinese liquor, each sourced from distinct brands and produced using different manufacturing techniques. The analysis clearly showed that the types and concentrations of the target components varied significantly across the four samples, highlighting the diversity in Chinese liquor production processes. Despite these differences, all target peaks exhibited symmetrical shapes and demonstrated effective separation from neighboring compounds, as shown in Figure 8. This indicates that the method provides reliable and precise peak identification regardless of the sample complexity or production differences.

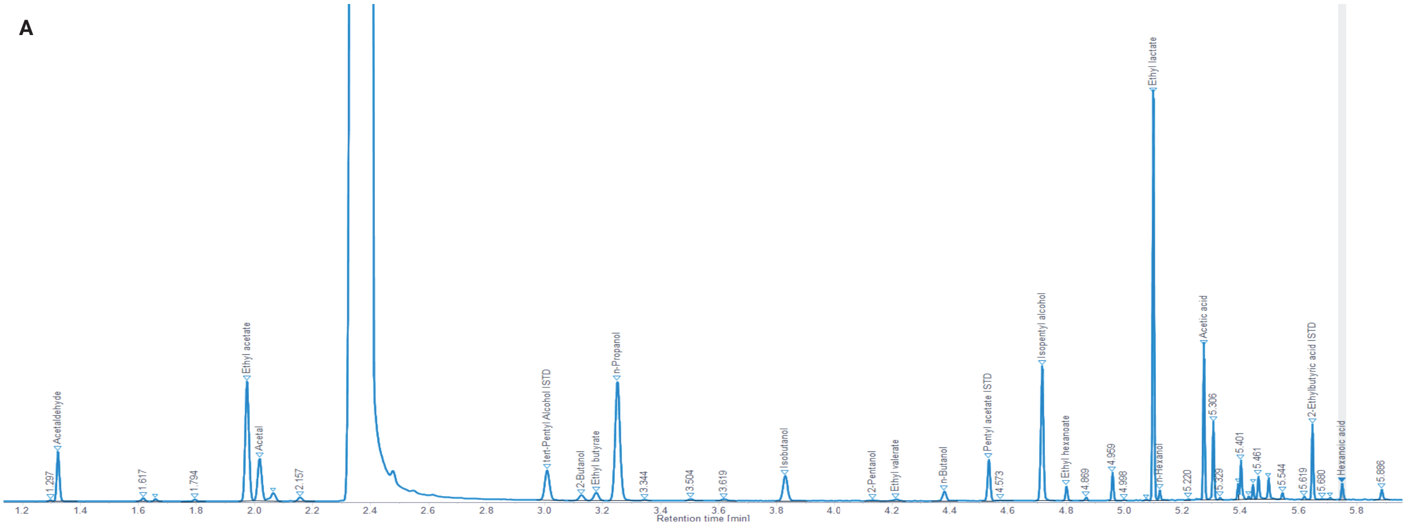


Figure 8. Chromatograms of Chinese liquor with different flavor profiles by using N_2 carrier gas (A) sauce-aroma type, (B) strong-aroma type, (C) light-aroma type, and (D) mixed-aroma type (continued on the next page).

