Isothiazolinone in Residential Interior Wall Paint: A High-Performance Liquid Chromatographic–Mass Spectrometry Analysis

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Background: **There is limited information regarding isothiazolinone content in residential wall paints in the United States.**

Objective: **The aim of this study was to evaluate the prevalence of 5 isothiazolinones—methylisothiazolinone (MI), methylchloroisothiazolinone, benzisothiazolinone (BIT), butyl BIT, and octylisothiazolinone—in US residential wall paints.**

Methods: **Forty-seven paints were obtained from retailers in Minneapolis/St Paul, Minnesota. Paint samples were assessed for the presence of the 5 isothiazolinones using high-performance liquid chromatographic–mass spectrometry.**

Results: **At least 1 isothiazolinone was detected in all 47 paints. However, no paint contained butyl BIT, and only 1 paint had octylisothiazolinone. The MI and BIT were found in 96% and 94% of the paints, respectively. Methylisothiazolinone ranged in concentration from 17 to 358 ppm, whereas BIT varied from 29 to 1111 ppm. Methylchloroisothiazolinone was found solely in oil-based paints. Isothiazolinones were declared in 15% of Safety Data Sheets but did not correlate with high-performance liquid chromatographic–mass spectrometry. One "preservative-free" paint had BIT at 71.5 ppm. Paint sheen was not statistically associated with BIT or MI concentrations. Unpigmented paints and paints with volatile organic compound claims had significantly lower concentrations of MI, but not BIT.**

Conclusions: **All paints contained at least 1 isothiazolinone. Methylisothiazolinone and BIT were the most common. Safety Data Sheets are insufficient for ascertaining isothiazolinone content in US paints.**

Because of excellent antimicrobial properties, isothiazolinones are commonly used as preservatives in personal care products and household items. Several isothiazolinones have been reported to cause allergic contact dermatitis including benzisothiazolinone (BIT), octylisothiazolinone (OIT), butyl BIT (BBIT), methylchloroisothiazolinone (MCI), and methylisothiazolinone (MI). Methylisothiazolinone and MCI allergy is currently epidemic in North America and Europe.[1–8] In terms of allergy potential, MCI/MI and MI are most commonly implicated, followed by BIT and OIT; BBIT is rarely reported.[9] Cross-reactivity between isothiazolinones is variable.[10,11]

Contact dermatitis to isothiazolinones in painters has been previously documented.[12–16] There are more than 380,000 commercial painters in the US labor force[17]; this number is an underrepresentation because many painters are not formally registered. The at-risk population for isothiazolinone allergy from exposure to paints includes not only professionals but also consumers.[17] There have been numerous cases of airborne contact dermatitis secondary to paints in Europe[18–24] and more recently in North America,[25] Japan,[26] and Australia.[27] Lundov et al[28] studied the emission curves of BIT, MI, and MCI from freshly painted surfaces and found that, although levels of MI peaked after a few hours, it was still detectable (3 ng/L)—albeit at low concentrations—a month after application.

The prevalence of isothiazolinones in water-based paints has been evaluated in 2 studies, encompassing 5 European countries. Using high-performance liquid chromatography (HPLC) with an ultraviolet detector and HPLC–mass spectrometry (MS), water-based paints from Denmark, France, Germany, Sweden, and the United Kingdom were analyzed for the presence of MI, MCI, and BIT. Those studies found that isothiazolinones were present in more than 90% of paints; MI and BIT were the most prevalent.[29,30]

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Although the previously mentioned studies provide information regarding water-based wall paints in Europe, to our knowledge, there is no similar information on isothiazolinone content in US paints. The purpose of this study was to evaluate the presence and concentration of MCI, MI, BIT, OIT, and BBIT in consumer residential interior wall paints. In addition, we aimed to (1) ascertain the use of Safety Data Sheets (SDSs) for identifying isothiazolinone-containing paints and (2) assess the correlation between isothiazolinone concentration and volatile organic compound (VOC) claims.

