

Industrial Hygiene Report
Control of Glycol Ether Solvent Fumes Using Activated Carbon Filter Media:

Ethylene Glycol Monobutyl Ether

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Abstract

A study of organic vapor containment for a model glycol ether compound is reported. Glycol ethers are frequently used as reduced volatility solvent alternatives to lighter organic congeners. The prevalence of monoalkylated glycol ethers in a range of applications, and the regulation of worker exposure to this compound, prompted the investigation of a Sentry Air Systems filtration system for control of a model solvent vapor. For this study, a Sentry Air Systems Ductless Containment Hood equipped with activated carbon filter media was used for the containment of a representative glycol ether based carburetor cleaner. The collected data and analytical results suggest that the use of Sentry Air Systems Ductless Containment Hood with activated carbon filter media promotes healthy operator breathing conditions that are well within mandated exposure limits.

Background

Ethylene Glycol Monobutyl Ether, EGBE — Glycol ethers, such as EGME (IUPAC¹ systematic name: 2-butoxyethanol), comprise a class of compounds based on ethylene or propylene glycol derivatives.² The high boiling point and low volatility of glycol ethers, as well as their tunable polarity, uniquely suits these solvents for a range of applications including printing inks, degreasers, anti-freeze fluids, and as a co-solvent in aqueous coating systems.³ Recently, glycol ethers have been studied for application as a primary component of biodiesel mixtures.⁴ Although glycol ether solvents possess low volatility and a mild odor, the health impact from acute⁵ and chronic⁶ exposure carries considerable

¹ [International Union of Pure and Applied Chemistry](#).

² The ethylene and propylene glycol derivatives are commonly classified as the “e-series” and “p-series”, respectively. See <http://www.glycol-ethers.eu/what-are-glycol-ethers> (Accessed 8 September 2014)

³ Cheremisinoff, N. P. Glycol Ethers. In *Industrial Solvents Handbook, Revised and Expanded*, 2nd ed.; CRC Press: U.S.A., 2003.

⁴ Dayong, A. J.; Yun, B. B. Performances on engine-out emissions and combustion of ethylene glycol monobutyl ether palm oil monoester as a newtype biodiesel. *Journal of Renewable and Sustainable Energy* **2012**, *4*, 053118-1 – 053118-10.

⁵ Boatman, R.; Kelsey, J.; Ball, N. Acute toxicity classification for ethylene glycol mono-*n*-butyl ether under the Globally Harmonized System. *Regulatory Toxicology and Pharmacology* **2014**, *68*, 41–50.

risk, including pulmonary edema, liver and kidney damage, and adverse neurological and blood effects.⁷ The characteristic sweet taste of glycol ethers presents a significant danger to children, and has been linked to incidents of acute exposure, including metabolic acidosis, upon ingestion of glycol based solutions such as brake fluid.⁸ While the EPA⁹ has not classified glycol ethers for carcinogenicity, researchers continue to investigate tumorous liver activity that may be linked to metabolites of certain glycol ethers.¹⁰ A typical route of exposure to glycol ethers in the work place occurs during cleaning operations with floor and furniture polishing solutions.¹¹ In 2006 the European Commission established exposure limits for a range of glycol ethers,¹² including an 8 hour TWA¹³ value for EGBE of 20 ppm. In the United States, OSHA¹⁴ set the permissible occupational exposure limit (PEL) value for EGBE at 50 ppm (8 hr TWA), while NIOSH¹⁵ recommends a TWA value ≤ 5 ppm.¹⁶ Due to the broad range of applications associated with glycol ethers, Sentry Air Systems investigated the application of Sentry Air Systems 30" Wide Ductless Containment Hood equipped with activated carbon filter media as a primary source capture solution for EGBE.

Test Design

To test the efficacy of Sentry Air Systems Ductless Containment Hood for capture of EGBE, a representative carburetor cleaning application was simulated to produce an enriched concentration of the desired analyte, EGBE. Using a containment hood equipped with a standard Sentry Air Systems 300 Series Mounted Sentry air cleaner, air sampling was conducted to evaluate filter efficiency and air quality at multiple locations. The sampling of air at the inlet and outlet of the fume extractor system, as well as the

⁶ Starek-Swiechowicz, B.; Miranowicz-Dzierzawska, K.; Szymczak, W.; Budziszewska, B.; Starek, A. Hematological effects of exposure to mixtures of selected ethylene glycol alkyl ethers in rats. *Pharmacological Reports*, **2012**, *64*, 166-178.

⁷ See <http://www.epa.gov/ttn/atw/hlthef/glycolet.html> (Accessed 8 September 2014)

⁸ Wang, G. S.; Yin, S.; Shear, B; Heard, K. Severe Poisoning After Accidental Pediatric Ingestion of Glycol Ethers. *Pediatrics* **2012**, *130*, e1026-1029.