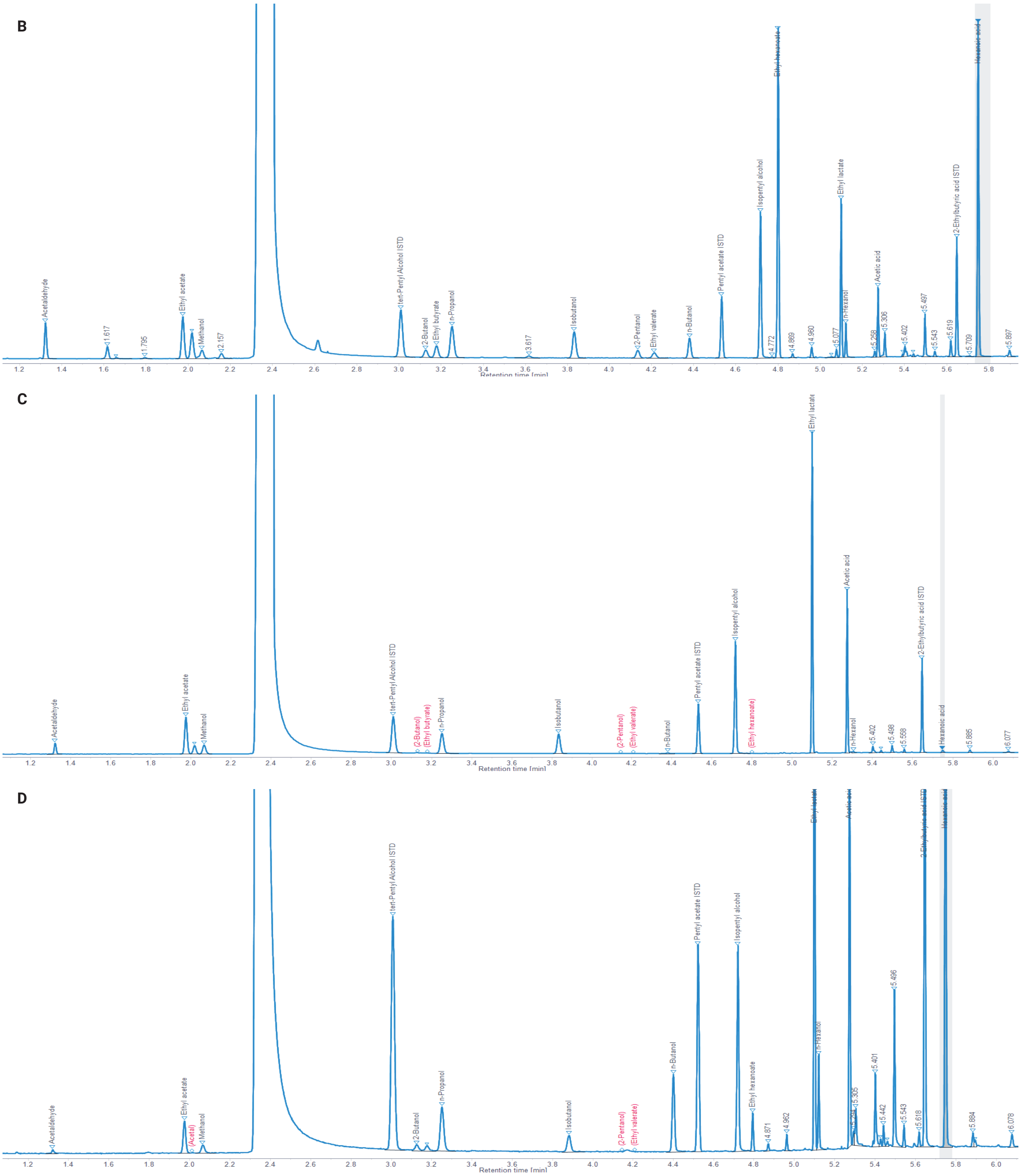


Figure 8. Chromatograms of Chinese liquor with different flavor profiles by using N_2 carrier gas (A) sauce-aroma type, (B) strong-aroma type, (C) light-aroma type, and (D) mixed-aroma type (continued from previous page).

To further confirm the reliability and robustness of the analytical system over time, long-term stability experiments were conducted using real samples. The 10-meter DB-WAX column remained consistent throughout the entire study, and only consumables such as septum and liner were replaced periodically to maintain optimal performance. The results of these stability tests are presented in Figure 9, which compares chromatograms obtained from the first injection, the 100th, the 500th, the 1,000th, the 1,500th, and the 2,000th injection. The results clearly demonstrate that even in the presence of a significant amount of water (~ 50% water in this Chinese liquor sample), after 2,000 injections, the retention time remained consistent, and all target peaks maintained sharp and symmetrical shapes with consistent and effective separation. This highlights the exceptional stability and robustness of the system over extended use, making it highly suitable for routine analysis of spirit samples.

