

Determination of Ethanol and Isopropanol Content in Hand Sanitizers Using Nitrogen Carrier Gas

■ Introduction

The current coronavirus pandemic has created an unprecedented demand for alcohol-based hand sanitizers. The US FDA has provided guidance to allow manufacturing of hand sanitizers using ethanol or isopropanol (IPA) as their active ingredient. The United States Centers for Disease Control (CDC), the World Health Organization (WHO), and the US Pharmacopeia (USP) all have determined that ethanol or IPA concentrations in hand sanitizers must be between 60 and 95% to ensure germicidal and viricidal properties.

We developed a GC FID method to accurately quantify ethanol and IPA concentrations in two hand sanitizer samples. By using nitrogen as the carrier gas, this method is cost-effective and ensures the product compliance with CDC and USP guidelines and regulations.

■ Samples and Analytical Conditions/ Experimental

Ethanol (200 proof) and *n*-butanol (min. 99%) were purchased from Sigma Aldrich. 2-propanol (isopropanol or IPA, min. 99.9%) was purchased from Fisher Scientific. The solutions and samples were diluted in deionized water to specified concentrations.

A Shimadzu GC-2030 chromatograph equipped with split/splitless injector (SPL) and flame ionization detector (FID) was used for this analysis and the data were acquired, analyzed and reported using LabSolutions LCGC software. The method parameters are shown in table 1 below.



Table 1: Instrument Configuration and Analysis Conditions

GC system	Shimadzu GC-2030 with SPL, FID and AOC-20 Plus autosampler
Column	Rxi-624Sil MS, 30m x 0.32mm x 1.8µm
Injector Mode	Split at 1:20 ratio
Injection Volume	1.0 µL
Carrier Gas	Nitrogen (N ₂)
Flow mode	Constant linear velocity of 40cm/sec
Column Temperature	30°C, 4min – 30°C/min –120°C, 2min
Injection Port Temperature	250°C
FID Temperature and Gases	250°C, Hydrogen 32mL/min, Air 200mL/min, Makeup (N ₂) 24mL/min

■ Results and Discussion

Calibration Curves

Since both ethanol and 2-propanol (isopropanol alcohol or IPA) can be used to prepare hand sanitizer, calibration standards were prepared with both types of alcohol. An internal standard (IS) is commonly used in these assays to improve accuracy. Although acetonitrile is specified in the USP method as the IS for ethanol, it elutes closer to IPA and may cause column/liner deterioration with repeated injections. In comparison, *n*-butanol elutes away from both ethanol and IPA, and is not known to cause degradation to the GC systems. It is commonly used in blood alcohol content assays as an IS for ethanol. Therefore, *n*-butanol was used as the IS in this study.

Nitrogen (N₂) was chosen as the carrier gas to reduce the cost of analysis compared to using helium. As shown in Figure 1, all peaks were well resolved, and no contaminating peaks were found in water blank with IS only.

The calibration standards were diluted to indicated concentrations with 0.5% (v/v) of *n*-butanol in deionized water. Internal standard quantification methods were used, and the calibration curves were fitted to linear regression without forcing through zero.

