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FTC Octane Testing

Use of Infrared Analyzers for Determining Octane

Presented To

Federal Trade Commission

Washington, DC

May 14, 2010

Overview

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- Background
- Infrared Octane Analyzers
- State and Industry Use
- Key FTC Issues
- Recommendation

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- Independent refiner and marketer of petroleum products
- Operates seven refineries in western U.S. with combined capacity of approximately 665,000 barrels per day
- Tesoro's retail-marketing system includes over 870 branded retail stations
- Seven refineries located in:
  - Anacortes, Washington
  - Mandan, North Dakota
  - Kapolei, Hawaii
  - Martinez, California
  - Kenai, Alaska
  - Salt Lake City, Utah
  - Wilmington, California

FTC Octane Rule

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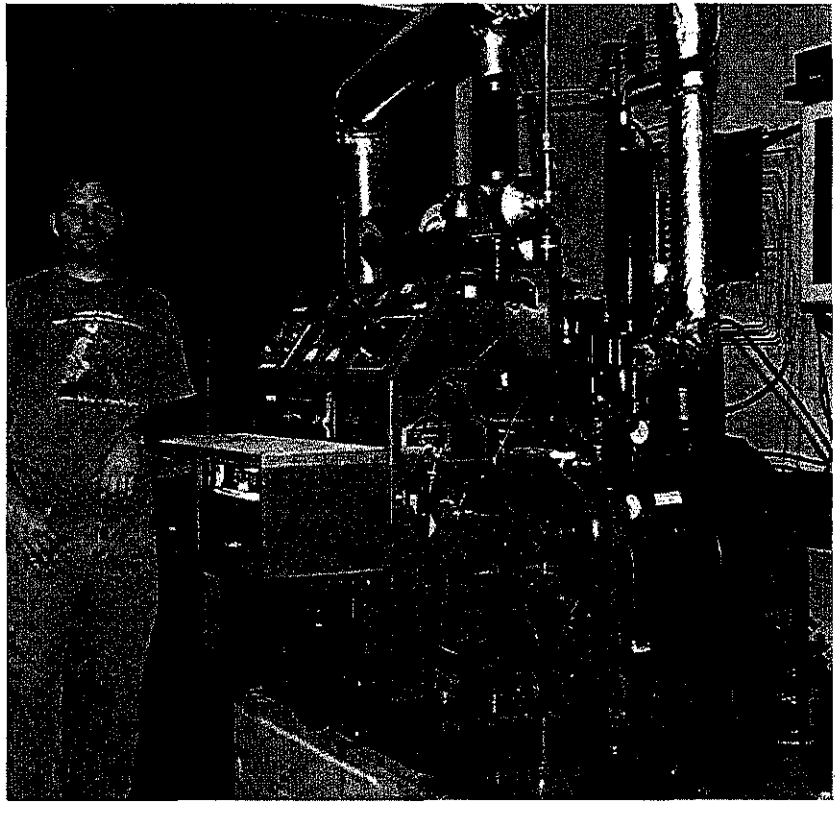
- **Current Rule**
  - Requires refiners & importers determine octane of gasoline according to ASTM D2699 & ASTM D2700
- **Proposed Rule**
  - Would allow on-line method set forth in ASTM D2885-08
- ***Recommendation for Final Rule***
  - *Allow Infrared (IR) methods as alternative for determining octane provided:*
    - *Results are correlated with D2699 and D2700, and*
    - *ASTM D2699 & D2700 would still be used as referee method for enforcement*

Benefits of Infrared Technology

- Widely used procedure for determining octane of gasoline & ethanol blends
- Provides greater precision than ASTM D2699 and D2700
- Infrared technology used by many state Weights and Measures officials to monitor gasoline octane at retail sites
- Allows increased fuel quality and consumer protection
- Analyzers can also test for other fuel properties, including diesel cetane number, ethanol, and biodiesel (FAME) content