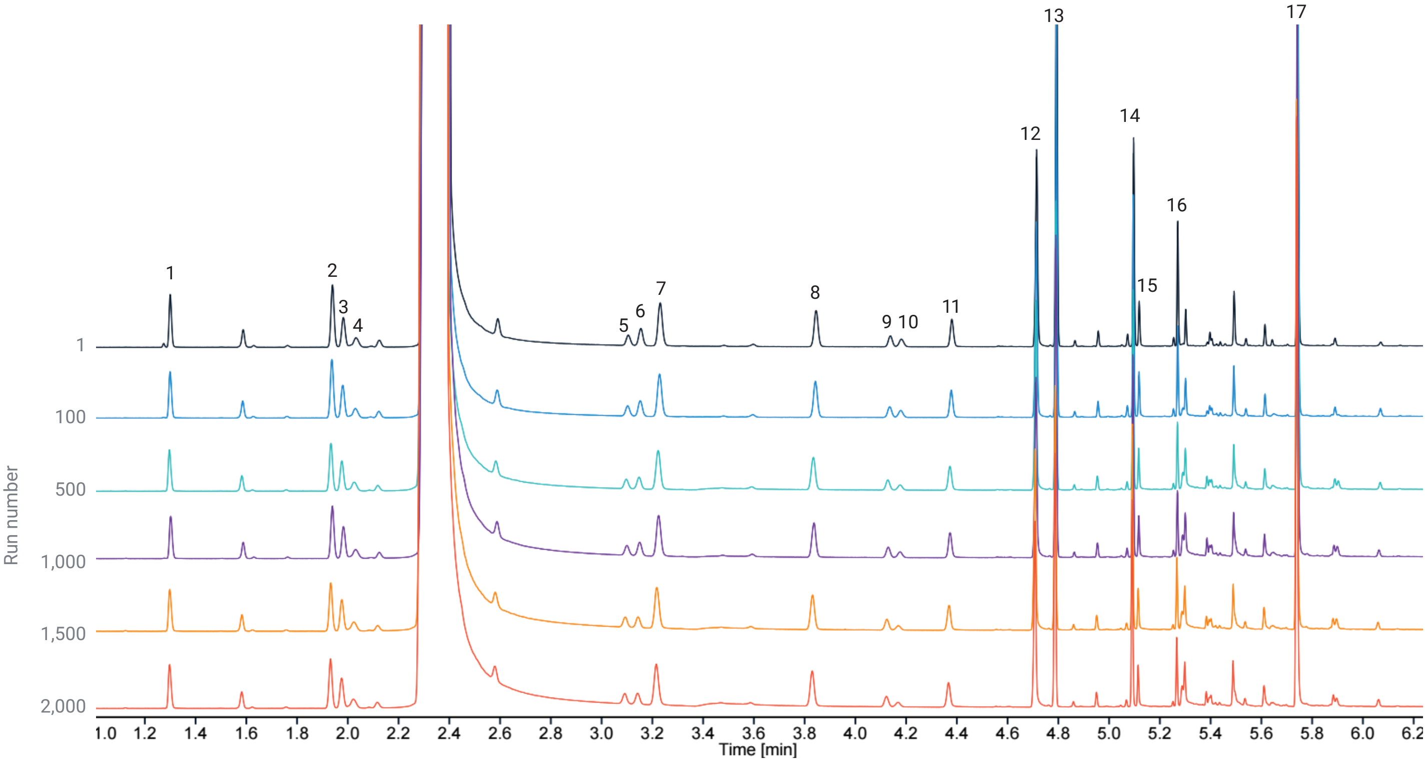


Figure 9. Overlaid GC/FID chromatograms of repeat injections of the same Chinese liquor using N_2 carrier gas.

Energy savings with 8850 GC

Compared to a traditional method, using the 8850 GC to analyze distilled spirits increases the speed by 3x, effectively tripling laboratory efficiency. Using the 35-minute traditional method, 41 samples can be analyzed in 24 hours. In contrast, with the 11-minute rapid method, 130 samples can be analyzed within the same time period. Through the browser Interface or touch screen of the 8850 GC, the daily power consumption can be observed, as shown in Figure 10. When 8850 is operated continuously for 24 hours to analyze distilled spirit samples, the daily power consumption was recorded as 10.02 kWH. During this 24-hour period, 130 samples were analyzed, resulting in an average power consumption per sample cycle of 0.07708 kWh. In comparison, when distilled spirits are analyzed using traditional methods on a conventional GC, only 41 samples can be completed within 24 hours, with a total power consumption recorded at 9.07 kWH. This results in an average power consumption per sample cycle calculated at 0.22122 kWH. The power used by the GC when at idle or when the thermal zones are at temperature is relatively small compared to the power used during ramping thermal zones, especially ramping the oven. Within the same period, three times as many heating cycles were performed by the 8850 GC. Although the total power consumption was slightly increased due to these cycles, the power consumption per sample on 8850 is calculated to be only 34.8% of that of a traditional GC system.