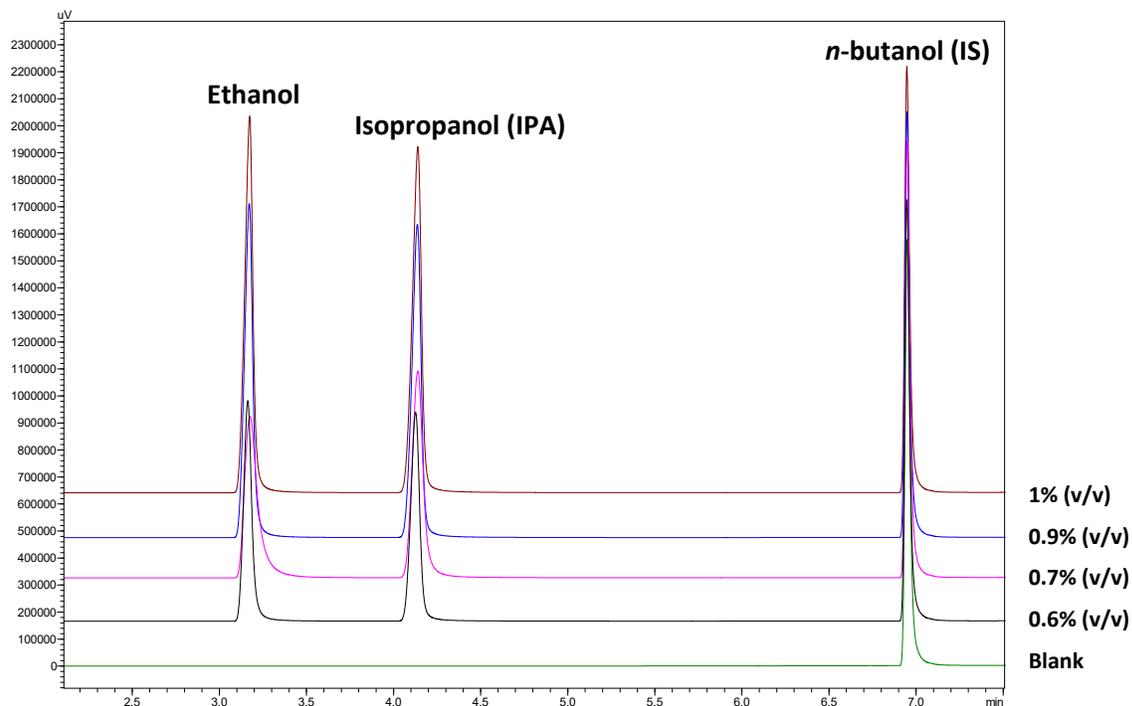


Figure 1: Chromatograms of calibration standards and water blank with IS (*n*-butanol)

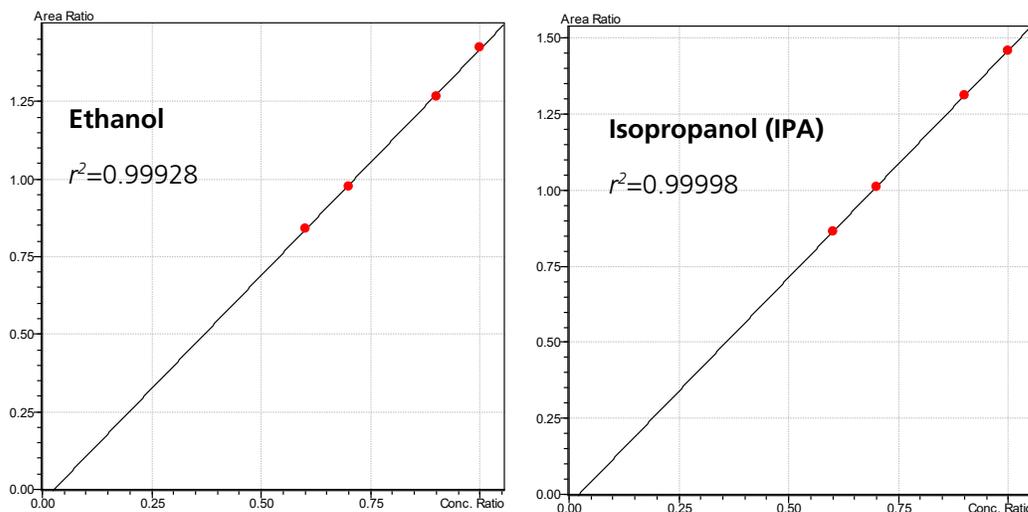


Figure 2: Four-point calibration curves for ethanol and IPA

Hand Sanitizer Samples

Two hand sanitizer samples were analyzed, one containing ethanol and the other IPA. Each sample was diluted 100-fold in IS solution for this analysis. The concentration of alcohol content is calculated by multiplying the concentration reported from the software by 100.

Table 2: Concentration of alcohols in hand sanitizer samples. Results are average of four injections. And the relative standard deviation (RSD) for the repeated injections was also shown for each sample.

