



Evaluation of Wildland Fire Chemicals

Standard Test Procedures

STP 4.3 Density

Summary: When working with wildland fire chemicals, the density is most frequently used as an indicator of the salt content of a product that previously has been tested and correlation tables developed. Another important use of the density is to calculate safe loading of the aircraft used to deliver the products to the fire.

Several methods are used to determine the density of a liquid. The method of choice will depend on several factors including the required accuracy of the measured value, the number of measurements to be performed, and the consistency of the liquid.

For most applications, the density of wildland fire chemicals can be measured using an electronic density meter. Sometimes the consistency of the product is too dense to be injected into the density meter without possible damage to the meter. In that case, a pycnometer or specific gravity bottle is used to determine the weight of a precisely known volume of liquid. Straightforward calculations are performed to obtain the density. When a less accurate value and time to obtain the value has a higher priority, a similar measurement can be obtained by weighing a syringe filled with liquid to a specific volume mark on the syringe.

These methods are described in the following pages.

STP-4.3a	Density Determination Using an Electronic Meter
STP-4.3b	Calibration of the Electronic Meter
STP-4.3c	Density Determination Using a Pycnometer or Specific Gravity Bottle
	STP-4.3d
	Calibration of the Pycnometer or Specific Gravity Bottle
STP-4.3e	Density Determination Using a Syringe

STP 4.3a Electronic Density Meter

Summary: An electronic density meter can be used to determine the density of most wildland fire chemicals. Density of the concentrate or mixed product is an indirect measure of the salt content of the product. Density is also a concern as it relates to the weight of material that an aircraft can safely carry and drop-in support of fire operations.

Equipment:

Electronic density meter 5-mL syringe

Calibration standard (usually room temperature distilled water)

Method:

1. Calibrate the density meter following the directions provided in the standard test procedure.
2. Draw a sample of fire chemical into a 5-mL syringe being careful not to draw in air bubbles.
3. Insert the syringe tip into the meter opening and gently push the sample into the meter. This serves to rinse the oscillator tube.
4. Draw a second sample of fire chemical into the syringe and push about half of the volume into the meter.
5. Allow the meter to stabilize. There should be no air bubbles in the syringe or the meter's oscillator tube.
6. Do not take the reading when the sample is being pushed into the meter.
7. Record the density and temperature.
8. Repeat steps 2 through 7 to obtain at least 3 density values.
9. Record the highest of the values obtained as the density.
10. Clean the meter by pushing several syringes full of clean, distilled water through the meter ensuring that all residual sample is removed.
11. Pull as much water as possible out of the meter using the same syringe.
12. Turn the meter off.

Caution: Do not allow sample to stand in the meter. If the product starts to dry in the meter, it is extremely difficult to remove.

Reference: American Society for Testing and Materials. Standard Test Method for Density and relative Density of Liquids by Digital Density Meter; D4052-96(2002).

4.3b Electronic Density Meter – Calibration

Summary: Electronic density meters provide a convenient method to determine the density of many samples; however, they must be calibrated to assure accurate readings.

Equipment:

Electronic density meter

Instruction manual for density meter

5-mL syringe

Calibration standard (usually room temperature distilled water)

Method:

1. Draw a sample of distilled water into a 5-mL syringe being careful not to draw in air bubbles.
2. Insert the syringe tip into the meter opening and gently push the distilled water into the meter. This serves to rinse the oscillator tube.
3. Draw a second sample of distilled water into the syringe and push about half of the volume into the meter.
4. Allow the meter to stabilize. There should be no air bubbles in the syringe or the meter's oscillator tube.
5. Read the density and temperature from the meter's display.
6. Compare these values with the values on the density/temperature chart.
7. If the density is high or low for the given temperature (according to the chart), adjust the meter according to the manufacturer's instruction manual.
8. Repeat steps 3 through 7 until three repeat readings agree with the values on the density temperature chart to within 0.001 g/cm^3 .
9. Pull as much water as possible out of the meter using the same syringe.
10. Turn the meter off.

Caution: Do not allow samples to stand in the meter. Dried samples, even of distilled water, can affect the reliability of the meter.

C°	Density (g/cm ³)
15	0.99910
16	0.99894
17	0.99878
18	0.99860
19	0.99841
20	0.99821
21	0.99799
22	0.99777
23	0.99754
24	0.99730
25	0.99705

4.3c Density - Pycnometer

Summary: This procedure is used to determine the densities of fire retardants that are either too dense or contain high particulate, making it impossible to use the density meters. This method is more accurate than the syringe method.