In distilled spirits QC laboratories, it is quite common to run one to two hundred samples per day, so multiple GC systems are typically operated simultaneously. For example, if 130 samples are analyzed in one day, only one 8850 GC is required to complete the task, whereas three conventional GCs would be needed to achieve the same output within the same timeframe. Assuming a five-day workweek and 50 workweeks per year, one 8850 GC can process 32,500 samples annually, with a total power consumption of 2,505.1 kWH. In contrast, to process the same number of samples in a year, three conventional GCs would be required, resulting in a total power consumption of 7,189.65 kWH. In the U.S., where electricity costs are approximately \$0.12/kWH[2], this translates to annual savings of \$562.2, without the need to purchase two additional conventional GCs, as shown in Table 5.

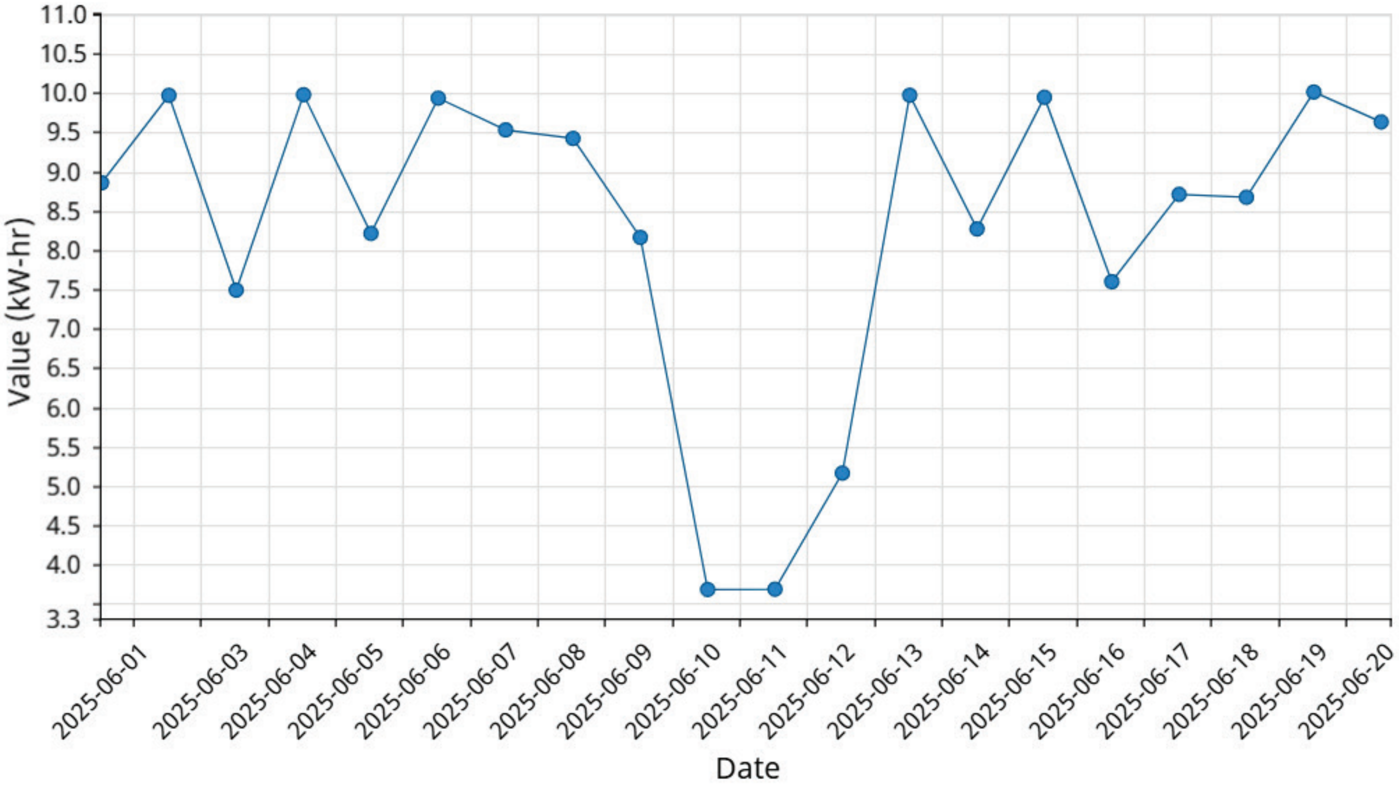


Figure 10. Daily power consumption of the Agilent 8850 GC used during real sample analysis using N_2 carrier gas.

