Measuring Cetane Number: Options for diesel and alternative diesel fuels

Response by Caltex Australia Ltd
to
A Discussion Paper by the Department of the Environment and Heritage

1. Petroleum-derived diesel fuel

1.1 Routine refinery production

Caltex recommends continuation of the current reliance on cetane index as the primary specification and test method for ignition quality. However, the current method ASTM D4737 is in the process of being modified as it over-predicts low sulfur, low cetane (approx. 40 cetane number) fuels that are sold in the US. As Australian fuels are much higher cetane we propose that the standard method be changed to EN 4264 (IP 380), as is the practice in Europe. IP 380 is equivalent to the current version of ASTM D4737.

The principal reasons to retain cetane index as the preferred test method are:

- It is well established.
- It is an important tool for production of diesel fuel that has a sound track record of satisfying the ignition quality requirements of the Australian vehicle fleet.
- It does not contribute unduly to manufacturing costs.
- It has very satisfactory repeatability and reproducibility.
- It is subjected to ongoing assessment programs[1] to confirm its alignment with cetane number as measured by the cetane engine method (ASTM D613).

The average cetane index of Australian diesel fuel is substantially higher than the national specification of 46 minimum. Australian diesel fuel usually can be manufactured without undue attention to cetane quality, and without the significant economic penalties that apply to manufacture of petrol with excess ignition (octane quality). There are times, however, when the crude oils processed by a refinery yield diesel fuel with cetane index close to the national specification, requiring careful processing and/or blending to ensure compliance. The simplicity and precision of IP 380 are vital to efficient refinery operations in these circumstances.

From the perspectives of both consumers and Environment Australia, cetane quality of diesel fuel as it is distributed from refineries to end-users should seldom cause any concern. The average cetane index of Australian diesel fuel is well above the national specification. A particular refinery production batch that has a cetane index only marginally above the specification of 46 is very likely to be mixed with other diesel fuel with a higher cetane index before it is consumed in diesel engines. If the marketplace is supplied with fuel certified by refineries, samples taken for the purposes of checking compliance will therefore, in almost all cases, very easily satisfy the specification. Because of the averaging of quality that occurs during fuel distribution, Australian diesel engines will generally run on fuel that has cetane quality well above the specification. This favourable situation provides further justification for retaining cetane index as the primary specification and test method for ignition quality.

In summary, the current practice of certifying petroleum-derived diesel fuel by cetane index contributes to the efficient manufacture of diesel fuel that satisfies the national standard and the needs of diesel engines in service in Australia.

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[1] *Cetane Number and Cetane Index Relationship,* Petroleum Review, May 2003, pp. 38-39.

1.2 Use of ASTM D613 (cetane engine) when cetane additives are used

As an alternative to cetane index, Caltex supports granting of approvals or amendment of the national standard to allow use of the cetane engine method (ASTM D613) for certification and compliance purposes.

Occasionally, refiners may wish to employ cetane-improving additives to produce premium quality fuel, or to overcome poor cetane quality inherent in diesel fuel from some crude oils. Cetane index does not register the improvement in ignition quality provided by additives. As an alternative to cetane index when cetane-improving additives are used, Caltex supports the use of the cetane engine test method (ASTM D613).

The poor repeatability and high cost of certifying fuel by ASTM D613 suggests that control and certification of cetane number would be best achieved by cetane index (IP 380), together with accurate control and measurement of the concentration of cetane additive in diesel fuel. Refiners using this approach will need to establish the concentration of additive required to boost cetane number by any shortfall in cetane index, and report the concentration on certificates of quality. Periodic confirmation – using ASTM D613 engine testing – that the expected boost in cetane quality has actually been provided would be prudent.

For compliance purposes, testing of diesel fuel containing cetane additives could be approached by first measuring the cetane index. If the cetane index is below 46, the presence of cetane additives could be confirmed[2] by the Australian compliance laboratory. Other avenues for compliance testing are ASTM D613 at an overseas laboratory, and perhaps the Ignition Quality Test, which may be introduced to Australia for certification and compliance of alternative fuels such as biodiesel.

2. Issues for Comment

1. Are you aware of any equipment available in Australia that may be used to test diesel to ASTM D613 (Standard Test Method for Cetane Number of Diesel Fuel Oil)? This test method requires use of a standard single cylinder, four-stroke cycle, variable compression ratio, indirect injected diesel engine.

ChevronTexaco Global Lubricants (CTGL) has an ASTM D613 engine at its Kurnell laboratory. This engine has been mothballed since 1996, and re-commissioning will probably not occur. CTGL is very likely to favorably consider offers to purchase the engine.

2. Are you aware of any equipment available in Australia that may be used to test the Cetane Number of biodiesel to ASTM D613 (Standard Test Method for Cetane Number of Diesel Fuel Oil) or EN ISO 5165 (Petroleum products – Determination of the ignition quality of diesel fuels – cetane engine method)?

See previous discussion on the ASTM D613 engine at the CTGL facility, Kurnell.

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[2] The concentration of cetane additive in diesel fuel can be measured by ASTM D4046 *Standard Test Method for Alkyl Nitrate in Diesel Fuels by Spectrophotometry*, This test method is relatively simple and useful for indicating the presence of cetane additives, but is not sufficiently accurate for quality certification purposes. It may prove to be sufficiently accurate for compliance purposes, given that the alternative (ASTM D613) is not very accurate.

During the 1980s, CSIRO (Division of Energy Technology and Division of Chemical and Wood Technology) developed a laboratory engine method[3] for testing the ignition quality of diesel fuels derived from crops such as rapeseed. Caltex/Ampol used this engine for studies on refining of coal-derived syncrudes. The test method was based on a British Institute of Petroleum standard (IP 41/60 *Ignition quality of diesel fuels. Method B - throttling*).

The main advantage of the CSIRO cetane engine was that it required only 100 to 300 mL of test fuel, much less than ASTM D613. The very high cost of producing experimental alternative diesel fuels justified the costs of establishing the test engine.

With the demise of interest in alternative fuels in the early 1990s, the hardware and expertise has probably been lost. In any case, the Ignition Quality Tester (IQT) is almost certainly a better approach to Australia's future needs.

3. Are you aware of appropriate test methods for determining the cetane number of diesohol and/or emulsified diesel?

Ignition Quality Tester (ASTM D6890–03) appears to be the best approach.

4. Do you have any information on alternatives to 'traditional' Cetane Number testing methods, such as ignition quality testing?

See discussion above on CSIRO work during the 1980s.

Ignition Quality Tester (ASTM D6890–03) appears to be the best approach.

5. Is it practical or desirable to manage cetane by developing indices for alternative diesel fuels and diesel with cetane additives?

Caltex considers that this approach is unlikely to provide a practical solution to Australia's requirements.

6. What is the appropriate means of determining the cetane number of Australian diesel and alternative diesel fuels or a surrogate in place of the direct measurement of cetane number?

The Ignition Quality Tester (ASTM D6890–03) appears to be the best approach.

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[3] R R M Johnston and G Kill, *Vegetable Oils as Fuels for Diesel Engines,* National Energy Research, Development and Demonstration Program, End of grant report no. 171, 1983.
R R M Johnston and G Kill, *Diesel Engine Test Data with Small Samples,* Australian Institute of Energy Conference, Melbourne, August 1985.