METHODS

Paint Collection and Sampling

Residential interior paints were purchased from major, national, and regional home improvement stores, as well as independent, local paint retailers in the Twin Cities (St Paul and Minneapolis, MN) between January and February 2017. A total of 47 paints were chosen to provide a variety of colors and sheens including flat, matte, eggshell, satin, and semigloss (Table 1). In addition, 1 paint was purchased from an online retailer, because it specifically advertised being free of preservatives (Green Planet Paints; Go Green World Products, LLC, Phoenix, AZ). At the time of purchase, electronic SDSs for each paint were downloaded from the manufacturer/retailer's Web site, and VOC claims (located on either the paint can or product Web site) were recorded. Volatile organic compound claims were divided into the following 3 categories: (1) "zero VOC," "low VOC," and "miscellaneous" (eg, phrases such as "low odor" or "meets most stringent VOC requirements").

Each paint was thoroughly mixed by hand, and 10 mL was transferred to a 15-mL vial and mailed to the National Institute of Occupational Safety and Health (Morgantown, WV) of the Centers for Disease Control and Prevention for analysis.

Reagents

Methylisothiazolinone (≥98%, CAS# 2682-20-4), BIT (96%, CAS# 2634-33-5), OIT (99.9%, CAS# 26530-20-1), atrazine-desethyl (99%, CAS# 6190-65-5, used as an internal standard), and trichloroethylene were obtained from Sigma-Aldrich Inc (Millipore Sigma, St Louis, MO). Methylchloroisothiazolinone (67.7%, CAS# 26172-55-4) was obtained from Combi-Block, Inc (San Diego, CA), and BBIT (95%, CAS# 4299-07-4) was purchased from Creative Dynamics Inc (BOC Science, Shirley, NY). Acetonitrile (liquid chromatography/tandem MS [LC/MS] grade), methanol (HPLC grade), and formic acid (LC/MS grade) were purchased from Fisher Chemical Inc (Battle Ground, WA). Water was made by Milli-Q (Milipore Sigma, Burlington, MA).

TABLE 1. Paint Characteristics

Paint Property	Attribute (n = 47)
Composition	Water-based (n = 45)
	Oil-based (n = 2)
Sheen	Flat/matte (n = 20)
	Satin/pearl (n = 10)
	Eggshell (n = 9)
	Semigloss (n = 3)
	Primer (n = 5)
Pigmentation	Pigmented (n = 28)
	Unpigmented (n = 19)

Sample Preparation

A total of 200 to 250 mg of each water-based paint was weighed in a 6-mL glass vial and diluted 10-fold (weight/volume) with mixture A consisting of 0.4% of formic acid and methanol at a ratio of 80/20 (volume/volume) containing 3.0 ng/μL of internal standard. Each sample was vortexed for 30 seconds and then sonicated for 15 minutes. After briefly vortexing again, the samples were centrifuged for 15 minutes at 1360*g* at 4°C. The top phase was filtered with a 13-mm, 0.2-μm polytetrafluoroethylene syringe filter into 2 vials, approximately 0.5 mL for each for LC/MS2 analysis.

A similar process was used for oil-based paints. Approximately 100 mg of each paint was mixed and vortexed with 1 mL of trichloroethylene for 30 seconds, followed by the addition of 3 mL of the previously mentioned mixture A, followed by the previously described steps to get to the final sample for LC/MS2 analysis.

Ultra High-Performance Liquid Chromatograph MS/MS

All isothiazolinones in paints were analyzed by an ultra HPLC coupled to an ion trap mass spectrometer (Thermo Fischer Scientific, San Jose, CA) equipped with a heated electrospray ionization probe. The analytes were separated on an Accucore C18 HPLC column (2.1 mm × 50 mm) by a mobile phase consisting of acetonitrile and 0.1% formic acid under a gradient elution program at a fixed 1-mL/min flow rate. The analytes were ionized by the heated electrospray ionization probe operated in positive mode. The MS detector was operated to select specific ions during different periods of each run. The specific ions selected were as follows: 0.00 to 0.45 minutes for MI (116 m/z), 0.45 to 0.9 minutes for MCI (150 m/z), 0.9 to 1.4 minutes for BIT (152.33 m/z), 1.4 to 2.0 minutes for international standard (188.3 m/z), 2.0 to 2.6 minutes for BBIT (208.3 m/z), and 2.6 to 3.5 minutes for OIT (214.4 m/z), with their respective individual tune method. Quantification of the analytes was performed using response factors calculated from a 6-point calibration curve. The limits of quantification of this method at less than 20% of percentage relative standard deviation were the following: MI, 150 pg/injection; MCI, 200 pg/injection; BIT, 230 pg/injection; BBIT, 70 pg/injection; and OIT, 75 pg/injection.

