

AIR RESOURCES BOARD

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

SOP NO. MLD 126

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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 liquid at 60 °F with vapor pressures below 600 torr and viscosities below 1500 mm²/s at 60 °F.
- 1.3 This SOP is based on ASTM D4052-96(2002)e¹.

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 4500 with optional sample handling unit.
- 3.2 Luer cone syringes for manual sample introduction.

4 Reagents

- 4.1 Isooctane, A.C.S. reagent grade or better.

4.2 Deionized water.

5 **Preparation of Instrument**

5.1 No special preparation of the instrument is required.

6 **Calibration**

6.1 Calibration (also referred to as adjustment in the instrument manual) must be performed when the instrument is first installed, and as required when quality control checks indicate a need.

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 hexane can be run through the instrument as a normal sample (see section 7) to clear out any residue.

6.3 Press the menu key and select the menus “adjustment”, “adjust”, and “density (air, water)” using the up, down, and enter keys.

6.4 Start the air adjustment by pressing the OK key.

6.5 Press the enter key and enter the current air pressure.

6.6 Wait until the air adjustment is finished.

6.7 Fill the measuring cell with freshly deionized water, checking for the presence of bubbles through the viewing window.

6.8 Start the water adjustment by pressing the OK key.

6.9 Wait until the water adjustment is finished. After pressing the OK key the deviation of the new adjustment from the last adjustment performed is displayed at a density of 1 g/mL.

6.10 The adjustment is saved by selecting “save” after “recommendation:save” is displayed.

7 Procedure

- 7.1 Check to make sure that the rinse bottle(s) contain sufficient isooctane before beginning analyses.
- 7.2 If necessary, press the “method” key to switch the analysis method to the proper temperature.
- 7.3 Press the “sample#” key. Enter the sample identification using the external keyboard.
- 7.4 Place the inlet hose into a large quantity of the sample (preferably the original container). Activate the FRS by pressing and holding the “s-start” key.
- 7.5 After the FRS is finished pumping, put the inlet hose into the waste bottle. Use the instrument’s window to quickly check for bubbles. If bubbles are present, eject the sample from the cell by pressing and holding the “esc” key and repeat step 7.4.
- 7.4 When the instrument display begins flashing, the density can be recorded.
- 7.5 The sample handling unit will automatically wash the cell with isooctane 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 °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.

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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 4500 Instruction Manual," Anton-Paar GmbH, Graz, Austria, 2006.

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.

Version 2.0: Adopted 10/1/07 to reflect the use of DMA 4500 instrumentation.

Section 3.1 modified to reflect new hardware.

Section 3.3 deleted – the DMA 4500 uses factory-provided tubing.

Section 4.1 on methanol deleted. Methanol is no longer used as a rinsing solvent.

Section 5 on instrument preparation replaced with a statement that preparation is not required.

Section 6 completely revised to reflect new hardware.

Section 7 completely revised to reflect new hardware.

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Version 2.1: Adopted 1/1/09.

Section 6.1 modified to require calibration only when needed rather than after a specific interval. In over 12 years of experience with this method, there has never been a demonstrated need for recalibration, nor has annual calibration provided any improvement in data quality.