Comparison of Octane Engine vs. FT NIR



D2699 and D2700 Standard Octane Test Engine

Infrared Octane Analyzer

Steps for Establishing Valid Results

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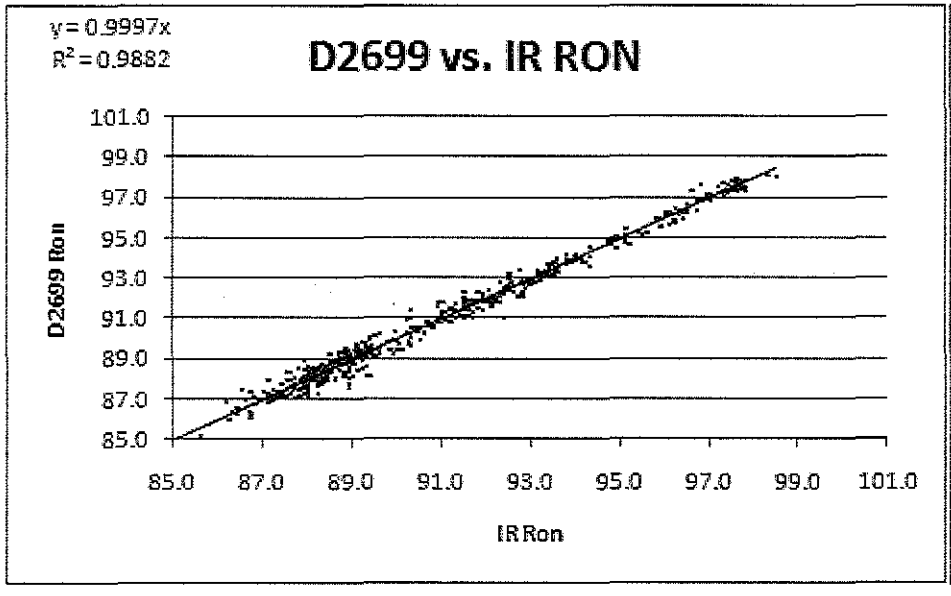
- *Create model*
  - ASTM E1655 *"Standard Practices for Infrared Multivariate Quantitative Analysis"*
  - Collect a balanced data set that reflects all historical variations of a particular grade to create model
- *Validate model*
  - ASTM D6122 *"Standard Practice for Validation of the Performance of Multivariate Process Infrared Spectrophotometers"*
  - Check FT NIR results vs. octane engines weekly for each grade. Chart and correct any differences between them.
- *Ensure analyzer working properly*
  - *ASTM D6299 "Standard Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance"*
  - Daily charting of lab control standard to ensure analyzer is accurate and reliable

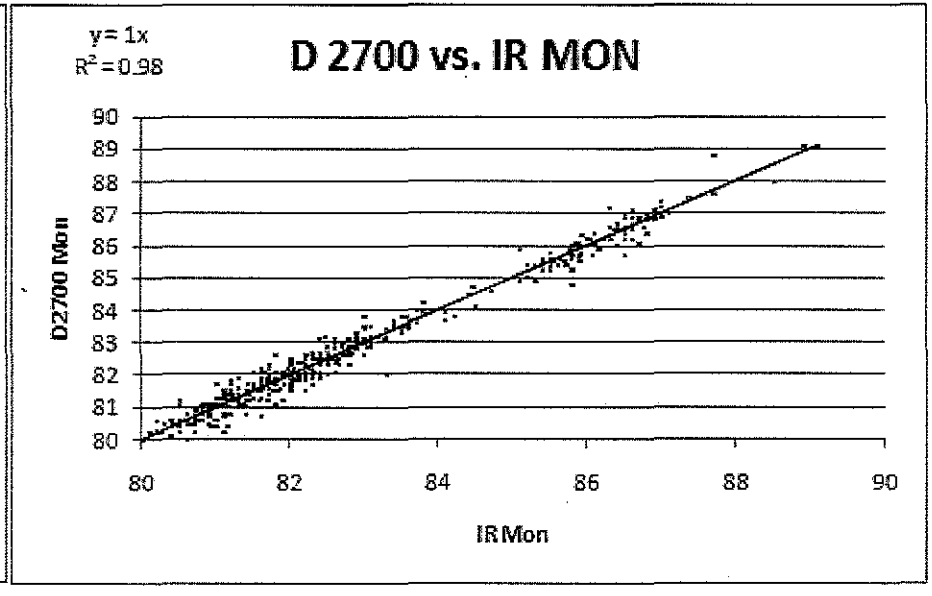
How Do I Know That My Test Result Is Correct?

