METHOD 310

DETERMINATION OF VOLATILE ORGANIC COMPOUNDS (VOC) IN CONSUMER PRODUCTS AND REACTIVE ORGANIC COMPOUNDS (ROC) IN AEROSOL COATING PRODUCTS

(Including Appendix A)

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METHOD 310

DETERMINATION OF VOLATILE ORGANIC COMPOUNDS (VOC) IN CONSUMER PRODUCTS AND REACTIVE ORGANIC COMPOUNDS (ROC) IN AEROSOL COATING PRODUCTS

(Including Appendix A)

1 APPLICABILITY

1.1 This method (Method 310) applies to the determination of the percent by weight of:

   (1) volatile organic compounds (VOC) in consumer products, antiperspirant and deodorant products, as those terms are defined in Title 17, California Code of Regulations (CCR), Division 3, Chapter 1, Subchapter 8.5 (Consumer Products), commencing with sections 94500 and 94508, and

   (2) low vapor pressure-volatile organic compounds (LVP-VOC) as that term is defined in section 94508(a), and

1.2 This method (Method 310) applies to the determination of product weighted maximum incremental reactivity (PWMIR) of aerosol coating products, as that term is defined in Title 17, CCR, section 94521.

1.3 Method 310 determines the total volatile material in a product and the presence of any compounds prohibited by ARB regulations ("prohibited compounds"). Components of the product that do not meet the definition of a VOC or are exempted by ARB regulations for a specific product category ("exempt compounds") are subtracted from the total volatile material to determine the final VOC content for the product. Method 310 is also used to determine the percent by weight of the ROCs contained in aerosol coating products, for the purpose of determining compliance with the Regulation for Reducing the Ozone Formed from Aerosol Coating Product Emissions, Title 17, CCR, sections 94520 to 94528 (the "Aerosol Coating Products Regulation").

1.4 Method 310 does not apply to the determination of the composition or concentration of fragrance components in products.

1.5 The term "Executive Officer" as used in this document means the Executive Officer of the Air Resources Board or his or her authorized representative.
TEST METHODS

Method 310 incorporates by reference the following ASTM International, (ASTM), National Institute for Occupational Safety and Health (NIOSH), and United States Environmental Protection Agency (US EPA) analytical test methods:


2.5 ASTM D859-00: Standard Test Method for Silica in Water (determination of polymethylsiloxyanes after digestion) (June 10, 2000).

2.6 ASTM D3074-94: Standard Test Methods for Pressure in Metal Aerosol Containers (November 15, 1994) with the modifications found in Appendix A to this Method 310.

2.7 ASTM D3063-94: Standard Test Methods for Pressure in Glass Aerosol Bottles (November 15, 1994) with the modifications found in Appendix A to this Method 310.


2.10 Gas Chromatography/Mass Spectrometry for Volatile Organics (analysis of exempt and prohibited compounds in the product by headspace/gas chromatography/mass spectrometry).


3 CONSUMER PRODUCTS TESTING PROCEDURE

3.1 The testing begins when the Executive Officer selects a product for analysis by Method 310. The Executive Officer will maintain sample chain of custody throughout the selection and analytical process.
3.2 Initial Testing of Aerosol Products

If the sample is an aerosol product, the aerosol propellant is separated from the non-propellant portion of the product by using ASTM D3074-94 (as modified in Appendix A for metal aerosol container) or ASTM D3063-94 (as modified in Appendix A for glass aerosol container). The propellant portion is analyzed for exempt or prohibited compounds by using US EPA Reference Method 18. The remaining non-propellant portion of the product is then analyzed as specified in section 3.3.

3.3 Initial Testing of Non-Aerosol Products and the Non-Propellant Portion of Aerosol Products

The non-aerosol product or non-propellant portion of an aerosol product is analyzed to determine the total volatile material present in the sample and to determine the presence of any exempt or prohibited compounds. This analysis is conducted by performing the following tests:1

3.3.1 Gravimetric analysis of samples to determine the weight percent of total volatile material, using US EPA Reference Methods 24/24A, ASTM D2369-01.