Data Analysis

Data were entered into Excel (Excel 2010; Microsoft Corporation, Redmond, WA). Statistical analysis was performed using SAS software (version 9.2, Statistical Analysis System; SAS Institute Inc,

Cary, NC). Pearson χ^2 tests (and Fisher exact tests, where appropriate) were used for tests of association of isothiazolinone concentration (<75 ppm, >75 ppm) and VOC claims ("none," "low," "miscellaneous," "others"), sheen (primer, flat/matte, satin/pearl/eggshell/semigloss), and pigmentation (yes, no), with a P value of equal to or less than 0.05 considered statistically significant.

RESULTS

Isothiazolinone Content

All paints contained at least 1 isothiazolinone (Table 2). Methylisothiazolinone was the most prevalent (45/47, 95.7%), with concentrations ranging from 1.02 to 357.89 ppm. Benzisothiazolinone was found in 44 (93.6%) of paints at concentrations of 28.60 to 1110.74 ppm. Methylchloroisothiazolinone was present in only 2 paints (both oil-based) at concentrations of 8.23 and 13.05 ppm. Octylisothiazolinone was found in only 1 paint at 43.16 ppm. Butyl BIT was not detected in any of the paints. One paint sample contained 3 isothiazolinones (MI, BIT, and OIT); the unpigmented (base color) of this same product (different paint sample) had no OIT and slightly lower concentrations of MI and BIT. The product claiming to be "preservative free" had a BIT concentration of 71.5 ppm. The 2 oil-based paints had relatively low concentrations of MI (14.53 and 1.02 ppm) and MCI (13.05 and 8.23 ppm) with no detectable BIT, OIT, or BBIT.

Association of Isothiazolinone Concentration and Paint Sheen

Sheen composition of study paints included the following: flat/matte (n = 20), satin/pearl/eggshell/semigloss (n = 22), and primer (n = 5). There was no statistical association of sheen (flat/matte vs others—including and excluding primers) and MI concentration (<75 ppm—including and excluding those with no level detected—vs >75 ppm) ($P > 0.2140$). Similarly, there was no statistical association of sheen (flat/matte vs others—including and excluding primers) and BIT concentration (<75 ppm—including and excluding those with no level detected—vs >75 ppm) ($P > 0.1341$). The 2 MI-free paints were both flat. The 3 BIT-free paints were satin, primer, and matte. The 2 MCI-containing paints were satin and primer. The 1 OIT-containing paint was flat.

TABLE 2. Prevalence and Concentration of Isothiazolinones in Paints

Isothiazolinone	No. Samples (n = 47), n (%)	Range, ppm	Mean (SD), ppm
MI	45 (95.7)	1.02–357.89	91.2 (90.53)
BIT	44 (93.6)	28.60–1110.74	170.57 (179.17)
MCI	2 (4.3)	8.23–13.05	10.64 (3.41)
OIT	1 (2.1)	43.16	—
BBIT	0 (0.0)	—	—

Association of Isothiazolinone Concentration and Pigmentation

There were 28 pigmented paints and 19 unpigmented paints included in this study. There was a statistical association of pigmentation and MI concentration; unpigmented paints had a lower concentration of MI as compared with pigmented paints ($P = 0.0132$ excluding 2 paints with no detectable levels and $P = 0.291$ including those 2 paints). Conversely, there was no statistical association of pigmentation and BIT concentration ($P > 0.5103$). The 2 MI-free paints were both pigmented. The 3 BIT-free paints were pigmented (n = 2) and unpigmented (n = 1). The 2 MCI-containing paints were pigmented (n = 1) and unpigmented (n = 1). The 1 OIT-containing paint was pigmented.

Association of Isothiazolinone Concentration and VOC Claims

Approximately three quarters of paints (33/47, 70.2%) had some form of VOC claim: zero VOC (n = 21), low VOC, (n = 9), and miscellaneous (n = 3), which included phrases such as "low odor" and "meets most stringent VOC requirements." Fourteen paints had no VOC claim. There was a statistical association of VOC claim and MI concentration; zero VOC paints (n = 21) were more likely to have low MI concentrations (<75 ppm) than "all others" (n = 26, $P < 0.0136$ including and excluding paints with no detectable MI levels). Similarly, there was a statistical association of "some claim" (zero/low/miscellaneous, n = 33) with low MI levels as compared with paints with "no claim" (n = 14) (P values borderline significant: $P = 0.0527$, including paints with no detectable MI levels, and $P = 0.0881$, excluding paints with no detectable MI levels). In contrast, when paints with zero VOC claims (n = 21) were compared with those with low VOC claims (n = 9), there was no statistical association with MI levels ($P > 0.2451$, including and excluding paints with no detectable MI levels).

