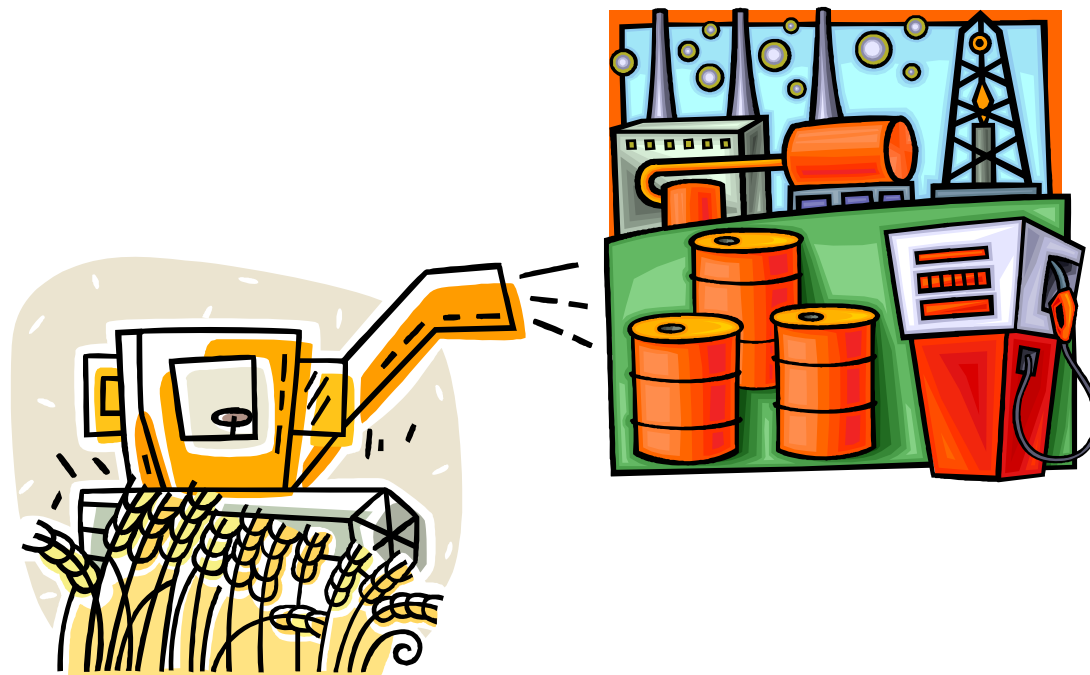


Biodiesel Quick Reference

Gas Chromatography Solutions
From Agilent Technologies



Agilent Technologies

Biodiesel – Why It Is HOT



Biodiesel is Green

- Reduces air pollution, less toxic, and biodegradable



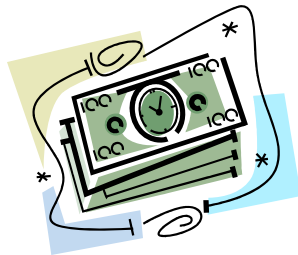
Biodiesel replaces imported petroleum

- Reduces reliance on expensive imports



Biodiesel stimulates agriculture

- Renewable resource that can be locally grown



Biodiesel generates CASH

- Worldwide government subsidies and tax incentives

Biodiesel Terms

Triglyceride – natural oil from vegetables or animal fat. Triglyceride is NOT biodiesel.

Fatty Acids – The part of the triglyceride molecule that becomes biodiesel.

Biodiesel – Motor fuel made from triglycerides (vegetable oil or animal fat).

FAME (Fatty Acid Methyl Ester) – the chemical compounds that are biodiesel.

B100 – Pure biodiesel (100% FAME).

Glycerol – Byproduct of B100 production, also known as glycerin.

Mono-, Di- and Triglycerides – Common contaminants found in B100.

B5, B10, B20, etc. – Biodiesel fuels that are blends of B100 and petroleum diesel. The number is the volume percent FAME in the fuel. For example, B20 = 20% FAME.