Table 5. Energy saving with an 8850 GC using N_2 carrier gas.

Parameter	Value	
GC Type	**8850 GC**	**Conventional GC**
Average Power per Spirit Run	0.07708 kWH	0.22122 kWH
Spirit Run Time	11 min	35 min
Number of Runs for 24 Hours per Day	130 samples	41 samples
Instrument Usage	5 days per week 50 weeks per year	
Energy Used for 32,500 Samples per Year	2505.1 kWH with one 8850 GC	7189.65 kWH with three conventional GCs
Energy Cost	$0.12 per kWH	
Energy Cost per Year	$300.6	$862.8
Energy 8850/ Energy Conventional	34.8%	
Energy Cost Savings for 8850 GC per Year	$562.2	

If helium or hydrogen is used as the carrier gas, the analysis speed for a sample can be faster, allowing more samples to be completed within a unit of time. Additionally, the energy-saving effects will be more significant compared to using nitrogen. For details, please refer to the appendix table.

Helium carrier gas result

Compared to nitrogen carrier gas, using helium as the carrier gas allows for faster analysis. The GC runtime requires only 4 minutes, including postrun time, cooling, and oven equilibration, the total analysis cycle for a single run is shortened to 9 minutes, as shown in Figure 11.

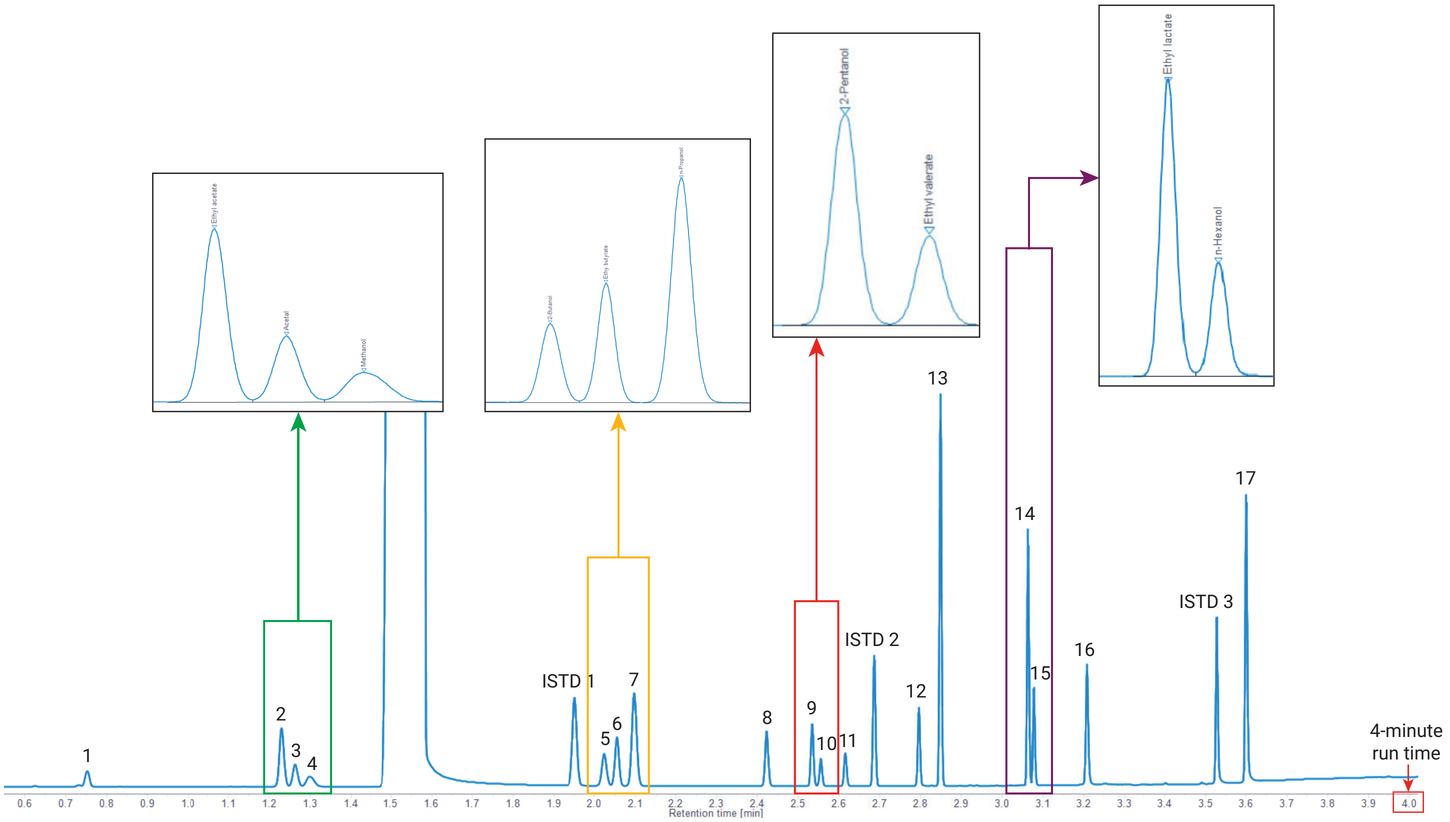


Figure 11. GC/FID chromatogram of 17 target compounds at the concentration of L2 using He carrier gas.

Using helium as the carrier gas, method validation was also conducted. The range of the calibration curve is consistent with when nitrogen is used as the carrier gas, as shown in Table 2. The correlation coefficients for all compounds were ≥ 0.9995. Table 6 also illustrates that for the 17 compounds, the area %RSD is well below 2.7%. The method for calculating LOD is the same as that used with nitrogen carrier gas. It is shown that the LOD results are also generally consistent with those obtained using nitrogen carrier gas, ranging between 0.5 and 4.3 ppm, as shown in Table 6.

