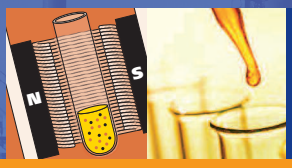
Application Note

Standard Method for Hydrogen Content in Fuels

(ASTM D7171-05)



NMR

The hydrogen content of aviation fuel is an important parameter as it determines the combustion properties of the fuel. Traditional methods such as smoke point, smoke volatility index and luminometer number are tedious, time-consuming and usually require skilled analysts. Nuclear Magnetic Resonance (NMR) offers the opportunity to monitor the hydrogen content of fuels rapidly, non-destructively and with minimal sample preparation.

Method

For 20 years, Oxford Instruments led the way with the Oxford 4000 Continuous Wave (CW) NMR Analyser, an American Society for Testing and Materials (ASTM) compliant instrument, for rapid and efficient measurement of hydrogen content in fuels.

Since CW instruments are no longer commercially available the previous ASTM standard method has been updated for the use of Pulsed NMR. The new method is D7171-05 Standard Test Method for Hydrogen Content of Middle Distillate Petroleum Products by Low Resolution Pulsed Nuclear Magnetic Resonance Spectroscopy.

In this method, the fuel samples are carefully transferred into glass tubes using a pipette, weighed and conditioned at 35°C or 40°C for 30 minutes prior to NMR analysis.

Note: Although not covered by this standard method, fuels and other petroleum products that are too volatile to be conditioned at 35°C /40°C can be measured at room temperature. Please contact Oxford Instruments for further details.

Calibration and Results

The instrument can be calibrated using real samples of known hydrogen content (e.g. n-dodecane, n-hexadecane, cyclohexane and iso-octane) or artificial standards using differing masses of pure n-dodecane in the NMR tubes provided.

Figure 1 shows the calibration line for the measurement of hydrogen in fuels performed on several different masses of n-dodecane at 40°C. Figure 2 shows the calibration line for the measurement of hydrogen in fuels using several hydrocarbons of known hydrogen content at 40°C (n-dodecane, cyclohexane, n-hexadecane and iso-octane).

Table 1 shows the precision obtained when measuring two artificial standards made up from different masses of n-dodecane (3.760 and 7.687% H) and one n-hexadecane sample (15.148% H).

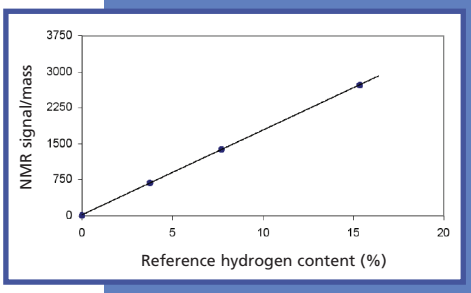


Figure 1. 40°C calibration (gravimetric method)

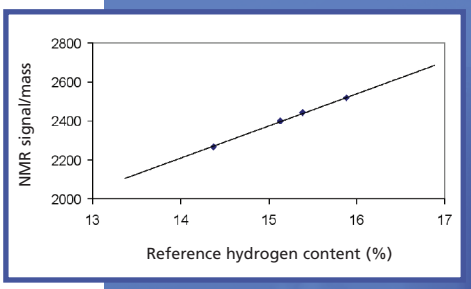


Figure 2. 40°C calibration (hydrocarbons)

Table 1. Precision for the hydrogen in fuel method

Sample	Ref. % H	SD%, w/w	Mid range precision (95% confidence) (%, w/w)
n-dodecane	3.760	0.052	0.002
n-dodecane	7.687	0.052	0.004
n-hexadecane	15.15	0.024	0.006

Benchtop NMR for Petrochemicals

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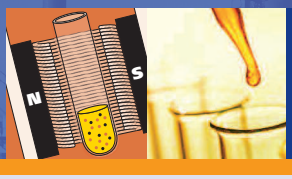

NMR

Table 2. Accuracy for the hydrogen in fuel method

Sample	Ref. % H	NMR % H	Difference
Cyclohexane	14.37	14.3524	0.0176
n-hexadecane	15.13	15.1594	-0.0294
n-dodecane	15.39	15.3993	-0.0093
iso-octane	15.88	15.8589	0.0211

Recommended Instrument

The **MQC**-23 fitted with an 18mm diameter (8 ml) probe is a suitable instrument for this application. The Hydrogen in Fuel package comprises:

- **MQC**-23 with a built-in computer, operating the latest version of Microsoft® Windows® (no separate PC is required)
- **MultiQuant** software including **RI Calibration, RI Analysis,** and the **EasyCal** 'Hydrogen in Fuel' application
- 18 mm glass tubes
- PTFE stopper (to seal the test cells)
- Stopper insertion/removal rod
- Installation manual
- Method sheet

In addition to this package you will also require:

- A dry heater and aluminium block with holes for conditioning the sample at 35°C or 40°C
- A precision balance

The instrument offers multiple advantages over other instruments on the market:

- High signal sensitivity
- Small benchtop footprint
- Low maintenance
- The sample tubes are recyclable, lowering consumable costs
- Minimal sample preparation

Note: Alternative methods/packages are available for light distillate (low flash point) samples that need to be measured at room temperature although they are not covered by this standard method. Please contact Oxford Instruments for further details.

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