⁹ [Environmental Protection Agency](http://www.epa.gov).

¹⁰ Gehlhaus III, M. W.; Gift, J. S.; Hogan, K. A.; Kopylev, L.; Schlosser, P. M.; Kadry, A. Approaches to cancer assessment in EPA's Integrated Risk Information System. *Toxicology and Applied Pharmacology* **2011**, *254*, 170-180.

¹¹ Wieslander, G; Norbäck, D. A field study on clinical signs and symptoms in cleaners at floor polish removal and application in a Swedish hospital. *Int. Arch. Occup. Environ. Health* **2010**, *83*, 585-591; Fromme, H.; Nitschke, L.; Boehmer, S.; Kiranoglu, M.; Göen, T. Exposure of German residents to ethylene and propylene glycol ethers in general and after cleaning scenarios. *Chemosphere* **2013**, *90*, 2714-2721.

¹² The values were established based on the recommendation of the Scientific Committee on Occupational Exposure Limits Values (SCOEL). For a tabulated listing of glycol ethers with exposure limit values, see <http://www.glycol-ethers.eu/regulations/indicative-exposure-limits> (Accessed 8 September 2014)

¹³ Time Weighted Average.

¹⁴ [Occupational Safety and Health Administration](http://www.osha-slc.gov).

¹⁵ [National Institute for Occupational Safety and Health](http://www.niosh.gov).

¹⁶ See https://www.osha.gov/dts/chemicalsampling/data/CH_222400.html (Accessed 8 September 2014)

ambient room space, allows for meaningful comparisons of relevant EGBE concentrations.

For this test, a small engine part was submerged in a constant temperature bath containing *ca.* 3 L of Chem-Dip[®] Carburetor and Parts Cleaner solution¹⁷ for more than two hours. The uncovered bath was enclosed in the SS-330-DCH for the duration of the experiment and pre-warmed to 40°C prior to activation of the sampler pumps. The stainless steel basket liner was occasionally agitated to simulate conventional parts cleaning activity.

The sampling method conforms to NIOSH Test Method 1403,¹⁸ which recommends a sample volume range between 2 – 10 L and a sampling rate of 0.01 – 0.05 L/min. The guidelines were used to determine a target sample volume of 5.0 L, while sampling at 0.04 L/min, to ensure sufficient analyte loading for subsequent prescribed instrumental analysis.

Test Equipment and Setup

The evaluation of the filter efficiency was performed using a 30” Wide Sentry Air Systems Ductless Containment Hood (SS-330-DCH). The SS-330-DCH was configured with a standard carbon pre-filter pad (SS-300-CFP), and a 10 lb. activated carbon filter (SS-310-CF) without previous usage or modification performed. The stated configuration is representative standard equipment recommended by Sentry Air Systems for most applications where volatile organic carbon compounds (VOCs) are a concern. Similar to the previously reported SAS activated carbon filtration systems,¹⁹ the capture of chemical vapors is accomplished through a well-defined van der Waals adsorption, or physisorption.²⁰

Air sampling was conducted using personal air sampler pumps (Universal XR Pump Model PCXR4, SKC Inc.), each calibrated with a Bios DryCal Defender 510 primary flow calibrator (MesaLabs). The flow rate of each sampler was measured to comply with the NIOSH Method 1403 test protocol requirements. The sampler flow rates were recorded both before and after testing (Table 2) to ensure pump stability within the specified NIOSH requirement ($\% \text{RSD} \leq 5\%$). Total sample volume size was calculated using the integrated sampler pump timer and the average calibrated flow rates (Table 3).

Consistent with the prescribed test parameters, each sampler was configured with a flow rate of *ca.* 40 mL/min, and continuously operated for a total collection time of *ca.* 130 minutes. The collection pumps were equipped with a sample train consisting of an Anasorb CSC sorbent sample tube connected in series with an adjustable low flow

¹⁷ Contains ~10% 2-butoxyethanol. The Safety Data Sheet (SDS) for the cleaning solution is appended to the manuscript.

¹⁸ Collection and analysis of the samples was accomplished using NIOSH Method 1403. For additional details, see appended transcript of the method.

¹⁹ For Sentry Air Systems in-house test data for a range of VOCs see <http://sentryair.com/data.htm>

²⁰ Bansal, R. C.; Goyal, M. Adsorption Energetics, Models, and Isotherm Equations. In [*Activated Carbon Adsorption*](#), CRC Press: U.S.A., 2005.

holder.²¹ Test samples were collected without interruption at four locations during the test. Definitions of the test points can be found in Table 1 below.

Table 1. Defined sample collection locations for EGBE testing.