Table 6. R^2, RSDs, and LODs for 17 target compounds using helium carrier gas.

				Area %RSD (n = 7)			LOD ppm (P2P)
	Name	RT	R^2	L1	L3	L6	
1	Acetaldehyde	0.75	0.9999	0.77	0.83	0.88	2.5
2	Ethyl acetate	1.227	0.9999	0.96	0.83	0.64	2.5
3	Acetal	1.26	0.9998	0.92	0.93	0.82	2.1
4	Methanol	1.295	0.9998	1.59	1.22	1.01	4.3
5	2-Butanol	2.021	0.9999	0.58	1.22	1.18	1.4
6	Ethyl butyrate	2.052	0.9999	0.92	0.96	0.86	1.7
7	n-Propanol	2.095	0.9999	0.65	1.17	1.18	1.5
8	Isobutanol	2.418	0.9999	0.76	1.13	1.23	0.9
9	2-Pentanol	2.532	0.9999	0.90	1.26	1.28	0.7
10	Ethyl valerate	2.555	0.9999	1.18	0.99	0.98	1.0
11	n-Butanol	2.613	0.9999	0.89	1.36	1.29	0.7
12	Isopentyl alcohol	2.795	0.9999	0.88	1.32	1.31	0.6
13	Ethyl hexanoate	2.849	0.9999	0.76	1.08	1.17	0.7
14	Ethyl lactate	3.064	0.9999	0.94	1.03	1.04	1.0
15	n-Hexanol	3.077	0.9998	0.99	1.46	1.33	0.5
16	Acetic acid	3.207	0.9995	2.52	1.94	1.24	4.0
17	Hexanoic acid	3.601	0.9997	2.43	1.64	2.68	0.9

Hydrogen carrier gas result

If ultra-fast analysis is pursued, hydrogen can be chosen as the carrier gas. When hydrogen is used as the carrier gas, the GC runtime only takes 3 minutes. Including the postrun time, cooling time, and oven equilibration time, the cycle time for analyzing a single sample can be shortened to 7 minutes, enabling ultra-fast analysis of spirit.

When using hydrogen carrier gas, the method validation approach is the same as when nitrogen is used as the carrier gas. Figure 12 and Table 7 show the performance results. It is found that hydrogen enables ultra-fast analysis, while the performance results including peak shape, resolution, linearity, repeatability, and detection limits, are just as outstanding as those achieved with nitrogen/helium as the carrier gas.