In contrast, there were no statistical associations of VOC claim and BIT concentration (zero VOC paints [n = 21] vs all others [n = 26], some claim [n = 33] vs no claim [n = 14], or zero VOC claims [n = 21] vs low VOC claims [n = 9]; all analyses repeated including and excluding paints with no detectable BIT levels, all Ps > 0.5012).

The 2 MI-free paints had claims of zero VOC (n = 1) and no claim (n = 1). The 3 BIT-free paints had no claim (n = 1) and "miscellaneous" (n = 2). The 2 MCI-containing paints had no claim (n = 1) and miscellaneous (n = 1). The 1 OIT-containing paint had a low VOC claim.

Isothiazolinone Information on SDSs

Only 7 (14.9%) paint SDSs mentioned an isothiazolinone. However, the specific isothiazolinone compound listed did not necessarily correlate to HPLC-MS testing. Four SDSs referenced MCI, yet it was not detectable in any of those paints. Benzisothiazolinone was listed

in 2 SDSs; although BIT was present in those paints, MI, which was not declared, was also detected. Finally, 1 SDS listed MCI and MI, but the paint contained MI and BIT.

DISCUSSION

This HPLC-MS analysis of consumer residential interior wall paints yields a number of key findings. First, all paint samples were found to contain isothiazolinones, including one purported to be preservative free. Second, MI and BIT were the most prevalent isothiazolinones overall and were found in 95.7 and 93.6% of the samples, respectively. Third, most SDSs did not disclose the presence of isothiazolinones. Finally, neither BIT nor MI concentrations were statistically associated with sheen. Manufacturer VOC claims and pigmentation were associated with MI, but not BIT, concentrations.

Isothiazolinone Content

All of the paints in this study were found to contain at least 1 isothiazolinone and frequently 2 isothiazolinones. The use of MI and BIT in paints is not surprising. A study of the Danish Product Register Database in 2012 found that most registered goods containing MI or BIT were paints or varnishes.[31] In 2015, 71 European water-based paints were tested and found to have MI and BIT present at 0.7 to 180.9 and 0.1 to 462.5 ppm, respectively.[30] A follow-up study in 2017 of an additional 60 European paints showed similar levels of MI at 1.1 to 142.7 ppm and BIT at 0.4 to 331.0 ppm.[29] A smaller study conducted in 2014 on 4 Belgium paints found MI in all paints, at concentrations ranging from 8 to 225 ppm, and BIT in 3 paints, at 23 to 41 ppm.[32] Compared with these European studies, our study found higher concentrations of MI (up to 357.89 ppm) and BIT (up to 1110.74 ppm). However, our study found similar frequencies of MI (95.7% vs 93%,[30] 91.7%[29]) and BIT (93.6% vs 95.8%,[30] 88.3%[29]) (Table 3).

Octylisothiazolinone was found in only 1 paint in our study; this is in contrast to the 2017 European study where it was found in 26.7% of paints but at low concentrations (0.03–16.01 ppm).[29] The Belgium study found no OIT.[32] A retrospective analysis of the Danish Allergen database for a 20-year period documented 20 positive patch test reactions to OIT in 648 patients tested.[33] Of those 20 positive patients, 15 completed a follow-up questionnaire; on the basis of questionnaire findings and personal medical records, 6 OIT reactions were attributed to paint exposure.

Safety Data Sheets

In this analysis, most paint SDSs did not declare isothiazolinones. In some cases, a specific isothiazolinone was declared but did not correlate to the compound found on analysis, and no SDSs completely correctly identified the isothiazolinone(s) found. Of SDSs declaring isothiazolinones, MCI was the most commonly cited (n = 5), yet MCI was not found in any of these paints. Methylchloroisothiazolinone does not degrade into other isothiazolinones.[34] It is possible that these discrepancies may be due to a variation in compositions of specific lots or outdated SDSs.