3.3.2 Determination of sample water content. For determination of water content either ASTM D4017-96a, or ASTM D3792-99 may be used, or results from both procedures may be averaged and that value reported.

3.3.3 Determination of ammonium content using ASTM D1426-98 or US EPA Method 300.7.

3.3.4 Determination of ketones and alcohol content using NIOSH Method 1400.

3.3.5 Analysis of exempt and prohibited compounds, if present (US EPA Reference Method 18, US EPA Method 8240B, US EPA Method 8260B, ASTM D859-00, NIOSH Method 1400). Effective January 1, 2015, for nonaerosol “Multi-purpose Solvent” and “Paint Thinner” products sold, supplied, offered for sale, or manufactured for sale in the South Coast Air Quality Management District, analysis of exempt and prohibited compounds shall include analysis for methyl esters with 17 or more carbon atoms, if present.

3.3.6 If LVP-VOC status is claimed or the analysis indicates the presence of an LVP-VOC component and the percent VOC is not in compliance, the Executive Officer will request formulation data as specified in Section 3.5.2.

1 Alternate test methods may be used, as provided in section 7.0


3.4 Prohibited Compounds

If the sample is found to contain compounds prohibited by ARB regulations (i.e., ozone-depleting compounds) at concentrations equal to or exceeding 0.1 percent by weight, the Executive Officer will reanalyze the sample for confirmation.

3.5 Initial Determination of VOC Content

The Executive Officer will determine the VOC content pursuant to sections 3.2 and 3.3. Only those components with concentrations equal to or greater than 0.1 percent by weight will be reported.

3.5.1 Using the appropriate formula specified in section 4.0, the Executive Officer will make an initial determination of whether the product meets the applicable VOC standards specified in ARB regulations. If initial results show that the product does not meet the applicable VOC standards, the Executive Officer may perform additional testing to confirm the initial results.

3.5.2 If the results obtained under section 3.5.1 show that the product does not meet the applicable VOC standards, the Executive Officer will request the product manufacturer or responsible party to supply product formulation data. The manufacturer or responsible party shall supply the requested information. Information submitted to the ARB Executive Officer may be claimed as confidential; such information will be handled in accordance with the confidentiality procedures specified in Title 17, California Code of Regulations, sections 91000 to 91022.

3.5.3 If the information supplied by the manufacturer or responsible party shows that the product does not meet the applicable VOC standards, then the Executive Officer will take appropriate enforcement action.

3.5.4 If the manufacturer or responsible party fails to provide formulation data as specified in section 3.5.2, the initial determination of VOC content under this section 3.5 shall determine if the product is in compliance with the applicable VOC standards. This determination may be used to establish a violation of ARB regulations.
3.6 Determination of the LVP-VOC status of compounds and mixtures. This section does not apply to antiperspirants and deodorants or aerosol coatings products. Effective January 1, 2015, this section also does not apply to nonaerosol “Multi-purpose Solvent” and “Paint Thinner” products sold, supplied, offered for sale, or manufactured for sale in the South Coast Air Quality Management District. There is no LVP-VOC exemption for these products.

3.6.1 Formulation data. If the vapor pressure is unknown, the following ASTM methods may be used to determine the LVP-VOC status of compounds and mixtures: ASTM D86-01 (August 10, 2001), ASTM D850-00 (December 10, 2000), ASTM D1078-01 (June 10, 2001), ASTM D2879-97 (April 10, 1997), ASTM D2887-01 (May 10, 2001) and ASTM E1719-97 (March 10, 1997).

3.6.2 LVP-VOC status of “compounds” or “mixtures.” The Executive Officer will test a sample of the LVP-VOC used in the product formulation to determine the boiling point for a compound or for a mixture. If the boiling point exceeds 216°C, the compound or mixture is an LVP-VOC. If the boiling point is less than 216°C, then the weight percent of the mixture which boils above 216°C is an LVP-VOC. The Executive Officer will use the nearest 1 percent distillation cut that is greater than 216°C as determined under 3.6.1 to determine the percentage of the mixture qualifying as an LVP-VOC.