T1A & T2A	Located in the interior of the hood 6 inches below the fan filter unit inlet port; tube intake end directed perpendicular to EGBE bath surface
T1B	Located on the exterior of the hood, just above the fan filter unit outlet port; tube intake end directed perpendicular to exhaust airflow
T1C	Located on a shelf in the working space approximately two meters from the containment hood in the breathing zone of the operator; sampling was completed prior to EGBE exposure to establish background room air conditions.
T1D & T2D	Located on a shelf in the working space approximately two meters from the containment hood in the breathing zone of the operator; sampling was activated concurrent with EGBE exposure to establish test room air conditions
Blank	Consists of a sorbent sample tube of the identical lot number and exposure to testing conditions, however, no dynamic air sampling was performed.

At the onset of the model part cleaning process, a small engine carburetor was immersed completely in a 3L stainless steel digital heater ultrasonic cleaning bath. The constant temperature bath was filled to capacity with Chem-Dip[®] Carburetor and Parts Cleaner solution and pre-warmed to 40°C. The temperature was maintained at 40°C for the duration of the testing period, and the stainless steel interior holding basket was agitated manually every 15-20 minutes, sufficiently to disrupt surface tension. To ensure a detectable vapor load, the cleaning bath was not covered with the stainless steel lid for the experimental time period. The SS-330-DCH air cleaner was powered to the maximum air flow setting concurrent with the contained EGBE application. The cleaning process was continued for 130 minutes without interruption, followed by post-test flow rate calibration and sealing of the sorbent sample tubes. Under identical conditions, the cleaning operation was repeated without powering the SS-330-DCH air cleaner and air sampling only at the application (T2A) and ambient room (T2D) test points. The sealed samples were labeled and couriered to a certified analytical lab for testing. The laboratory extracted and analyzed the sample sorbent tubes for EGBE content and reported the results in milligrams (mg) of EGBE. The mass data was converted to a concentration value in mg/m³ using the calibrated air flow sampler data (See Table 2).

²¹ Coconut shell charcoal: 70 mm length x 6 mm dia. size; 2-section, 50/100 mg sorbent media. P/N 226-01; SKC Gulf Coast Inc. (Houston TX)

Data/Findings

Table 2. Sampling flow rate data and collected EGBE mass.

Test Point	Sampling Time, min	Ave. Flow Rate, mL/min	% RSD Flow Rate*	Mass EGBE, mg
T1A	130	38.065	0.72%	0.30
T1B	130	37.300	0.85%	< 0.003
T1C	98	38.847	0.78%	< 0.003
T1D	130	38.297	0.29%	< 0.003
T2A	135	38.053	0.35%	2.1
T2D	135	38.371	0.95%	0.024
Blank	N/A	N/A	N/A	< 0.003

*Percent Relative Standard Deviation of sample flow rate calculated from pre-test and post-test flow rates.

Table 3. Calculated sampling volume and EGBE concentration values using SS-330-DCH.

Test Point	Sample Volume, L	[EGBE], mg/m ³	[EGBE], ppm*	% Filter Efficiency**
T1A	4.948	63	13	≥ 99.0%
T1B	4.849	< 1	< 0.2	
T1C	3.807	< 1	< 0.2	
T1D	4.979	< 1	< 0.2	

*Parts per million based on mass. **Calculated from inlet and outlet EGBE mass data.

Table 4. Calculated sampling volume and EGBE concentration values without fume extraction.

Test Point	Sample Volume, L	[EGBE], mg/m ³	[EGBE], ppm*	% Relative [EGBE] Increase
T2A	5.137	410	85	N/A
T2D	5.180	4.6	0.96	480%

*Parts per million based on mass.

Results Summary

HIH Laboratory (Webster, TX) prepared the collected samples and measured EGBE content using gas chromatography analysis with flame ionization detection (GC-FID). In accordance with the instrumental technique, the detection limit for EGBE is 0.003 mg, or 1.0 mg/m³. Therefore, for samples containing immeasurable quantities of EGBE, a concentration less than or equal to the detection limit of GC-FID analysis is assumed.

The collected EGBE mass data and calculated concentrations for the testing samples are summarized in Tables 2 and 3. Lab analysis determined 0.30 mg of EGBE at test point T1A, which corresponds to an enclosure EGBE concentration of about 63 mg/m³ (13 ppm). The sample analysis at the filter outlet port, T1B, suggests an immeasurable quantity of EGBE, indicating an analyte concentration that is below the method detection limit (MDL) of the GC-FID instrumental method. Based on the measured difference in

concentration across the filter stack, and basing the outlet test point concentration on the reported detection limit values, the indicated filter efficiency for EGBE using Sentry Air Systems Ductless Containment Hood with activated carbon filter media is $\geq 99\%$. During the course of the test, the ambient room EGBE concentration remained unchanged and below the detection limit of the GC-FID analysis (See T1C and T1D entries).