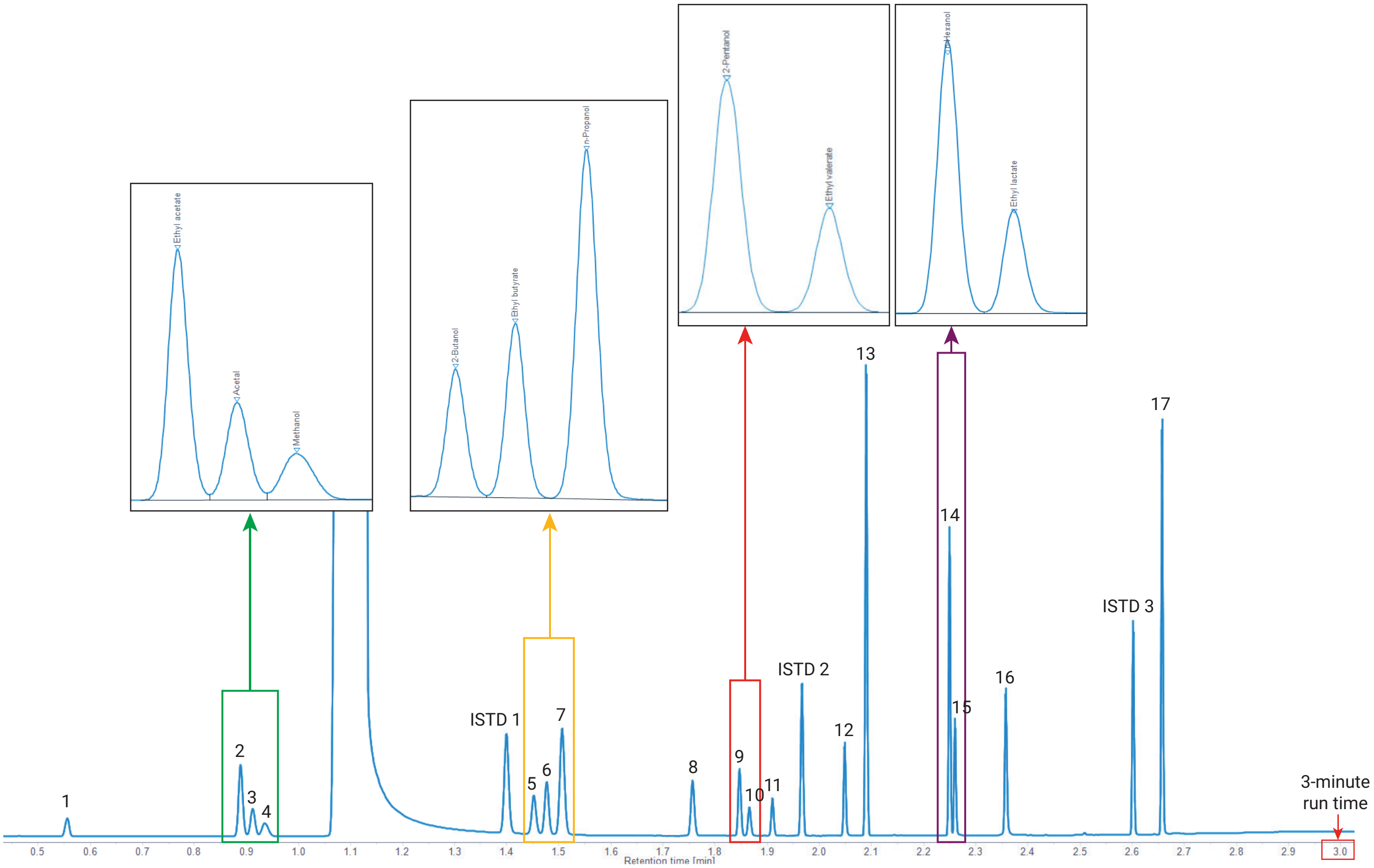


Figure 12. GC/FID chromatogram of 17 target compounds at the concentration of L2 using H_2 carrier gas.

Table 7. R^2, RSDs, and LODs for 17 target compounds using hydrogen carrier gas.