3.7 Final Determination of VOC Content

If a product’s compliance status is not satisfactorily resolved under sections 3.5 and 3.6, the Executive Officer will conduct further analyses and testing as necessary to verify the formulation data.

3.7.1 If the accuracy of the supplied formulation data is verified and the product sample is determined to meet the applicable VOC standards, then no enforcement action for violation of the VOC standards will be taken.

3.7.2 If the Executive Officer is unable to verify the accuracy of the supplied formulation data, then the Executive Officer will request the product manufacturer or responsible party to supply information to explain the discrepancy.

3.7.3 If there exists a discrepancy that cannot be resolved between the results of Method 310 and the supplied formulation data, then the results of Method 310 shall take precedence over the supplied formulation data. The results of Method 310 shall then determine if the product is in compliance with the applicable VOC standards, and may be used to establish a violation of ARB regulations.
4 CALCULATION OF VOC CONTENT

This section specifies the procedure for determining the final VOC content of a product, which is reported as percent by weight of VOC. Effective January 1, 2015, for nonaerosol “Multi-purpose Solvent” and “Paint Thinner” products sold, supplied, offered for sale, or manufactured for sale in the South Coast Air Quality Management District (SCAQMD) the final VOC content is reported as grams of VOC per liter of material (g/L) as set forth in section 4.2.4.

4.1 Aerosol Products

4.1.1 For aerosol products, except those containing LVP-VOC, the percent VOC content shall be calculated using the following equation:

\[
\text{% VOC} = \frac{WL \times (TV - A - H - EL) + WP - EP}{WL + WP} \times 100
\]

Where:\n
\begin{align*}
WL &= \text{weight (g) of the non-propellant portion, excluding container and packaging.} \\
TV &= \text{weight fraction of non-propellant total volatile material.} \\
A &= \text{weight fraction of ammonia (as NH}_4\text{) in the non-propellant portion.} \\
H &= \text{weight fraction of water in the non-propellant portion.} \\
EL &= \text{weight fraction of exempt compounds in the non-propellant portion.} \\
WP &= \text{weight (g) of propellant.} \\
EP &= \text{weight (g) of exempt compounds in propellant.}
\end{align*}

\[2\text{Alternate test methods, as provided in section 7.0, or appropriate approved methods from section 2.0 may be used.}\]
4.1.2 For aerosol products containing LVP-VOC, the percent VOC shall be calculated using the following equation:

\[ \% \ VOC = \frac{WL [(1 - H)(1 - LVP) - EL] + (WP - EP)}{WL + WP} \times 100 \]

Where:

LVP = weight fraction of LVP-VOC compounds and/or mixtures in the non-propellant, non-aqueous portion.

1 – H = weight fraction of the non-propellant portion that does not contain water.

1 – LVP = weight fraction of the non-propellant, non-aqueous portion that is volatile.

4.2 Non-Aerosol Products

4.2.1 For non-aerosol products, except those containing LVP-VOC, the percent VOC content shall be calculated using the following equation:

\[ \% \ VOC = (TV - A - H - EL) \times 100 \]

4.2.2 For non-aerosol products containing LVP-VOC, the percent VOC shall be calculated using the following equation:

\[ \% \ VOC = [(1 - H)(1 - LVP) - EL] \times 100 \]

4.2.3 For Fabric Softener – Single Use Dryer Product, the grams of VOC per sheet shall be calculated as follows:

Total Grams VOC per Sheet = (TV – A – H – EL) × WS

Total Grams VOC per Sheet with LVP = [(1 – H)(1 – LVP) – EL] × WS

Where:

WS = weight of single dryer sheet in grams
4.2.4 Effective January 1, 2015, for nonaerosol “Multi-purpose Solvent” and “Paint Thinner” products sold, supplied, offered for sale, or manufactured for sale for use in the SCAQMD, grams of VOC per liter of material (g/L) shall be calculated using the following equation:

\[
g/L \text{ VOC} = \frac{WM \times (TV - H - EL)}{VM}
\]

Where:

\begin{align*}
WM & \quad \text{weight of the material in grams.} \\
VM & \quad \text{volume of the material in liters.} \\
TV & \quad \text{weight fraction of total volatile material.} \\
H & \quad \text{weight fraction of water.} \\
EL & \quad \text{weight fraction of exempt compounds including the weight fraction of methyl esters with 17 or more carbon atoms in the total volatile material.}
\end{align*}

4.3 Consumer products subject to low VOC limits (below 5.0%) may have their VOC content characterized by a low level direct determination.

4.3.1 For aerosol products the percent VOC content may be calculated using the following equation:

\[
\% \text{ VOC} = \frac{WL \left( \sum V_n \right) + WP - EP}{WL + WP} \times 100
\]

Where:

\begin{align*}
V & \quad \text{weight fraction of non-exempted VOCs in the non-propellant portion.} \\
n & \quad \text{number of non-exempted VOCs in the non-propellant portion.} \\
WL & \quad \text{weight (g) of the non-propellant portion, excluding container and packaging.} \\
WP & \quad \text{weight (g) of propellant.} \\
EP & \quad \text{weight (g) of exempt compounds in propellant.}
\end{align*}
4.3.2 For non-aerosol products the percent VOC content shall be calculated using the following equation:

\[ \% \text{ VOC} = \left[ \sum V_n \right] \times 100 \]

5 TESTING TO DETERMINE REACTIVE ORGANIC COMPOUNDS (ROC) IN AEROSOL COATING PRODUCTS

This section specifies the procedure for determining the percent by weight of the reactive organic compounds (ROC) contained in aerosol coating products, for the purpose of determining compliance with the Aerosol Coating Products Regulation.

5.1 The testing begins when the Executive Officer selects a product for analysis. The Executive Officer will maintain sample chain of custody throughout the selection and analytical process. When a product is selected for testing, the Executive Officer will request the product manufacturer or responsible party to supply the product formulation data specified in Title 17, CCR, section 94526(b)(1). The manufacturer or responsible party shall supply the requested information within 25 working days. Information submitted to the Executive Officer may be claimed as confidential; such information will be handled in accordance with the confidentiality procedures specified in sections 91000 to 91022, Title 17, CCR.

5.2 Initial Testing of the Propellant Portion of Aerosol Coating Products

The aerosol propellant is separated from the non-propellant portion of the product by using ASTM D 3074-94 (as modified in Appendix A for metal aerosol container) or ASTM D 3063-94 (as modified in Appendix A for glass aerosol container). The propellant portion is analyzed for ROCs and other compounds by using US EPA Reference Method 18. The remaining non-propellant portion of the product is then analyzed as specified in section 5.3.

5.3 Initial Testing of the Non-Propellant Portion of Aerosol Coating Products

The non-propellant portion of the product sample is analyzed to determine the ROCs in the sample, including the presence of any prohibited compounds. This analysis is conducted by performing the following tests:\(^3\)

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\(^3\) Alternate test methods may be used, as provided in section 7.0
5.3.1 Gravimetric analysis of samples to determine the weight percent of total volatile material, using US EPA Reference Methods 24/24A, ASTM D 2369-01.

5.3.2 Determination of sample water content. For determination of water content either ASTM D 4017-96a, or ASTM D 3792-99 may be used, or results from both procedures may be averaged and that value reported.

5.3.3 Determination of ammonium content using ASTM D 1426-98 or US EPA Method 300.7.

5.3.4 Determination of ketones and alcohol content using NIOSH Method 1400.

5.3.5 Direct determination of ROCs and, if present, prohibited compounds (US EPA Reference Method 18, US EPA Method 8240B, US EPA Method 8260B, ASTM D859-00, NIOSH Method 1400, and modified ASTM D5443-04).

