NARRATIVE REPORT

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Report Date: February 22, 2005
Client: Samuel J. Goldberg, American Formulation & Manufacturing
Product I.D.: 10252Q Safecoat Cabinet & Trim Enamel Semigloss Paint
Manufacturer's I.D.: 10252Q Batch-JR74
Production Date: October 14, 2004
Product Received: November 10, 2004
Report Prepared By: R.S. Tannous, Laboratory Director

Report Approved By: _____ **Date:** 2/24/05
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OBJECTIVE

The objective of this test was to measure the emissions of formaldehyde and total volatile organic compounds (TVOC) from a white cabinet & trim enamel semigloss paint sample at 24 hours. The test conformed to the guidance of the Japanese Industrial Standard, JIS A 1901 (2003), "Determination of the emission of volatile organic compounds and aldehydes for building products-Small chamber method."

SUMMARY

The white cabinet & trim enamel semigloss paint was tested for emissions of formaldehyde and TVOC. The test specimen was prepared by applying 4.5 grams of the enamel semigloss paint to a 178-mm x 178-mm (0.0316 m^2) stainless steel plate with a roller. The enamel semigloss paint was allowed to cure for one hour before transferring to the test chamber. The environmental parameters for the test were 28±1°C temperature, 50±5% relative humidity and 1.0±0.05 air change rate. Measurements of chamber VOC concentrations were made at 24 hours after initiating the test. Area-specific emission rates (EF_a) were calculated by mass balance. The enamel semigloss paint did not emit formaldehyde above the lower limit of quantitation of <2.1 µg m^{-2} h^{-1}. The TVOC area-specific emission rate was 1,157 µg m^{-2} h^{-1}.

METHODS

Description of Product Specimen

On November 10, 2004, the laboratory received a product sample consisting of a container of white cabinet & trim enamel semigloss paint. The sample was identified as: manufacture's ID # 10252Q Batch-JR74; product name Safecoat Cabinet & Trim Enamel Semigloss; sample ID 10252Q/JR74; manufacturing date 10/14/04. The sample was handled in accordance with BAA-SOP-2000.02, "Selection, Collection and Handling of Material Specimens for Testing to Determine the Emissions of Volatile Organic Compounds." On February 10, 2005, the container was opened. The enamel semigloss paint was first thoroughly mixed in its container by stirring. Approximately 100 ml volume was transferred to an aluminum tray. A paint

roller with a 10-cm cover was saturated with enamel semigloss paint by running the roller back and forth in the tray. The enamel semigloss paint was applied to one side of a 178-mm x 178-mm (0.0316 m^2) stainless steel plate using four strokes, two in the vertical direction and two in the horizontal direction, so that the entire area was uniformly covered. 4.5 Grams of enamel semigloss paint were applied in a single film. The coated surface area was 0.0316 m^2. Thus, the product loading was 142.4 g m^{-2}. The test specimen was allowed to dry for one hour before placing it on an open wire shelf in the test chamber.

GC/MS Analysis of TVOC

The methods used for the sampling and analysis of VOCs are based on U.S. EPA Methods TO17, "Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes" and TO1, "Determination of Volatile Organic Compounds in Ambient Air using Tenax Adsorption and Gas Chromatography/Mass Spectrometry (GC/MS)."

The multisorbent samplers (Model No. ST-032, Envirochem, Inc.) used for the collection of VOC samples contain Tenax-TA, Ambersorb XE-340 and activated charcoal, in series. With these samplers, C_4 to C_{16} nonpolar and moderately polar volatile organic compounds (VOCs), and many C_1 to C_3 compounds, depending upon functional group, are quantitatively collected. Highly reactive and very volatile compounds, such as formaldehyde, cannot be analyzed using these samplers.

The samplers are thermally desorbed, and the samples are introduced into a Hewlett-Packard 5971A GC/MS system using a UNACON 810 concentrating system (Envirochem, Inc.). Prior to analysis, an internal standard (ISTD) is added to each sampler. The ISTD is 121 ng of bromofluorobenzene (BFB). The ISTD is used to check on the operation of the system, to provide a retention-time marker, and for quantitative analysis. The GC/MS is operated in the SCAN mode over a mass range of *m/z* 33-300.

For the quantitative analysis of total VOCs (TVOC) in a sample, the GC/MS total-ion-current (TIC) chromatogram is integrated over a retention-time (RT) interval of 15 - 50 minutes using parameters that capture almost all of the TIC area in a sample. The integrated areas less the area of the ISTD are summed. The mass of the compounds represented by the sum is calculated relative to the known amount of the ISTD that is added to the sampler. The calculation uses the response factor for toluene relative to BFB. This relative response factor (RRF) is 2.03. Because there can be substantial variation in the TIC response of different classes of compounds, the measurement of TVOC is less accurate than the calibrated measurement of individual VOCs.

Formaldehyde Analysis

The methods used for the sampling and analysis of formaldehyde and other carbonyl compounds are based on ASTM Method D-5197, "Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)."

