



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

SOP MV-FUELS-126  
Version 3.2  
Effective Date: December 1, 2019

Fuels Analysis and Methods Evaluation Section  
Chemical Analysis and Emissions Research Branch  
Mobile Source Laboratory Division

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# SOP MV-FUEL-126 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 mm<sup>2</sup>/s at 60 °F.
- 1.3 This SOP is based on American Society for Testing and Materials (ASTM) D4052-96(2002)e<sup>1</sup>.

## 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 that meets the requirements of ASTM D4052-96(2002)e<sup>1</sup> and the California Air Resources Board (CARB) Enforcement Division needs.
- 3.2 Luer cone syringes for manual sample introduction.

## 4 Reagents

- 4.1 Isooctane, American Chemical Society (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 (sometimes referred to as adjustment in the instrument manual and menus) 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.

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With ordinary, proper use of the filling and rinsing system (FRS) there should not be any residue. If necessary, a solvent such as hexane can be run through the instrument as a normal sample (see section 7) to clear out any residue.

- 6.3 Select calibration from the instrument menu and use the air/water option.
- 6.4 Start the air measurement.
- 6.5 If necessary, enter the current air pressure.
- 6.6 Wait until the air measurement 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 measurement.
- 6.9 Wait until the water measurement 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 If necessary, choose the option to save the new calibration.

### 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 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.

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## 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 0.6955 g/mL (at 60 °F) or 0.6959 (at 15 °C) by no more than 0.0006 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

- 9.1 "Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter (Designation D4052-96(2002)e<sup>1</sup>)," *Annual Book of ASTM Standards*, Vol 05.02, 2005.
- 9.2 Manufacturer's instruction manuals.

## 10. Revision History

- 10.1 Version 1.0: Effective Date: 6/1/1996.
- 10.2 Revision 1.1: Effective Date: 4/1/2006.

Significant changes:

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.

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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.

10.3 Version 2.0: Effective Date: 10/1/2007

Significant changes:

Changes were made 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.

10.4 Revision 2.1: Effective Date: 1/1/2009.

Significant changes:

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.

10.5 Version 3.0: Effective Date: 5/1/2017.

Significant changes:

Removed all references to manufacturers, brands and models.

Changed the instructions in section 6 to be generic rather than instrument-specific.

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10.6           Version 3.1:           Effective Date: 1/1/2018

Section 8.2 changed to reflect the correct tolerance for QC results, as well as documenting the density value for isooctane at 15 °C.

10.7           Version 3.2:           Effective Date: 12/1/2019

SOP format updated for ADA compliance