- Accurate – no bias
- Precise – low variation
  - The lower the variation, the better
  - Variation measured by
    - Repeatability (r) – comparing variation on same analyzer, in sequence, same technician
    - Reproducibility (R) – comparing variation by different lab, different analyzer, different technician
  - Variation (as measured by reproducibility) is significantly lower by IR than by engine
  - Octane engine may not always yield valid test results

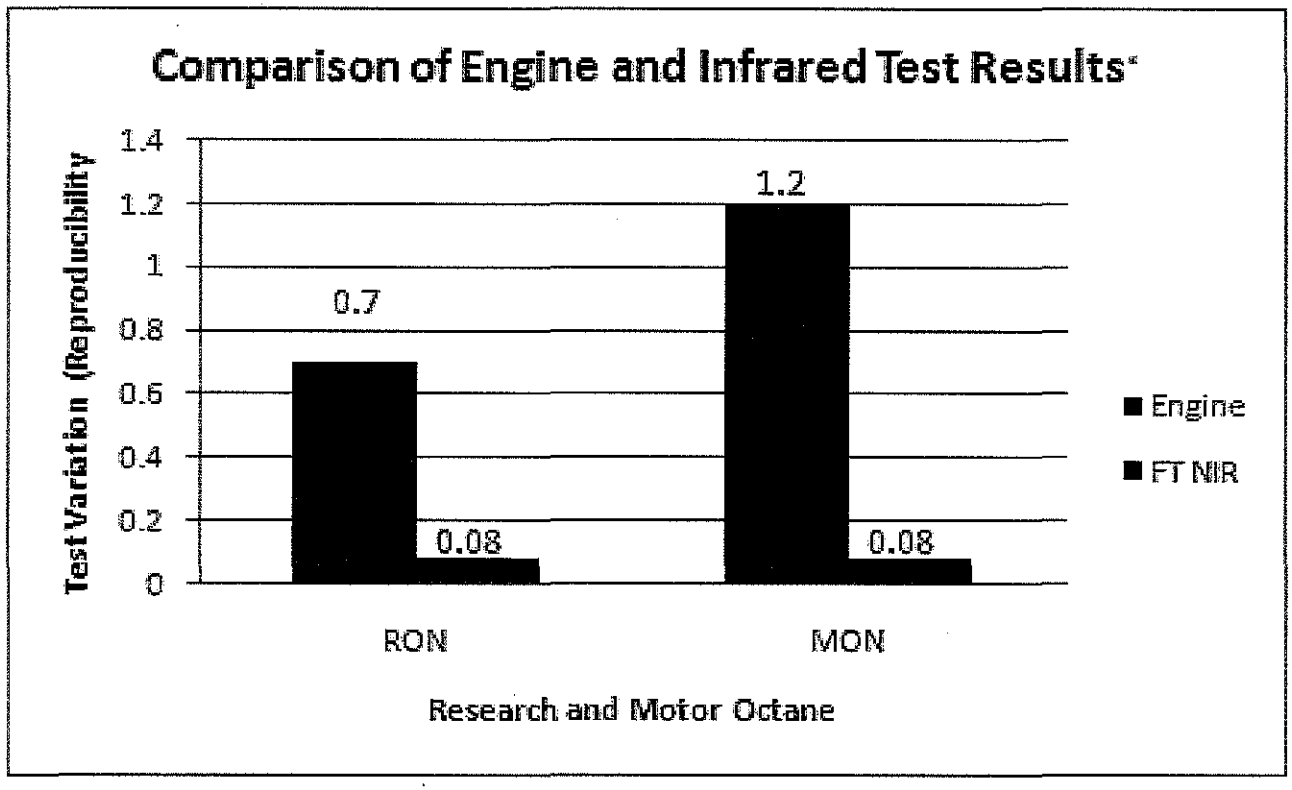
Accuracy

- Excellent correlation between engine and IR octane numbers





Enhanced Precision With IR



*Interlaboratory Study

Benefits of Enhanced Precision With IR

- Greater confidence in correctness of any one test result
- Greater confidence that product meets specification
- Greater confidence that consumer is receiving gasoline meeting minimum posted octane

EPA Alternative Test Methods

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- EPA has approved number of alternative test methods for gasoline and diesel (40 CFR 80.46, 80.580, 80.584, 80.585)

- EPA alternative methods required to be correlated with designated test method or meet other EPA criteria

- Under RFG program, EPA has approved use of infrared analyzers for specific refineries to certify RFG (40 CFR 80.65, 80.69)

EPA ALTERNATIVE TEST METHODS

RFG, CG & DIESEL MOTOR VEHICLE FUEL PROGRAMS

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PROPERTY	EPA DESIGNATED TEST METHODS	EPA ALLOWED ALTERNATIVE TEST METHODS	REQUIREMENTS	CFR CITATION
Aromatics (Gasoline)	D5769-04, (except sample chilling requirements in Table 8 are optional)	D1319-03 $^{\varepsilon 1}$	Must be correlated with ASTM D5769-04	40 CFR §80.46