5.3.6 Determination of metal content using ASTM D5381-93 (2009).

5.3.7 Determination of specular gloss using ASTM D523-08 (2008).

5.3.8 Determination of acid content using ASTM D1613-06 (2006).

5.4 Prohibited Compounds

If the sample is found to contain compounds prohibited by the Aerosol Coating Products Regulation (e.g., ozone-depleting compounds) at concentrations equal to or exceeding 0.1 percent by weight, the Executive Officer will reanalyze the sample for confirmation.

5.5 Initial Determination and Verification of ROC Content

The Executive Officer will determine the ROC content by verifying formulation data pursuant to sections 5.2 and 5.3. Only those components with concentrations equal to or greater than 0.1 percent by weight will be reported.

5.5.1 Based on manufacturer’s formulation data and the analysis conducted under section 5, the Executive Officer will make an initial determination of whether the product meets the applicable requirements specified in the Aerosol Coating Products Regulation. If initial results show that the product does not meet the applicable requirements, the Executive Officer may perform additional testing to confirm the initial results.

5.6 Final Determination of ROC Content

If a product’s status is not satisfactorily resolved under section 5.1 - 5.5, the Executive Officer may conduct additional analyses and testing as necessary to verify the formulation data.
5.6.1 If the Executive Officer is unable to verify the accuracy of the supplied formulation data, then the Executive Officer will request the product manufacturer or responsible party to supply additional information to explain the discrepancy.

5.6.2 If the additional information supplied by the manufacturer or responsible party shows that the product does not meet the applicable requirements, then the Executive Officer will take appropriate enforcement action.

5.6.3 If the manufacturer or responsible party fails to provide additional information as specified in section 5.6.1, the initial determination of ROC content under section 5.1 – 5.5 shall determine if the product is in compliance with the applicable reactivity limits. This determination may be used to establish a violation of the Aerosol Coating Products Regulation.

5.6.4 If there exists a discrepancy that cannot be resolved between the results of Method 310 and the formulation data or additional information supplied by the manufacturer or responsible party, then the results of Method 310 shall take precedence over the supplied formulation data or additional information. The results of Method 310 shall then determine if the product is in compliance with the applicable requirements, and may be used to establish a violation of the Aerosol Coating Products Regulation.

6  METHOD PRECISION AND ACCURACY

6.1 The precision of Method 310 for determining VOC content was evaluated using seven representative products with known volatile organic compound (VOC) contents ranging from 6.2 to 81.2 percent VOC by weight. Each sample was divided into six portions, and each portion was separately analyzed to determine the VOC content. Based on the results of this analysis, the 95 percent confidence interval for Method 310 is 3.0 percent by weight (Wt/Wt%).

6.2 For determining the percent by weight of the individual ingredients in aerosol coating products, the precision and accuracy of the determination for each ingredient is governed by the precision and accuracy of the test method used to ascertain the percent by weight of each ingredient.

7  ALTERNATE TEST METHODS

Alternative test methods which are shown to accurately determine the concentration of VOCs or constituent components in antiperspirant/deodorants, consumer products, or aerosol coating products (or their emissions) may be used upon written approval of the Executive Officer.
Method 310 - Appendix A

PROPELLANT COLLECTION PROCEDURES

1 APPLICATION

The procedure applies to modify ASTM D3074-94 and D3063-94 to allow collection of the propellant for analysis and density measurement for metal aerosol containers and glass aerosol containers, respectively. These modified procedures also retain the aerosol standard terminology listed in ASTM D3064-97.

2 LIMITATIONS

Nitrogen analysis: Nitrogen may be used as a component of the propellant system. Ambient air is 78 percent nitrogen and may be present as a contaminant in the system prior to sample collection. This is eliminated by sweeping out any connecting lines to the Tedlar bag with product before starting sample collection. This procedure will eliminate or reduce nitrogen contamination to less than 0.1% by weight of the sample and the analysis of the propellant gas will be unaffected.

