AIR RESOURCES BOARD

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PROCEDURE FOR THE DETERMINATION OF DENSITY OF LIQUID FUELS BY DIGITAL DENSITY METER

SOP NO. MLD 126

Southern Laboratory Branch
Monitoring and Laboratory Division
State of California

Haagen-Smit Laboratory
9480 Telstar Ave., Ste. 4
El Monte, CA 91731

CALIFORNIA AIR RESOURCES BOARD
MONITORING AND LABORATORY DIVISION

Standard Operating Procedure for the Determination of Density of Liquid Fuels by Digital Density Meter

1 Introduction

1.1 This document describes the standard operating procedure (SOP) for measuring the density of liquid fuels using a digital density meter.

1.2 This test method is applicable to liquid fuels and related products which are liquids at 60 ^{o}F with vapor pressures below 600 torr and viscosities below 1500 mm^2/s at 60 ^{o}F.

1.3 This SOP is based on ASTM D4052-96(2002)e[1].

2 Method

2.1 A small volume (approximately 0.7 mL) of liquid sample is introduced into the density meter's oscillating sample tube.

2.2 The change in the oscillating frequency of the tube, caused by the increased mass of the tube, is used in conjunction with calibration data to determine the density of the sample.

3 Instrumentation

3.1 Digital density meter: Anton-Paar Model DMA 48 with optional filling and rinsing system (FRS).

3.2 Luer cone syringes for manual sample introduction.

3.3 Tygon brand fuel resistant tubing F-4040-A or equivalent.

4 Reagents

4.1 Methanol, A.C.S. reagent grade or better.

4.2 Isooctane, A.C.S. reagent grade or better.

4.3 Deionized water.

5 Preparation of Instrument

5.1 The instrument should be set to 60 ^{o}F (15.56 ^{o}C) for at least an hour before calibration or analyses are performed. For special projects or at a client's request, other analysis temperatures may be used.

5.2 After a master reset, the FRS must be configured with an 8-digit command, which is entered using "F802" on the keyboard. The 8-digit command, which is normally never changed, is recorded in the front of the instrument notebook.

6 Calibration

6.1 Calibration (also referred to as adjustment in the instrument manual) must be performed at least once per year, and any time the instrument undergoes a master reset.

6.2 Visually ensure that the sample cell is free of any residue from previous samples. With ordinary, proper use of the FRS there should not be any residue. If necessary, a solvent such as methanol or hexane can be run through the instrument as a normal sample (see section 7) to clear out any residue.

6.3 Enter "F500" on the DMA 48 keyboard to set the display to oscillation period.

6.4 Wait until the instrument is stable (the front-panel X does not flash.)

6.5 Enter "F100" to start the air adjustment routine.

6.6 Enter the correct air density from appendix G of the instrument manual.[2] The current atmospheric pressure must be known.

6.7 Wait until the front-panel X stops flashing.

6.8 Enter the oscillation period for air in the instrument notebook.

6.9 Remove the sample inlet tube connector from the instrument. Using a Luer tip syringe, fill the measuring cell with deionized water.

6.10 Check the measuring cell for bubbles. If any bubbles are visible, remove the water from the cell and repeat step 6.9.

6.11 Enter "F101" on the keyboard. Acknowledge the instrument's value for the density of water at the measurement temperature by pressing enter.

6.12 Wait until the X stops flashing.

6.13 The number on the instrument display should either be between 1.3 and 1.6, or else between 0.0002 and -0.0002.

6.13.1 If the number is not within either of these ranges, the entire calibration process needs to be repeated starting at step 6.2. If the calibration process fails the requirements of 6.13 again, the reason for the instrument's instability must be determined.

6.14 Enter "F500" on the keyboard, and not the oscillation period for water in the instrument notebook.

6.15 Enter "F110" on the keyboard to cycle through the calibration parameters. Enter the A and B constants to 5 decimal places in the instrument notebook.

6.16 Enter "F505" on the keyboard to return the display to density measurement.

6.17 Using the Luer tip syringe, remove as much water from the instrument as possible. Run methanol through the instrument as a normal sample (see section 7) one or more times until there is no liquid visible in the cell after the rinse cycle.

7 **Procedure**

7.1 Check to make sure that the rinse bottles contain sufficient methanol before each analysis. The bottles typically need to be refilled after every six analyses.

7.2 Place the inlet hose into a large quantity of the sample (preferably the original container). Activate the FRS by pressing and holding the "*" key until the FRS begins pumping the sample.

7.3 After the FRS is finished pumping, put the inlet hose into the waste bottle. Use the instrument's interior light to quickly check for bubbles. If bubbles are present, eject the sample from the cell by pressing and holding the CLR key and repeat step 7.2.

7.4 When the instrument display begins flashing, the density can be recorded.

7.5 The FRS will automatically wash the cell with methanol and dry it with air. After the air stops blowing, the next sample may be analyzed.

8 Quality control

8.1 At the beginning and end of a set of samples, the density of pure isooctane is measured.

8.2 The measured density of isooctane should differ from the standard value of 0.6954 g/mL (at 60 ^{o}F) by no more than 0.0003 g/mL. Note that density measurements are extremely sensitive to sample contamination.

8.3 If the measured density of isooctane falls outside the acceptable range, the instrument cell should be carefully cleaned and dried. If a second analysis fails, a new bottle of isooctane should be opened. If a third analysis fails, the instrument should be recalibrated.

9 References

1. "Standard Test Method for Distillation of Petroleum Products (Designation D86-96(2002)e1)," *Annual Book of ASTM Standards*, Vol 05.02.

2. "DMA 48 Instruction Handbook," Anton-Paar GmbH, Graz, Austria, 1995.

10. Standard Operating Procedure Revision History

Version 1.0: Adopted 6/1/96.

Version 1.1: Adopted 4/1/06.

Section 1.2 modified to include the current ASTM method.

Section 5.1 modified to acknowledge the use of other temperatures for special projects.

Section 6.2 modified to reflect the FRS's ability to keep the sample cell clean.

Section 6.10 modified to remove the unnecessary step of rerinsing the cell if bubbles in the deionized water are observed.

Section 7.1 modified to allow the use of the FRS with diesel samples. Studies in the lab have confirmed that the FRS has no problem with diesel samples.

Section 8.2 modified to correct the literature density of isooctane.