Oxygen (Gasoline)	D5599-00 (2005)	D4815-04	Must be correlated with ASTM D5599-00(2005)	40 CFR §80.46
Sufur (Gasoline)	D2622-05	D5453-08a	Must be correlated with ASTM D2622-05	40 CFR §80.46
		D6920-07	Must be correlated with ASTM D2622-05	40 CFR §80.46
		D3120-06 $^{\varepsilon 1}$	Must be correlated with ASTM D2622-05	40 CFR §80.46
		D7039-07	Must be correlated with ASTM D2622-05	40 CFR §80.46
Sulfur (Diesel) (500 ppm)	D2622-05	D4294-03	Must be correlated with ASTM D2622-05	40 CFR §80.580
		D5453-08a	Must be correlated with ASTM D2622-05	40 CFR §80.580
		D6920-07	Must be correlated with ASTM D2622-05	40 CFR §80.580
Sulfur (Diesel) (15 ppm and 500 ppm) For test methods approved by consensus-based body	N/A	Any method approved by EPA under 40 CFR §80.585(a) (test methods approved by ASTM/ other consensus-based bodies)	EPA approval required for each test facility for each test method. Must meet requirements of 40 CFR §80.585(a) and applicable accuracy and precision criteria under 40 CFR §80.584. Approval limited to facility performing accuracy and precision testing.	40 CFR §80.580 40 CFR §80.584 40 CFR §80.585(a)
Sulfur (Diesel) (15 ppm and 500 ppm) For test methods not approved by consensus - based body	N/A	Any method approved by EPA under 40 CFR §80.585(b) (test methods not approved by consensus-based bodies)	EPA approval required for each test facility for each test method. Must meet requirements of 40 CFR §80.585(b) and accuracy and precision criteria under 40 CFR §80.584.	40 CFR §80.580 40 CFR §80.584 40 CFR §80.585(b)