For comparison to room air conditions in the absence of containment, the identical cleaning process was conducted with the Sentry Air Systems air cleaner unpowered. The sample analysis of the application and ambient room test points are outlined in Table 4. As expected, in the absence of negative pressure, the EGBE concentration above the cleaning bath solution increased significantly from 63 mg/m^3 to 410 mg/m^3 (T1A and T2A, respectively). Likewise, the ambient room EGBE concentration was increased nearly five-fold, from a sub-MDL level of less than 1 mg/m^3 to 4.6 mg/m^3 (T1D and T2D, respectively).

Conclusions and Considerations

The study results presented herein suggest that the use of a Sentry Air Systems Ductless Containment Hood configured with activated carbon filter media would prove beneficial in reducing operator exposure to acute and chronic health hazards associated with prolonged exposure to EGBE. Furthermore, effective application of the aforementioned equipment for processes in which EGBE is a significant solution component, may reduce operator EGBE exposure to a concentration substantially below the OSHA and NIOSH permissible and recommended limits.¹⁶ Under this investigation, the 99% efficiency rating of the fan filter unit is consistent with the solvent capture properties of activated carbon filter media,²⁰ and similar results are expected to be observed for the series of Sentry Air Systems air cleaning products.

Luke Turner
Chemical Applications Specialist
Sentry Air Systems



Material Safety Data Sheet

Section 1 – Product and Company Identification

Product Name: Chem-Dip® Carburetor & Parts Cleaner

Product Synonym: CD-A-Int

Product Numbers: 0996

Product Description: Parts dip cleaner

Manufacturer: Berryman Products, Inc.
3800 E Randol Mill Rd
Arlington, TX 76011
(800) 433-1704 within USA
(817) 640-2376 outside USA
www.BerrymanProducts.com

Emergency Contact: Infotrac, Inc., (800) 535-5053

Section 2 – Hazards Identification

Emergency Overview: Eye and skin irritant. Harmful if swallowed.

Routes of Exposure: Ingestion, eye contact, skin contact

Possible Health Hazards

Eyes: Acute contact may cause moderate to severe irritation of the eyes and result in conjunctivitis, blurred vision, and corneal damage. Prolonged contact may result in chemical burns, tissue damage, and blindness.

Skin: May cause mild to moderate irritation of the skin. Prolonged or repeated contact may dry the skin and result in moderate to severe irritation, dermatitis, and effects similar to those of chronic overexposure by way of inhalation.

Inhalation: Acute overexposure is unlikely but may result in respiratory tract irritation, headache, dizziness, nausea, and vomiting. Chronic overexposure or intentional abuse may also adversely affect the liver and kidneys.

Ingestion: Ingestion of small quantities may result gastrointestinal effects, such as abdominal discomfort, pain, nausea, and vomiting. Ingestion of large quantities may adversely affect the liver and kidneys.

Supplemental Information: See “Section 11 – Toxicological Information” for additional information.

Section 3 – Composition / Information on Ingredients

<u>Ingredient</u>	<u>CAS Number</u>	<u>Weight</u>
2-(2-Butoxyethoxy)ethanol	112-34-5	<10%
2-Butoxyethanol	111-46-2	<10%
Ethoxylated Alkyl Amines	mixture	1-5%
Heterocyclic and Aliphatic Amines	Mixture	15-20%

Section 4 – First Aid Measures

Eye Contact: Immediately flush eyes with water for at least 15 minutes, holding eyelids apart at regular intervals to ensure complete irrigation. Dispose of contaminated contact lenses. Seek medical attention if irritation persists.

Skin Contact: Remove contaminated clothing, and wash affected areas of body thoroughly with soap and water. Rinse clothing and launder before reuse. Seek medical attention if irritation persists.

Inhalation: If breathing difficulties occur, remove source of exposure or move victim to fresh air and administer oxygen, if necessary. If symptoms persist, seek immediate medical attention. If breathing stops, give artificial respiration and seek medical attention immediately.

Ingestion: Do *not* induce vomiting unless otherwise directed by a medical professional. Dilute stomach contents by drinking 1-2 cups of fruit juice or water. Seek medical attention immediately.

Section 5 – Firefighting Measures

Flash Point and Method: >200°F by Setaflash closed-cup tester

Flammability Limits (composite): Lower – N/A Upper – N/A

Suitable Extinguishing Media: All, including water fog, foam, dry chemical, and carbon dioxide

Unsuitable Extinguishing Media: N/A

Protective Equipment: Employ SBCA and full protective gear, including shield, as sealed product may vent, rupture, or explode violently at elevated temperatures.

Specific Procedures: Move product from area if possible without risk of injury. Use water spray to cool nearby containers.

Section 6 – Accidental Release Measures

General Remediation Overview: Eye and skin irritant. Thoroughly ventilate area.