Industry Standard GC Methods for Measuring Biodiesel Quality

Methods Developed for Biodiesel made from Rapeseed, Soybean, Palm and Sunflower Oils

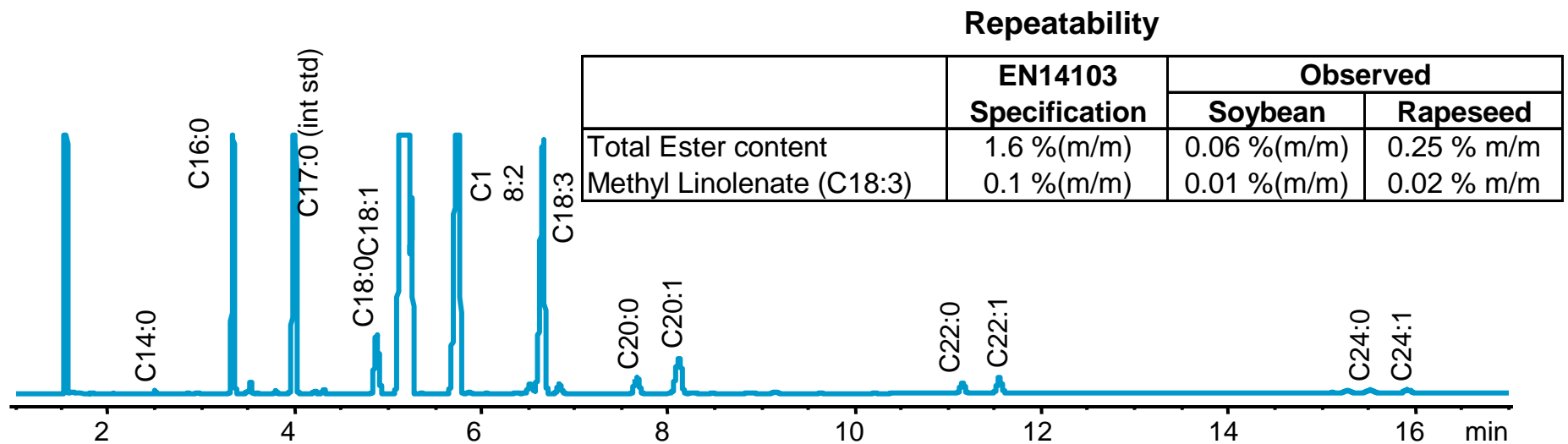
- will not work for palm kernel and coconut oil biodiesel
- **EN14103** Determination of Ester and Linoleic Acid Methyl Ester Content
 - measures the proper amount of FAME in B100
- **EN14105 and ASTM D6584** Determination of Free and Total Glycerin and Mono-, Di-, Triglyceride Content
 - high glycerin content can cause engine deposits
 - this is the most important GC method for B100
- **EN14110** Determination of Methanol Content
 - high methanol content can raise vapor pressure and increase flammability
- **EN14331** Separation and Characterization of FAME in Middle Distillate Fuels
 - analysis of FAMES in blends containing 5% or less biodiesel (B5 or lower)

Agilent Solution - EN14103

FAME Determination of Ester and Linoleic Acid Methyl Ester Content

- **Agilent Advantages:**

- Unsurpassed Quantitative Precision of the 7890 and 6850 GC
- Exceeds EN14103 Specification
- Retention Time Locking (RTL) assures correct qualitative accuracy and precision
- HP-Innowax column provides excellent peak shape

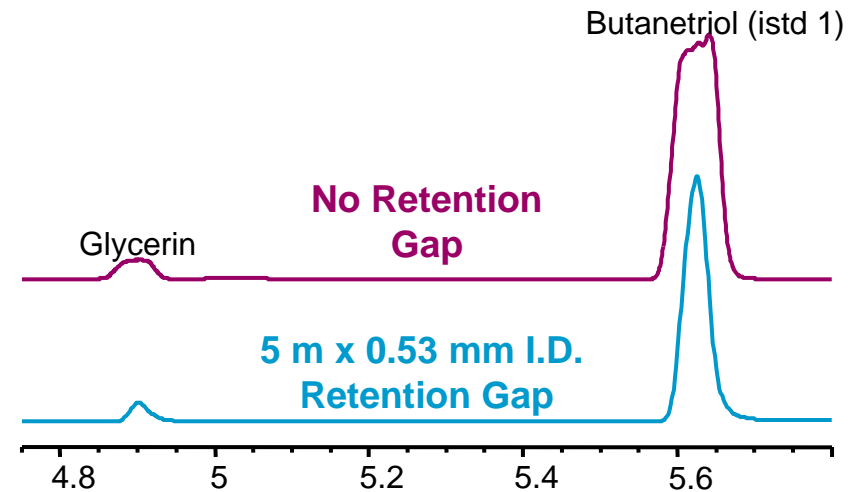
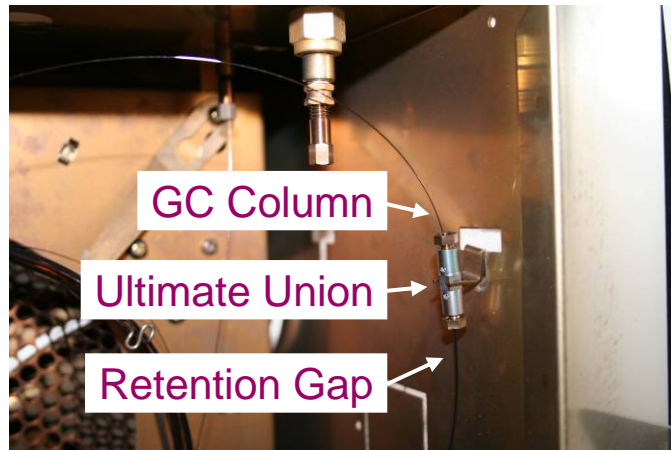