Sep-Pak XPoSure Aldehyde Samplers (Part number WAT047205, Waters, Corp.) are used to collect air samples for formaldehyde and other low-molecular weight carbonyl compounds. Air is pulled through a sampler, and the acidified 2,4-dinitrophenylhydrazine (DNPH) reagent in the sampler reacts with carbonyl compounds to form the stable hydrazone derivatives that are retained by the sampler. The hydrazone derivatives are eluted from a sampler with acetonitrile. An aliquot of the sample is analyzed for the hydrazone derivatives of formaldehyde and acetaldehyde using reverse-phase high-performance liquid chromatography (HPLC) with UV detection. The absorbance of the derivatives is measured at 360 nm. The mass responses of the resulting peaks are determined using multi-point calibration curves prepared from standard solutions of the hydrazone derivatives.

Testing for Emissions of VOCs from Products Using Small-Volume Chambers

The methods used for the measurement of emissions of VOCs from this product specimen are based on the Japanese Industrial Standard, JIS A 1901 (2003), "Determination of the emission of volatile organic compounds and aldehydes for building products-Small chamber method," English edition.

The chamber consists of a 67-L, stainless steel cylindrical vessel with a stainless-steel lid equipped with three fittings. The chamber is held in an incubator that is maintained at 28±1^{o} C. Purified air from a clean air generator is introduced into the chamber through one fitting with a stainless-steel tubing extension. The inlet flow rate of 1.12±0.06 standard L min^{-1} is regulated with electronic mass-flow controllers (calibrated at 25^{o} C and 1 atm. pressure). The gas stream is split into two streams. One of these is passed through a bubbler containing distilled water. This saturated gas stream is mixed with the dry gas stream to produce a humidified gas stream with a relative humidity (RH) of 50±5% that is then introduced into the chamber. A humidity probe (Model HMD 30YB, Vaisala) is inserted into the chamber through a second fitting on the lid. Chamber temperature and humidity are measured and recorded throughout the test. Gas exits and is sampled for the analytes of interest at the other fitting on the lid. Atmospheric pressure at the laboratory is near 1 atm. Prior to use, the chamber and fittings are cleaned by washing them with hot water and a detergent.

A clean, empty chamber is operated at the same testing conditions for at least three hours prior to a test. Chamber background concentrations are measured. Then, the chamber is opened and the material specimen is positioned on a wire rack approximately near the center of the chamber. To initiate a test, the chamber is sealed and ventilated. At specified times, gas samples are collected at the chamber exhaust. The sample flow rates are regulated with electronic mass-flow controllers (calibrated at 25^{o} C and 1 atm. pressure). Samples for VOCs are collected on multisorbent samplers at a flow rate of 100 standard cm^{3} min^{-1}. Aldehyde samples are collected on XPoSure Aldehyde Samplers at a flow rate of 0.65 standard L min^{-1}. For this test, a 1.2-L gas sample for the analysis of TVOC and a 78-L sample for the analysis of formaldehyde were collected 24-h after initiating the test period. The parameters for the emissions test are summarized in Table 1.

Table 1. Parameters for a VOC emission test conducted in a small-scale environmental chamber.

Parameter	Value
Chamber volume, m^{3}	0.067
Enamel substrate	Stainless steel
Substrate dimensions, mm	178 x 178
Coated surface area, m^{2}	0.0316
Loading ratio, m^{2} m^{-3}	0.472
Weight of enamel applied, g	4.5
Inlet flow rate, m^{3} h^{-1}	0.067 ± 0.003
Average temp, ^{o}C	28 ± 1
Atmosphere	Humidified Air
Average humidity, %RH	50 ± 5
Test duration, h	24

Data Analysis and Reporting for Emissions Tests

Steady-state emission rates (µg h^{-1}) are calculated for the quantified compounds using the following equation:

$$ER = Q (C - C_o) \quad (1)$$

where Q is the volumetric flow rate (m^3 h^{-1}) through the chamber; C is the average chamber concentration for the sampling interval (µg m^{-3}); and C_o is the chamber blank or inlet gas concentration (µg m^{-3}). An area-specific emission rate or emission factor, EF_a (µg m^{-2} h^{-1}) is calculated by dividing the emission rate by A, the exposed planar surface area of the product (m^2).

$$EF_a = ER / A \quad (2)$$

RESULTS

Emissions of TVOC and formaldehyde

The 24-h chamber sample was quantitatively analyzed for TVOC and formaldehyde. The chamber concentration and area-specific emission rate results are presented Table 2. The chamber blank formaldehyde concentration was below the quantitation limit of 1 µg m^{-3}. The enamel semigloss paint sample formaldehyde chamber concentration was also below the lower limit of quantitation of 1 µg m^{-3}.

Table 2. Chamber concentrations and emission factors of TVOC and formaldehyde measured at 24 hours for a test of 10252Q/JR74 Safecoat Cabinet & Trim Enamel Semigloss Paint.

Compound	Chamber Conc. (µg m^{-3})	Emission Factor (µg m^{-2} h^{-1})
TVOC	546	1,157
Formaldehyde	ND	ND