Personal Precautions: Avoid unnecessary contact with product.

Environmental Precautions: Prevent further loss of product if safely possible.

Methods for Containment: Use booms or other barriers as necessary to prevent further loss.

Methods for Cleaning Up: For small spills, mop up or absorb with inert material, such as corn cob, cellulose, or vermiculite. For large spills, pump or transfer material into containers for recovery and use absorbent material for collection of unrecoverable product.

Section 7 – Handling and Storage

Handling: Avoid contact with skin and eyes. Wash hands thoroughly after use.

Storage: Store in cool, dry location.

Section 8 – Exposure Controls / Personal Protection

<u>Ingredient</u>	<u>Exposure Limit</u>	<u>Source</u>
2-(2-Butoxyethoxy)ethanol	NE	N/A
2-Butoxyethanol	20 ppm	ACGIH
Ethoxylated Alkyl Amines	NE	N/A
Heterocyclic and Aliphatic Amines	NE	N/A

Engineering Controls: Use outside with adequate ventilation to minimize exposure.

Respiratory Protection: If necessary, use respiratory protection sufficient to reduce exposure to permissible limits.

Eye Protection: Use of safety with wrap-around lens or goggles is recommended.

Skin Protection: Employment of impermeable gloves is recommended.

Other Protection: For industrial settings, combination safety shower with eye wash station is recommended.

Section 9 – Physical and Chemical Properties

Physical State: Liquid

Appearance: Clear, dark amber

Odor: Mild, solvent

Freezing Point: 0°F (approximate)

Boiling Range: 212-600°F (approximate)

Specific Gravity: 1.035-1.040 at 68°F

pH: 10-11, as supplied

Solubility in Water: Infinite

Volatile Content: 70-75%

Evaporation Rate: same as water

Vapor Density: Heavier than air

Vapor Pressure: 0 PSI at 68°F

VOC Content (Commercial): 20% by weight (210 g/L) (by EPA Method 24)

VOC Content (Consumer): 10% by weight (100 g/L) (by CARB Method 310)

VOC Composite Partial Pressure, PP_c: 0.07 mm Hg at 68°F (as calculated by SCAQMD Rule 1171(B)(57))

Section 10 – Stability and Reactivity

Chemical Stability: Stable under normal conditions.

Incompatible Materials: Nitrites, strong acids, strong oxidizers

Hazardous Decomposition Products: None under normal conditions of use. Thermal decomposition may yield nitrogen oxides, carbon monoxide, and carbon dioxide as well as various nitrogenated and oxygenated organics.

Possibility of Hazardous Reactions: Negligible

Section 11 – Toxicological Information

General Information: This formulated product has not been evaluated for toxicological properties. Acute toxicity is anticipated to be low to moderate, depending on route of exposure. Chronic toxicity is also expected to be low to moderate.

Acute Toxicity: No specific data available on blend

Chronic Toxicity: No specific data available on blend

Carcinogenicity: N/A

Teratogenicity: N/A

Mutagenicity: N/A

Supplemental Information: See “Section 2 – Hazards Identification” of this MSDS for additional information.

Section 12 – Ecological Information

Ecotoxicity: This product is not anticipated to be ecologically significant in small amounts.

Persistence and Degradability: All ingredients have environmentally favorable biodegradation profiles and are not expected to be persistent.

Bioaccumulation Potential: None

Section 13 – Disposal Considerations

Disposal Instructions: None specific. Dispose of waste in accordance with applicable regulations.

Section 14 – Transportation Information

US Department of Transportation (DOT): In any size container shipped by ground, this product is *not* considered a hazardous material and is therefore *not* DOT-regulated.

International Air Transportation Association (IATA): In any size container shipped by air, this product is *not* considered a dangerous good and is therefore *not* IATA-regulated.

Section 15 – Regulatory Information

FEDERAL CONSIDERATIONS

SARA Title III, Section 302 – Extremely Hazardous Substances: Neither this product nor any of its components appear on the list of extremely hazardous substances (EHS) found in §40 CFR 355 Appendices A and B and are not subject to the emergency planning (EPCRA) requirements of §40 CFR 355.30 or the reportable quantity (RQ) and threshold planning quantity (TPQ) requirements of §40 CFR 355 Appendices A and B.

SARA Title III, Section 304 – Hazardous Substances: This product does not contain any components found in the list of hazardous substances of §40 CFR Table 302.4.