State Use of IR for Octane

- Widely used by states for screening and enforcement of octane
- Over 25 states use infrared analyzers for screening fuel samples in field and/or in laboratory
- Portability , reduced cost, and speed of test results provides major advantages
  - North Carolina Experience:
    - IR octane analyzer - 35 samples per hour
    - Octane Engine – 35 samples per day
- States using IR typically pass samples based on IR
- Samples screening as "off spec" may be sent to lab for verification prior to taking enforcement action
- Certain states taking enforcement action based on IR results

State Comments on Infrared Octane Analyzers

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*Missouri Department of Agriculture, Weights and Measures Division**

"We use it as a screening tool for all products. For gasoline it predicts the octane. Any sample slightly low in octane is then routed to the octane engines for final testing. Since it predicts the RON and MON, it speeds up testing by having target values for engines. To ensure our octane models are up to date, 20% of all samples are selected randomly for engine tests. The FTIR also is used for measuring and predicting other properties of the fuel.

We have been using the FTIR since 1995. It is a great tool when you have the engines and other equipment to back it up, which is a must for enforcement. For speed and a second check against other tests, we feel we have better assurance of reliable results. It has paid for itself many times."

*North Carolina Department of Agriculture, Standards Division**

"We have about 13 of these units (one for each field inspector, the field supervisor and the lab)....Some of our newer units include program for ethanol or cetane as well. We will approve a sample on octane using this unit, but we will not condemn one. Any approved results are noted as "NIR" on the inspection transcript so that is clear it was not an engine result. The unit provides RON, MON and the index (average). A sample can be run in about 45 seconds or less.

* * * *

The benefits we see are mainly in the field, it allows for very quick on site testing, especially if a technician is there to correct a blending issue with a dispenser(s). They can make an adjustment and then we can determine if the fuel will then meet the octane specs as posted (there is some line flushing that goes on here as well). Many stations now have blend pumps or have the single hose multi-product units, so it does save us from having to draw larger samples for the lab since we do multiple dispensers at each location. Otherwise samples would have to be sent to the lab, each field inspector has certain days their sample comes into the lab to be tested the next day and then the results reported, so turn around time is no longer a factor. If we do have a sample that is borderline, we conditionally approve it, meaning we leave the pumps open and take a sample for the lab to determine if it meets specs or not using the engines."

**Email Correspondence to Herman & Associates from Ron Hayes, Director, Weights and Measure Division, Missouri & Stephen Benjamin, Director, Standards Division, North Carolina*

Key Issues - Consumer Protection

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- Greater consumer protection
- No change to enforcement
- Better precision would minimize off spec material from reaching marketplace

Key Issues - Enforcement

- Approval of Infrared method as alternative would not change current enforcement
- IR would be correlated to designated ASTM test methods D2699 and D2700
- In all cases – D2699 and D2700 would continue to be used as referee method for enforcement

Summary

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- Infrared analyzers are a proven technology used extensively by industry and states
- Excellent precision allows for better consumer protection
- No additional enforcement burden (since ASTM D2699 & D2700 would continue to be used for enforcement)
- Request FTC amend §306.5 to permit IR to be used to determine octane

Proposed Regulatory Language

PART 306_AUTOMOTIVE FUEL RATINGS, CERTIFICATION AND POSTING

§ 306.5 Automotive fuel rating.

If you are a refiner, importer, or producer, you must determine the automotive fuel rating of all automotive fuel before you transfer it. You can do that yourself or through a testing lab. (a) To determine the automotive fuel rating of gasoline, add the research octane number and the motor octane number and divide by two, as explained by ~~the American Society for Testing and Materials~~ ASTM International (ASTM) in ASTM D4814–09b, entitled "Standard Specification~~s~~ for Automotive Spark-Ignition Engine Fuel." To determine the research octane and motor octane numbers you may either:

(1) Use ASTM standard test method D2699-~~08~~ 09 to determine the research octane number, and ASTM standard test method D2700-~~08~~ 09 to determine the motor octane number; or

(2) Use the test method set forth in ASTM D2885-~~08~~ 10, "Standard Test Method for Determination of Octane Number of Spark-Ignition Engine Fuels by On-Line Direct Comparison Technique"; **or**

(3) Use infrared test methods to determine research and motor octane number, provided that these methods are correlated with ASTM D2699-09 and ASTM D2700-09 and conform with ASTM D6122-10 "Standard Practice for Validation of the Performance of Multivariate Infrared Spectrophotometers". ASTM standard test methods D2699-09 and D2700-09 shall be the referee test methods.