Equipment:

Pycnometers with lids, marked Balance, readable to 0.1 mg

Method:

1. Select pycnometer flasks for the test, ensuring that each has a lid with a matching unique identification.
2. Calibrate the pycnometer/lid sets using the method on the following page.
3. Ensure that the liquid to be tested has been thoroughly, but gently stirred and that any entrained air has been removed.
4. Weigh each empty pycnometer/lid set and record the weight.
5. Carefully pour the test material into a pycnometer. The liquid should come nearly to the rim of the pycnometer.
6. Carefully place the lid straight onto the flask.
7. Firmly and evenly seat the lid on the flask. A small amount of liquid should appear from the hole in the lid.
 - a. If the flask was properly filled, a slight amount of liquid will come out of the hole in the lid.
 - b. If no liquid appears from the hole in the lid, remove the lid, add more liquid, and repeat the process.
8. Carefully wipe the excess fluid from the lid with a disposable wipe.
9. Looking through the lid, ensure that there is no air bubble remaining on the surface of the liquid.
10. Weigh the flask, lid, and test sample and record the weight.
11. Repeat the process with additional flasks and samples.
12. Wash, dry, and carefully store all flasks and lids.
13. Calculate the sample weight by subtracting the weight of the empty flask and lid from the weight of the full flask and lid.
14. Calculate the density by dividing the sample weight by the flask volume determined during the calibration step.
15. Average all replicates and report the final density.

4.3d Density – Pycnometer Calibration

Summary: Glass pycnometers can be used to determine the density of a liquid, but they must be calibrated to determine the volume of a unique flask and lid combination prior to use with test samples.

Equipment:

Pycnometers, at least 3 sets of flasks and lids Balance, readable to 0.1 mg

Thermometer

Method:

1. Match a lid to each flask, ensuring a good fit between the parts.
2. Mark each piece with a glass etcher and record the identity of each set.
3. Weigh each empty pycnometer flask and lid and record the weight.
4. Carefully pour distilled water into each flask being careful to eliminate bubbles in the flask. The flask should be filled to about 1/8 inch to 1/4 inch below the rim.
5. Put the lid straight down onto the flask, firmly (but not strong-arm) pressing the lid down into the flask
6. There should be enough sample volume that a small amount comes out through the hole in the lid and there is no air captured within the flask.
7. Wipe excess fluid from the lid with a disposable tissue. The sample should be flush with top of lid.
8. Weigh the full flask and lid and record weight.
9. Determine the temperature of the distilled water and record.
10. Determine the weight of distilled water in the flask by subtracting the weight of the empty flask/lid from the weight of the full flask/lid.
11. Empty and dry each flask and lid between tests. A pipe cleaner works well to dry the hole in the lid.
12. Using the temperature/density chart below, determine the density of the distilled water at the measured temperature.
13. Determine the volume of the flask by dividing the weight of the distilled water by the density of the distilled water at the measured temperature.
14. Repeat steps 3 through 12 at least 3 times for each flask. Average the results and record the volume for each flask/lid set.

4.3e Density – Syringe Method

Summary: Use this test method to determine the densities of products which cannot go through the density meter or which cannot be easily cleaned from pycnometers. This method can be fairly accurate, depending on the choice of syringe capacity, and the syringes can be disposed of easily. The method is essentially the same as with a pycnometer.

Equipment:

3-5 mL disposable syringes (preferred) or up to 50 mL for crude measurements Balance, readable to 0.1 mg (preferred) or 1.0 mg for crude measurements

Method:

1. Place an empty syringe on the balance and zero the balance.
2. Fill syringe to a predetermined mark (i.e. 2 ml or 3 ml) with test product.
3. Weigh and record result.
4. Discard the syringe.
5. Repeat Steps 1-4, 5 times or until consistent weights are obtained.
6. Find the density (g/cm^3) of each sample by dividing the weight of the test product by the volume mark used to fill the syringe.
7. Find the mean of all trials.
8. Examine the data for outlying values; recalculate the mean of the trials without the outlying values.
9. Sign and date the test sheet. Clearly show the mean value to use for further testing. Show all data and note reasons for eliminating any values.