SARA Title III, Sections 311/312 – Hazard Classes: This product contains one or more ingredients that are classified into the following hazard categories outlined in §40 CFR 370.40:

immediate (acute) health; delayed (chronic) health

SARA Title III, Section 313 – Toxic Chemicals: This product contains the following chemicals listed in the table of §40 CFR 372.65 exceeding the *de minimis* concentration reporting requirements of §40 CFR 372.38:

Certain Glycol Ethers (CAS #s 111-76-2 and 112-34-5)

Section 15 – Regulatory Information (continued)

FEDERAL CONSIDERATIONS (continued)

Clean Air Act, Section 183(e) – Consumer and Commercial Products: This product complies with the National Volatile Organic Compound Emission Standards for Consumer Products regulations found in §70 FR 69759.

Toxic Substances Control Act (TSCA): All chemicals known to be present in this product are either listed on the TSCA inventory or are not required to be per §15 USC 2601, et seq.

Occupation Safety and Health Administration (OSHA): This material safety data sheet is provided for compliance with applicable regulations of the Hazard Communication Standard (HCS) found in §29 CFR 1910.1200(g). Federal law requires persons receiving this document to study it carefully and become aware of the hazards of this product. Notify all employees, visitors, agents, and contractors of the information on this sheet.

Consumer Product Safety Commission (CPSC): If sold in the United States, this product is regulated under the Federal Hazardous Substances Act, is subject to the labeling requirements of 16 CFR 1500, and must include the following cautionary statements: Eye and skin irritant. Harmful if swallowed. Keep out of the reach of children.

REGIONAL CONSIDERATIONS

Lake Michigan Air Directors Consortium (LADCO): Complies with category VOC requirement

Ozone Transport Commission (OTC): Complies with category VOC requirement

STATE CONSIDERATIONS

California: This product is compliant with the category VOC requirements of §94509 of Subchapter 8.5 Article 2 of the Air Resource Board's "Regulation for Reducing Emissions from Consumer Products."

This product is *not* subject to the labeling requirements of "Proposition 65 – Safe Drinking Water and Toxic Enforcement Act of 1986" ("Prop 65").

New Jersey: For Right-To-Know ("RTK") labeling requirements, refer to "Section 3 – Composition / Information on Ingredients."

Section 16 – Other Information

Hazardous Materials Identification System (HMIS)

HMIS Hazard Rating	HMIS Hazard Index
Health 1	Least - 0
Flammability 1	Slight - 1
Reactivity 0	Moderate - 2
Protective Equipment X	High - 3
	Extreme - 4

Index of Abbreviations

ACGIH – American Council of Governmental and Industrial Hygienists

IARC – International Agency for Research on Cancer

N/A – Not applicable

NE – Not established

NIOSH – National Institute for Occupational Safety and Health

NTP – National Toxicology Program

PEL – Permissible Exposure Limit (as required by OSHA)

TLV – Threshold Limit Value (as recommended by ACGIH)

Date of Issuance: 7-11-2012

Date of Previous Revision: 11-30-2011

Primary Revision Change(s): General update

Applicability: This document only applies to part number 0996 manufactured on or after January 1, 2011.

Prepared By: Dan Nowlan

Legal Disclaimer: The information contained in this document is, to the best of Berryman Products, Inc.'s knowledge, complete and accurate but is not warranted. All materials may present unknown hazards and should be used with caution. It is the responsibility of the user to evaluate the information in a prudent manner and to use it in a manner consistent with its intended purpose. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.

ALCOHOLS IV

1403

(1) HOCH ₂ CH ₂ OCH ₃	MW: (1) 76.09	CAS: (1) 109-86-4	RTECS: (1) KL5775000
(2) HOCH ₂ CH ₂ OCH ₂ CH ₃	(2) 90.12	(2) 110-80-5	(2) KK8050000
(3) HOCH ₂ CH ₂ O(CH ₂) ₃ CH ₃	(3) 118.17	(3) 111-76-2	(3) KJ8575000

METHOD: 1403, Issue 3

EVALUATION: FULL

Issue 1: 15 August 1990

Issue 3: 15 March 2003

OSHA: See Table 1

PROPERTIES: See Table 1

NIOSH: See Table 1

ACGIH: See Table 1

SYNONYMS: (1) 2-methoxyethanol: methyl cellosolve, ethylene glycol monomethyl ether, EGME
 (2) 2-ethoxyethanol: cellosolve, ethylene glycol monoethyl ether, EGEE
 (3) 2-butoxyethanol: butyl cellosolve, ethylene glycol monobutyl ether, EGBE