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Appendix

State Use of IR for Octane Testing

Preliminary Responses to May 7, 2010 Survey by National Conference on Weights and Measures

State	Utilize IR	Use in Laboratory Testing	Use for Field Testing	Verify Failures with Engine Testing	Comments
Arizona	Yes	Yes	Yes	Yes	Used as screening tool. Enforcement taken on lab test results. Instrument correlated to ASTM 2699 and 2700.
Arkansas	Yes	Yes	Yes	Yes	Uses benchtop IR fuel analyzers in laboratory. Very failures with engine testing.
Connecticut	Yes	No	Yes	Yes	Used for enforcement. Engine tests performed if retailer does not agree to address problems with fuel.
Delaware	No	No	No	No	State has not started octane testing yet.
Florida	Yes	Yes	No	Yes	Used as screening tool. Enforcement taken on lab test results. Run percentage of samples that pass the IR on engines, to check for potential positive biases with the IR.
Georgia	Yes	Yes	No	Sometimes	Does not always verify failures with engine tests.
Hawaii	No	No	No	No	Hawaii does not test for octane ratings.
Illinois	No	No	No	No	Does not use IR equipment to scan for octane rating of gasoline.
Iowa	Yes	Yes	Yes	No	Used for screening and enforcement. Have enough confidence in unit to take immediate action if fuel found to be different than labeled.
Kansas	No	No	No	No	Does not use.
Maryland	Yes	Yes	Yes	Yes	Used as screening tool. Enforcement taken on lab test results. All samples are lab tested.
Massachusetts	Yes	No	Yes	Yes	Used for enforcement. Lab tests available for confirmation at request of retailer.
Michigan	Yes	Yes	Yes	Yes	Used for screening. If octane found to be low, official sample obtained for verification on engines. Enforcement based on engine results.

State	Utilize IR	Use in Laboratory Testing	Use for Field Testing	Verify Failures with Engine Testing	Comments
Minnesota	Yes	Yes	Yes	No	Used as screening tool. Enforcement taken on lab test results.
Missouri	Yes	Yes	No	Yes	Used as screening tool. Enforcement taken on lab test results. 20% of all samples are randomly selected for engine tests. FT IR used for biodiesel enforcement according to ASTM D7371.
Nevada	Yes	Yes	Yes	Yes	Used as screening tool. Enforcement taken on lab test results.
New Mexico	Yes	Yes	Yes	Yes	Used as screening tool. Enforcement taken on lab test results.
New York	No	No	No	No	Currently evaluating portable analyzers. Considering purchasing small number to reduce demands for lab testing. Would confirm screening test failure with ASTM tests. Enforcement taken only on official test.
North Carolina	Yes	Yes	Yes	No	Used as screening tool. Enforcement taken on lab test results.
Ohio	No	No	No	No	No Fuel Quality Program.
Oregon	Yes	Yes	Yes	Yes	Used as screening tool. Enforcement taken on lab test results.
South Dakota	No	No	No	No	Does not have a laboratory or own octane field analyzer. Would like to be able to use field test for octane when complaints received.
Virginia	Yes	Yes	Yes	No	Used portable fuel analyzer for several years. Plan to expand use of IR technology to cetane, ethanol, and biodiesel. May take action on gross violations detected by IR device. Close readings verified in laboratory.
Washington	Yes	No	Yes	Yes	Used as screening tool. Enforcement taken on lab test results.

Compiled by Herman & Associates, Washington, DC - May 11, 2010