	Name	RT	R^2	Area RSD% (n = 7)			LOD ppm (P2P)
				L1	L3	L6	
1	Acetaldehyde	0.556	0.9999	1.10	0.49	0.39	1.7
2	Ethyl acetate	0.889	0.9999	0.47	0.40	0.24	1.8
3	Acetal	0.912	0.9999	0.55	0.41	0.26	1.5
4	Methanol	0.935	0.9999	0.87	0.52	0.31	3.3
5	2-Butanol	1.452	0.9999	0.67	0.32	0.25	1.2
6	Ethyl butyrate	1.476	0.9999	0.82	0.46	0.28	1.3
7	n-Propanol	1.506	1	0.30	0.31	0.22	1.3
8	Isobutanol	1.756	0.9999	0.87	0.71	0.27	0.8
9	2-Pentanol	1.847	1	0.51	0.33	0.25	0.6
10	Ethyl valerate	1.866	0.9999	0.94	0.26	0.32	0.7
11	n-Butanol	1.91	0.9999	0.59	0.33	0.29	0.6
12	Isopentyl alcohol	2.049	0.9999	0.51	0.38	0.26	0.5
13	Ethyl hexanoate	2.09	0.9999	0.53	0.43	0.25	0.5
14	Ethyl lactate	2.25	0.9997	0.19	0.29	0.23	0.8
15	n-Hexanol	2.26	0.9999	0.44	0.54	0.25	0.4
16	Acetic acid	2.357	0.9991	1.33	2.06	0.49	1.3
17	Hexanoic acid	2.657	0.9999	1.45	1.94	0.99	0.5

Conclusion

This application note clearly demonstrates the positive impact of Agilent 8850 GC system, which is designed to be intelligent and user-friendly, highly efficient and fast, energy-saving and environmentally friendly, and compact in size, on the quantitative analysis of key components in distilled spirits. By leveraging the Agilent 8850 GC rapid heating and cooling capabilities along with the use of a short column, the analysis time is reduced by one-third compared to traditional methods. This reduction in analysis time significantly enhances laboratory efficiency while consuming only one-third of the energy of conventional GC systems. Importantly, these improvements in speed and energy savings come without compromising chromatographic performance.

In this study, we explored the separation and quantification of 17 key compounds in distilled spirits under three different carrier gas conditions tailored to the practical needs of various laboratories, yielding results that exceeded expectations. After over 2,000 injections of real samples, the retention times and peak shapes for alcohols, aldehydes, esters, and organic acids remained consistent, demonstrating the excellent inertness and stability of the system under predominantly aqueous sample conditions. This performance provides QC departments in the distilled spirits industry with a reliable method for rapid screening and accurate quantification.

References

1. Kenneth, L.; Zhou, Y. Analysis of Distilled Spirits Using an Agilent J&W DB-WAX Ultra Inert Capillary GC Column. *Agilent Technologies application note*, publication number 5991-6638EN, **2016**.
2. Denoyer, E. Improving Return on Innovation in Gas Chromatography. *Agilent Technologies application note*, publication number 5991-7833EN, **2017**.

Appendix

Table A1. Energy savings with an Agilent 8850 GC using He and H_2 carrier gas.

Parameter	Value		
GC Type	**Conventional GC (N_2 carrier)**	**8850 GC (He carrier)**	**8850 GC (H_2 carrier)**
Average Power per Spirit Run	0.22122 kWH	0.07331 kWH	0.06112 kWH
Spirit Run Time	35 min	9 min	7 min
Number of Runs for 24 Hours per Day	41 samples	160 samples	205 samples
Instrument Usage	5 days per week 50 weeks per year		
Energy Used for 32,500 Samples per Year	7,189.65 kWH	2,382.6 kWH	1,986.4 kWH
Energy Cost	$0.12 per kWH		
Energy Cost per Year	$862.8	$285.9	$238.4
Energy 8850/ Energy Conventional	100%	33.1%	27.6%
Energy Cost Savings for 8850 GC per Year	0	$576.9	$624.4

Note: To ensure consistency with Table 5, the sample throughput used for calculations here is 32,500 samples. In reality, when helium or hydrogen is used as the carrier gas, the annual sample throughput can reach as high as 40,000 and 51,250 samples, respectively. This means the calculated energy savings would be significantly greater than the values currently presented in the appendix table. However, for the sake of consistency in readability, the appendix table still uses a throughput of 32,500 samples for calculations.

www.agilent.com

DE-009756

Printed in the USA, October 9, 2025
5994-8642EN