SAMPLING		MEASUREMENT	
SAMPLER:	SOLID SORBENT TUBE (Coconut shell charcoal, 100 mg/50 mg)	TECHNIQUE:	GAS CHROMATOGRAPHY, FID
FLOW RATE:	0.01 to 0.05 L/min	ANALYTE:	2-methoxyethanol, 2-ethoxyethanol, and 2-butoxyethanol
VOL-MIN:	(1) 6 L (2) 1 L (3) 2 L	DESORPTION:	1 mL methylene chloride/methanol (95:5) in an ultrasonic bath for 30 minutes
-MAX:	50 L 6 L 10 L	INJECTION VOLUME:	1 µL
SHIPMENT:	Routine	TEMPERATURE	
SAMPLE STABILITY:	30 days @ 5°C	-INJECTION:	225°C
BLANKS:	2 to 10 field blanks per set	-DETECTOR:	300°C
		-COLUMN:	40°C (1 min) - 200°C (12°C/min)
		CARRIER GAS:	He, 2.5-3.0 mL/min
		COLUMN:	Capillary, fused silica, 30 m x 0.32-mm ID; crossbonded carbowax®-DA or equivalent
		CALIBRATION:	Solutions of analytes in desorption solvent
		RANGE:	(1) 2 to 387 µg (2) 2 to 373 µg (3) 3 to 361 µg
		ESTIMATED LOD:	(1) 0.8 µg/sample (2) 0.7 µg/sample (3) 1.0 µg/sample
		PRECISION (S_r):	(1) 0.024 (2) 0.022 (3) 0.048
ACCURACY			
RANGE STUDIED:	See Table 2.		
BIAS:	See Table 2.		
OVERALL PRECISION (S_{r,r}):	See Table 2.		
ACCURACY:	See Table 2.		

APPLICABILITY: The working range for 2-methoxyethanol was 0.095 to 204 ppm (0.33 to 64.5 mg/m³) for a 6-L sample volume, for 2-ethoxyethanol was 0.053 to 99 ppm (0.20 to 373 mg/m³) for a 1-L sample, and for 2-butoxyethanol was 0.3 to 36.8 ppm (1.5 to 180 mg/m³) for a 2-L sample.

INTERFERENCES: Any compounds having similar retention times as the analytes of interest.

OTHER METHODS: This method is an improved update of NMAM 1403, issue 2 (15 August 1994) [1]. NMAM 1403 (15 August 1994) previously combined and replaced methods S76 [2], S79 [2], and S361 [3]. Other less sensitive methods include OSHA 79 [4] and OSHA 83 [5].

REAGENTS:

1. Methylene Chloride, HPLC chromatographic grade.*
2. Methanol, HPLC chromatographic grade.*
3. Desorption solvent: methylene chloride (HPLC chromatographic grade) containing 5% methanol.
4. 2-methoxyethanol, reagent grade.
5. 2-ethoxyethanol, reagent grade.
6. 2-butoxyethanol, reagent grade.
7. Helium, purified and filtered.
8. Hydrogen, filtered.
9. Air, compressed, purified, filtered.

* See SPECIAL PRECAUTIONS

EQUIPMENT:

1. Sampler: glass tube, 7 cm long, 6-mm OD, 4-mm ID, flame-sealed ends, containing two sections of activated coconut shell charcoal (100 mg/50 mg) separated by a 2-mm urethane foam plug. A silylated glass wool plug precedes the front section and follows the back section. Tubes are commercially available from SKC, Inc.
2. Personal sampling pump, 0.01 to 0.05 L/min, connected with flexible tubing.
3. Gas chromatograph, FID, integrator, and capillary column (page 1403-1).
4. Autosampler vials, 11-mm glass with crimp caps.
5. Syringes, 10- μ L, 25- μ L, and 1-mL.
6. Volumetric flasks, 10-mL.

SPECIAL PRECAUTIONS: Methylene chloride is a carcinogen [6]. Methanol is very flammable.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling. Attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.01 and 0.05 L/min for a total sample size of 6 to 50 L (2-methoxyethanol); 1 to 6 L (2-ethoxyethanol); and 2 to 10 L (2-butoxyethanol).
NOTE: Maximum flow rate for 2-methoxyethanol and 2-butoxyethanol is 0.2 L/min.
4. Cap the samplers with plastic (not rubber) caps and pack securely for shipment.

SAMPLE PREPARATION:

5. Place the front and back sorbent sections of the sampler tube in separate vials. Place the glass wool preceding the front section into the vial containing the front sorbent section. Discard the remaining foam plugs.
6. Add 1.0 mL of the desorption solvent into each vial. Attach crimp caps to each vial.
7. Place the sample vials in an ultrasonic bath for 30 minutes.

CALIBRATION AND QUALITY CONTROL:

8. Calibrate daily with at least six working standards to cover the analytical range. If necessary, additional standards may be added to extend the calibration curve.
 - a. Add known amounts of analytes to 10-mL volumetric flasks and dilute to the mark with solvent.
 - b. Analyze together with samples and blanks (steps 11 and 12).
 - c. Prepare calibration graph (peak area vs μ g analyte).
9. Determine desorption efficiency (DE) at least once for each lot of charcoal used for sampling in the calibration ranges (step 8).
 - a. Prepare three tubes at each of five levels plus three media blanks.
 - b. Inject a known amount of DE stock solution directly onto the front sorbent section of each charcoal tube with a microliter syringe.