Agilent Solution - EN14105 and ASTM D6584

Free and Total Glycerin and Mono, Di, and Triglyceride Content

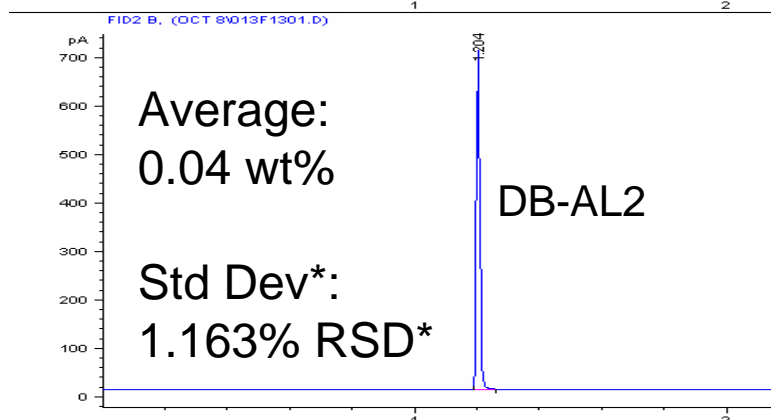
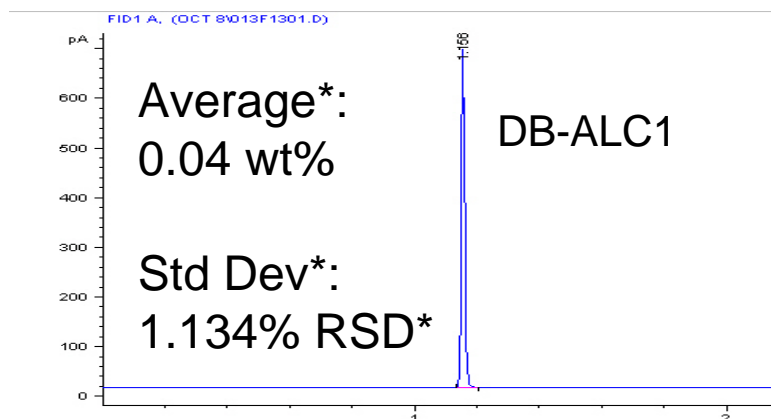
Agilent Advantages:

- Capillary Flow Technology Ultimate Union and 530 um High Temperature retention gap
 - Better peak shape, easier to use with cool-on-column inlet
- Retention Time Locking (RTL) makes peak identification easier
- High Precision Results with the 7890A GC
- Exceeds EN14105 and D6584 Specification



Agilent Solution – EN14110

Determination of Methanol Content



*10 consecutive runs of methanol found in soybean B100

Agilent Advantages:

Uses Agilent G1888 Headspace Sampler

- Automated sample preparation
- Better precision than manual preparation/injection

