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Methods to Determine Diesel Cetane Number

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ASTM recently published an updated ASTM D7170 test method for Derived Cetane Number (DCN) measurement using the ignition delay principle, which provides for an economical and reliable way to determine the diesel fuel cetane number.

The cetane number is a very important property of diesel oils indicating the quality of ignition of the diesel fuel (the higher, the better), somewhat analogous to octanes for gasoline.

Methods for Determining Cetane Number of Diesel Fuels

There are basically four different methods in use:

1. Use of a Cetane Engine
2. Use of an Ignition Quality Tester
3. Use of a Near Infra-Red (NIR) Analyzer
4. Use of Cetane Indices

1. Use of a Cetane Engine

This is the "Gold" standard used as a referee method (ASTM D613); measurement is straightforward once the engine is set up and calibrated.

The disadvantages are:

- the high purchase cost (\$500,000 plus), ongoing maintenance, and operating cost
- requirement for trained staff and expertise for operation and maintenance
- poor reliability and accuracy of results

Work Highlights

Fired Equipment



Reviewed the Design Basis Memorandum (DBM) prepared by a process

licensor for a new hydrogen plant to be installed at a refinery in Europe. The objective was to help ensure that the DBM had sufficient details to permit developing a detailed design specification that would meet the owner's requirements. Several areas for improvement were identified which were discussed during the project kickoff meeting, which are expected to result in some changes to the DBM.

Process, Operations, & Safety



Completed a Cold Eyes Review of an international

pharmaceutical company's global engineering standards, involving Incineration Systems, Bulk Storage of Liquefied Compressed Gases, and Distillation & Solvent Recovery Systems. Also participated in their global standards workshop to resolve issues and improve/streamline content.

2. Use of an Ignition Quality Tester (IQT)

This is a method that measures the time delay between the start of fuel injection and the start of significant combustion through auto-ignition of a pre-measured amount of diesel in a constant volume chamber. The time delay is used with a formula to calculate the Derived Cetane Number (DCN) which correlates to the D613 cetane engine. This is a relatively lower cost (less than one third of an engine), very reliable, high accuracy, faster, easily operated, and maintainable device.

There are two ASTM test methods using IQT: D6890 and D7170. The difference between them is the number of cycles run for the test (32 cycles for D6890 vs. 25 cycles for D7170) and the averaging of results.

3. Use of a Near Infra-Red (NIR) Analyzer

This method uses a Near InfraRed (NIR) analyzer to obtain the absorption spectrum of diesel which then is fed to a chemometric model to estimate cetane. Its reproducibility is an order of magnitude better than an engine; the reproducibility is the same (because we use the engine as the referee). It is very reliable and low maintenance if the chemometric property prediction model is set-up in accordance with ASTM E1655 practice and run as per ASTM D6122. The cost is the same as a cetane engine, but it measures 10 to 15 diesel properties simultaneously every 1 to 2 minutes.

4. Use of Cetane Indices

This is an estimation of measured cetane number based on formulas in ASTM D976 or ASTM D4737. The calculations rely on diesel fuels T10, T50, T90 distillation points, and gravity/density to estimate the cetane number. The sample population used to regress the formulas for D976 and D4737 are different, and the accuracy (r, R) is different.

They are, however, accepted by pipelines and marine terminals in lieu of D613 measurements.

Cetane Number (CN) Measurement Method Precision Comparison is summarized in the following table (varies with CN).

Test Method	Repeatability – r	Reproducibility – R	Basis
613	0.8	2.8	39.5 CN fuel, referee
6890	0.85	2.56	39.5 CN fuel
7170	0.71	1.5 - 3.0 model specific	39.5 CN fuel
NIR analyzer	0.08	Same as referee method	39.5 CN fuel

Ara Barsamian has over 30 years of experience in blending (crude, mogas, distillate, fuel oil, lubes), oil movements, & storage (OM&S), crude handling logistics, refinery tank farm sizing studies, refinery supply chain management, NIR analyzers, and master plan/automation benefits studies for major process plants and hydrocarbon storage facilities. Please contact Jerry Lacatena (jlacatena@carmagen.com) if you'd like more information on Carmagen's expertise in this area.