- c. Allow the tubes to air equilibrate for several minutes, then cap the ends of each tube and allow to stand overnight.
 - d. Desorb (steps 5-7) and analyze together with standards and blanks (steps 11 and 12).
 - e. Prepare a graph of DE vs μg analyte recovered.
10. Analyze three quality control blind spikes and three analyst spikes to ensure that the calibration graph and DE graph are in control.

MEASUREMENT:

11. Set the gas chromatograph according to manufacturer's recommendations and to conditions given on page 1403-1. Inject a 1- μL sample aliquot manually using the solvent flush technique or with an autosampler.

NOTE: If peak area is above the linear range of the working standards, dilute with desorption solvent, reanalyze and apply the appropriate dilution factor in the calculations.

12. Measure peak areas.

CALCULATIONS:

13. Determine the mass, μg (corrected for DE) of analyte found in the sample front (W_f) and back (W_b) sorbent sections, and in the average media blank front (B_f) and back (B_b) sorbent sections.

NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.

14. Calculate concentration, C, of analyte in the air volume sampled, V(L):

$$C = \frac{(W_f + W_b - B_f - B_b)}{V}, \text{mg} / \text{m}^3$$

NOTE: $\text{mg/L} = \text{mg/m}^3$

EVALUATION OF METHOD:Initial Method Development Effort (Issues 1 and 2)

Methods S79 (2-methoxyethanol), S361 (2-ethoxyethanol), and S76 (2-butoxyethanol) were issued on February 14, 1975 [2, 7], March 17, 1978 [3, 8, 9], and February 14, 1975 [2, 7], respectively, and validated using, respectively, 50-, 6-, and 10-L air samples of atmospheres generated by calibrated syringe drive. Storage stability of these alcohols was not determined.

Current Method Development Effort (Issue 3) [10]

Issue 3 is an update and improvement of NMAM 1403. Improvements in the method include the use of capillary column chromatography, lower LOD/LOQ values, a new 5 level desorption efficiency (DE) study at lower levels, and a storage stability study at 7, 14, and 30 days.

The average DE determined for 2-methoxyethanol was 97.8% (RSD = 1.0), for 2-ethoxyethanol the DE was 100.2% (RSD = 1.2), and for 2-butoxyethanol the DE was 99.9% (RSD = 1.3). The average 30-day storage stability recovery at approximately 0.5x REL for 2-methoxyethanol was 103.8% (RSD = 1.4), for 2-ethoxyethanol was 105.0% (RSD = 1.6), and for 2-butoxyethanol was 82.6% (RSD = 1.4).

The precision and accuracy information listed in Table 2 was calculated by using the data from generated air samples [7, 8] and the analytical data from the current update [10].

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METHOD WRITTEN BY:

Issue 3

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Issue 1 & 2

George Williamson, NIOSH/ DPSE; methods originally validated under Contracts 99-74-75 and 210-76-0123.

TABLE 1. Exposure Limits and Physical Properties

Compound	OSHA (ppm)	NIOSH (ppm)	ACGIH (ppm)	mg/m ³ = 1ppm @ NTP	MW	BP (°C)	Density @ 20°C (g/mL)	VP @ 20°C, KPa (mm Hg)
2-methoxyethanol	25 (skin)	0.1 (skin)	5 (skin)	3.16	76.09	124	0.966	0.8 (6)
2-ethoxyethanol	200 (skin)	0.5 (skin)	5 (skin)	3.75	90.12	135	0.931	0.5 (4)
2-butoxyethanol	50 (skin)	5 (skin)	25 (skin)	4.91	118.17	171	0.902	0.11 (0.8)

TABLE 2. Method Evaluation

Compound	Overall Method ^a					Analytical Method ^b				Storage Stability	
	Range (mg/m ³)	Accuracy	Breakthrough @ 2 x OSHA PEL	Bias	Precision S,T	Range studied (µg/sample)	LOD (µg/sample)	Ave. DE	Measurement Precision S _r	Levels (µg/sample)	Recovery (%)
2-methoxyethanol	44-160	0.41	128 L ^c	NS ^e	0.072	2-387	0.8	97.8	0.024	120.5	103.7
2-ethoxyethanol	340-1460	0.11	> 10 L ^d	NS	0.056	2-373	0.7	100.2	0.022	118.0	101.7
2-butoxyethanol	124-490	0.14	> 44 L ^c	NS	0.071	3-361	1.3	99.9	0.024	90.0	82

- a) Generated air sample data in References 7 and 8.
b) Data for analytical method in Reference 10.
c) Testing done in dry air.
d) Testing done in 90% relative humidity.
e) NS = not significant