Quantitative analysis done by external calibration

- Faster, less complicated sample preparation

DB-ALC Columns Designed for Headspace Alcohol Analysis

- Better peak shape, less tailing



Problems with Current Analytical Methods for Biodiesel Blends

Infra-Red (IR) Spectroscopy Method

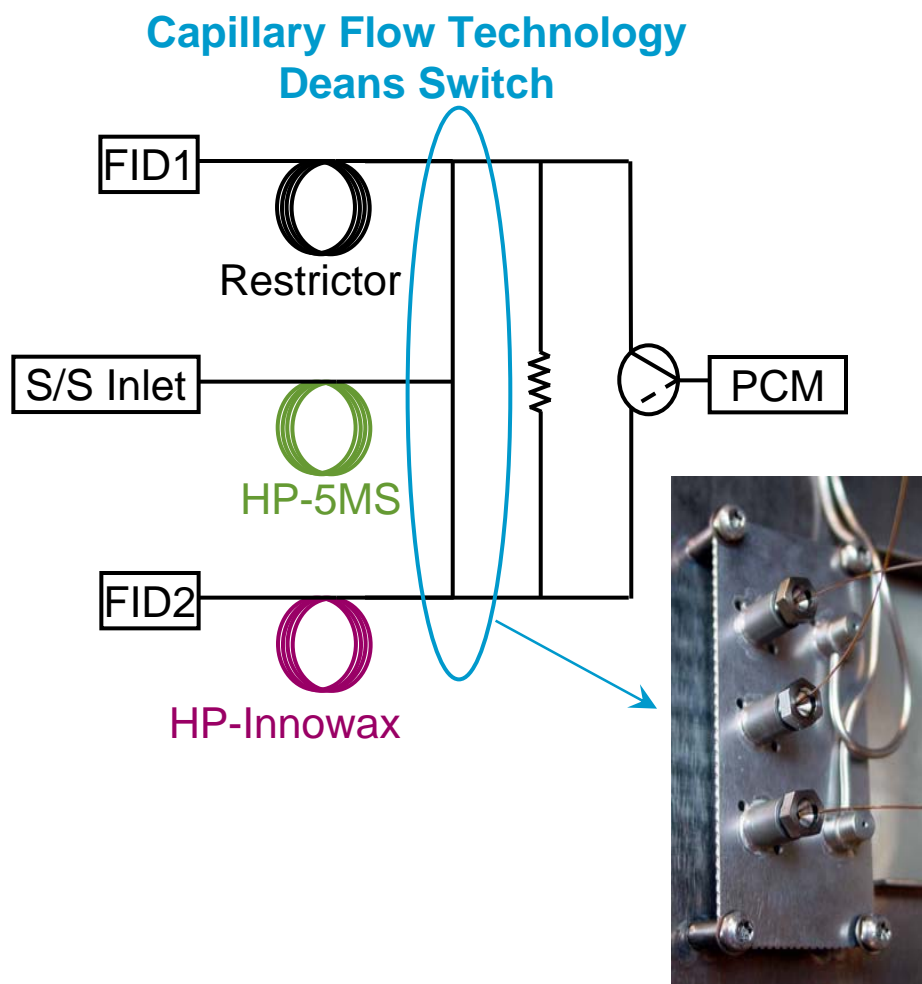
- EN14078 Determination of FAME in middle distillates by IR spectroscopy
 - Field portable instruments need an independent validation method
- Infra-red spectroscopy cannot determine distribution of individual FAMES in blend

GC Method

- EN14331 - Separation & Characterization of FAME from Middle Distillate Fuels
 - measures the FAME content in biodiesel blends
 - can only be used for B5 (5 vol%) or lower
 - requires a complex silica column chromatography sample preparation before running GC analysis

Agilent Solution For Biodiesel Blends

Deans Switch for 2-D Heart Cutting GC



Agilent Advantages:

Eliminated complicated and costly sample prep

- less time - no silica column preparation
- fewer consumable costs – silica columns, solvents