3 APPARATUS AND MATERIALS

3.1 Propellant Collection System: See Figure 1 (metal containers) and Figure 3 (glass containers).

3.2 Tedlar Bags equipped with slip valve and septum.

3.3 Density Measurement

3.3.1 250 mL gas dilution bulb, or

3.3.2 Density/Specific gravity meter meeting the following minimum specifications:

3.3.2.1 Measurement Range: 0 – 3 +/- 0.00001 g/cm3

3.3.2.2 Measurement Temperature Range: 4°C ~ 70°C.

3.4 Balance, capable of accurately weighing to 0.1 mg

3.5 Sample Venting Platform. See Figure 2 (metal containers)\(^1\) and Figure 4 (glass containers)\(^2\).

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\(^1\) See SOP SAS05, Figures 3 and 4.
\(^2\) See SOP SAS05, Figure 7.
3.6 Platform Shaker, equivalent to Thermolyne M49125

3.7 Cork Rings, 80 x 32 mm

4 PROEDURE

4.1 Propellant Collection for Metal Aerosol Containers

4.1.1 Close valves on Propellant Collection System (see Figure 1).

4.1.2 Remove the actuator from valve on the aerosol can and weigh can to the nearest 0.01 g.

4.1.3 Place the can in an inverted position onto the Sample Venting Platform, stabilized by cork rings.

4.1.4 Slowly raise the hydraulic jack until the can is pierced. Note the pressure of the can.

4.1.5 Vent the can until propellant is seen flowing from output 1. Collect the propellant in the Tedlar bag from output 1. Density is determined from this same Tedlar bag, as necessary.

4.1.6 After the propellant is collected, close and remove the Tedlar bag and vent the remainder of the propellant.

4.1.7 After the flow ceases from the can, it is removed from the assembly and allowed to vent overnight on a platform shaker, to vent the remainder of the propellant.

4.1.8 Reweigh the can to the nearest 0.01 g and record weight loss (total grams propellant). The can may now be opened for analysis of the non-propellant portion of the sample.

4.2 Propellant Collection for Glass Aerosol Containers

4.2.1 Remove the actuator from valve of the aerosol glass container and weigh container to the nearest 0.01 g.

4.2.2 With container in an inverted position place the valve onto the tapered adaptor.

4.2.3 Pressurize the air cylinder to actuate the sample container valve onto the tapered adaptor. Note the pressure of the sample container.

4.2.4 Open the sample valve and collect propellant sample into the Tedlar bag. Density is determined from this same Tedlar bag, as necessary.
4.2.5 After the propellant is collected, close and remove the Tedlar bag and vent the remainder of the propellant.

4.2.6 Continue to vent the container on the platform assembly until no pressure registers on the sample gauge and there is no visible propellant flowing from the sampling tube.

4.2.7 Remove the container from the platform.

4.2.8 Punch a small hole into the container valve assembly.

4.2.9 Place the container on a platform shaker to vent the remainder of the propellant.

4.2.10 Reweigh the container and valve assembly to the nearest 0.01 g and record weight loss (total grams propellant). The non-propellant portion of the sample is ready to be analyzed.
FIGURE 1

PROPELLANT COLLECTION SYSTEM
METAL AEROSOL CONTAINER

[Diagram of the propellant collection system with labeled parts such as valve 1, pressure gauge, aerosol can, corks ring, pressure regulator, rotometer, sample in, valve 2, Tedlar Bag, etc.]
FIGURE 2

SAMPLE VENTING PLATFORM

METAL AEROSOL CONTAINER
FIGURE 3

PROPELLANT COLLECTION SYSTEM
GLASS AEROSOL CONTAINER
FIGURE 4

SAMPLE VENTING PLATFORM

GLASS AEROSOL CONTAINER