	Sample 1	Sample 2
Ethanol conc. (v/v)	59.11	<i>not detected</i>
IPA conc. (v/v)	<i>not detected</i>	56.40
RSD	2.677%	1.175%

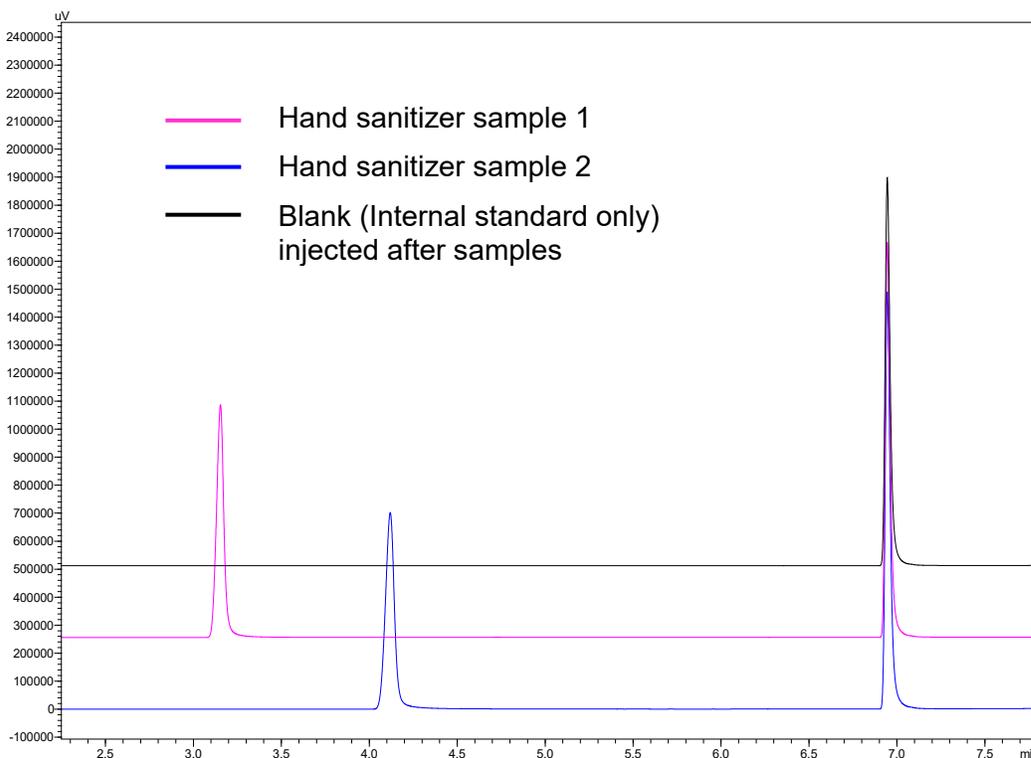


Figure 3: Chromatograms of hand sanitizer samples and a blank injected after the samples. No carryover of analytes was observed

Conclusion

Alcohol content in two hand sanitizer samples was successfully analyzed using Shimadzu GC-2030 on a Rxi-624Sil MS column using N₂ carrier gas. One of the samples contains ethanol, while the other contains isopropanol (IPA). The method used in this study was modified from USP standard general chapter 611, alcohol determination. The calibration curves for both ethanol and IPA were linear with $r^2 > 0.999$, and the analysis was straightforward with very good repeatability (RSD < 3% for both samples).

Nitrogen was successfully used as the carrier gas in this assay. Compared to helium, nitrogen is more cost-effective. It is also more inert thus safer than hydrogen, which is another commonly used cost-saving alternative carrier gas. Taken together, both ethanol and IPA content in hand sanitizers can be easily determined using Shimadzu GC-2030 with SPL and FID with nitrogen carrier gas.

Reference

1. USP General Chapter 611, Alcohol Determination.

■ Consumables

Part Number	Description	Unit	Instrument
221-76650-01	Septa, Green, Premium Low Bleed	Pk of 25	GC-2030
227-35007-01	Split Liner with Wool	Pk of 5	
221-75597-03	FID jet		
221-81162-02	ClickTek Ferrule 0.5mm	Pk of 6	
221-77155-41	ClickTek Column Connector	each	
221-34618-00	Syringe, 10µL, fixed needle	each	AOC-20i/s
220-97331-31	Sample Vials, 1.5mL Amber Glass with Caps & Septa	Pk of 100	
220-97331-47	Sample Vials, 1.5mL Amber Glass with Caps & Septa	Pk of 1000	
220-97331-63	200µL Glass Silanized Inserts for 1.5mL Vials	Pk of 100	
220-97331-23	Wash Vials, 4mL Amber Glass with Caps & Septa	Pk of 100	
227-36077-01	SH-Rxi-624Sil MS Capillary Column, 0.32 x 1.8 x 30	each	Column
227-36078-01*	SH-Rxi-624Sil MS Capillary Column, 0.53 x 3 x 30	each	

*Column conforms to USP general chapter 611 standard method

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