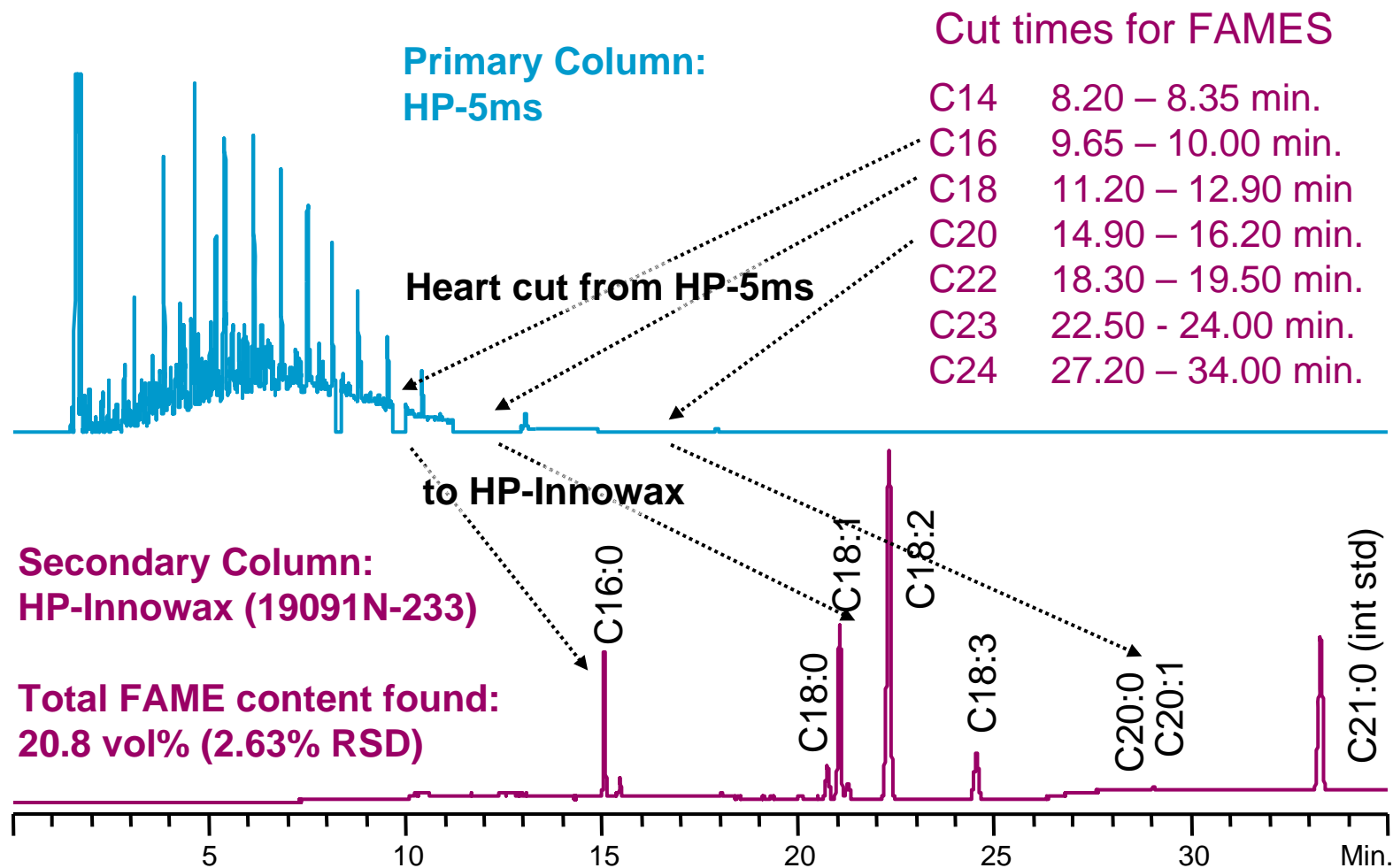
Employs the Latest GC Technology

- Capillary Flow Technology 2-D Deans Switch

Provides complete result for blends

- full analysis of FAME distribution in biodiesel blends
- can be used to validate IR field instruments (EN 14078)

Analysis of a Commercial B20 Biodiesel Blend Using Heart-Cutting 2-D GC



Final Message for Agilent Biodiesel Solutions

We have three complete SP1 solutions for the most widely run industry standard B100 methods

EN14103 – FAME Content: SP1 7890-0300

- Great precision with the easiest method to run

EN14105/ASTM 6584 Free and Total Glycerin Analysis: SP1 7890-0294

- Agilent implementation uses retention gap and Capillary Flow Technology Ultimate Union to give a robust system that exceed ASTM and EN14105 performance specs

EN14110 Residual Methanol Analysis: SP1 7890-0295

- G1888 headspace sampler and J&W columns offer a complete automated system for high throughput and precise results

Plus...

New 2-D GC solution for biodiesel blends: SP1 7890-0307

- New technology opens the door to analyzing more kinds biodiesel blends with easy, less expensive sample preparation