In the United States, industrial items, such as paints, are not held to the same labeling standards as personal care products. Per US Department of Labor Occupational Safety and Health Administration regulations, manufacturers of paint are not required to declare nonhazardous materials on SDSs if either (1) the total concentration is less than 1% in the final product or (2), if carcinogenic, the concentrations is less than 0.1%.[35] This lack of labeling unfortunately makes it difficult for patients with allergy to preservatives, which are often used in low concentrations and not considered hazardous. In contrast, the European Union has enacted stricter guidelines regarding permissible levels of MCI/MI in cosmetic and personal hygiene products, in part in response to the MI allergy epidemic.[36] European paints and varnishes cannot have a cumulative level of isothiazolinones exceeding 500 ppm to receive an EU Ecolabel.[37] Despite these stricter regulations, difficulties ascertaining allergens from SDSs are also a problem in Europe.[38]

A Web site curated by the US Department of Health and Human Services has attempted to serve as a repository of ingredients for a limited collection of paints.[39] However, the information provided was insufficient. First, only MCI, MI, and BIT were searchable, and after using the search engine, only one of our paint samples (Zinsser) was noted to contain MI and MCI. Both of these ingredients were listed on the corresponding SDS.

Association of MI and BIT Concentrations With Paint Characteristics

There was no association of paint sheen and either MI or BIT concentrations. Methylisothiazolinone concentration, however, was associated with pigmentation of paints; unpigmented paints had a lower MI concentration than pigmented paints. It is possible that the liquid colors added to paints are preserved with MI. Benzisothiazolinone concentration was not associated with pigmentation.

Volatile organic compounds in the paint industry are mainly composed of 10 solvents, which function to provide uniformity; none of these solvents is derived from isothiazolinones.[40] Architectural coatings, such as paint, are regulated through the Clean Air Act of the US Environmental Protection Agency, which has established the following guidelines regarding VOC content: nonflat paints of less than 380 g/L and flat paints of less than 250 g/L.[41] However, places such as Southern California have enacted stricter regulations: less than 50 g/L for both flat and nonflat paints.[42] Similar to the nebulous nature of "natural" or "green" products, "low" or "zero" VOC paints are not relegated to a clear, governed definition, although some manufacturers use categories of less than 50 g/L for "low" and less than 5 g/L for "zero."

In our study, there was an association of MI concentration with VOC claim; those paints with lower VOC claims had lower MI concentrations. However, there was no association of VOC claims and BIT concentrations. This is consistent with the expectations based on the vapor pressure and boiling points of MI and BIT. The vapor pressure and boiling point of MI are 0.62 mm Hg (at 25°C) and 155°C, respectively, as compared with those of BIT, which are

TABLE 3. Analysis Results

Company	Product	Sheen	Pigmented (Y/N)	MI, ppm	MCI, ppm	BIT, ppm	BBIT, ppm	OIT, ppm
ACE Hardware Corporation 2200 Kensington Court, Oak Brook, IL 60523 Phone: 1-88-827-4223 www.acehardware.com	Clark+Kensington Premium Interior	Flat	Y	41.17	ND	251.6	ND	ND
Behr Corp 3400 W Segerstrom Ave, Santa Ana, CA 92704 Phone: 1-800-854-0133 http://www.behr.com/consumer/	Marquee	Flat	N	46.69	ND	266.32	ND	ND
	Premium Plus	Flat	N	69.79	ND	243.65	ND	ND
	Premium Plus Ultra	Flat	N	205.73	ND	238.78	ND	ND
	Premium Plus Ultra	Flat	Y	282.96	ND	262.97	ND	43.16
Benjamin Moore & Co 101 Paragon Dr, Montvale, NJ 07645 Phone: 1-855-724-6802 http://www.benjaminmoore.com/en-us	Advance Satin Base	Satin	Y	65.18	ND	39.23	ND	ND
	Aura Waterborne Interior	Matte	Y	65.54	ND	273.67	ND	ND
	Ben Waterborne Interior	Eggshell	Y	91.49	ND	299.24	ND	ND
	Natura Waterborne Interior	Flat	Y	43.99	ND	196.07	ND	ND
	Regal Select Waterborne Interior	Pearl	Y	142.6	ND	356.22	ND	ND
	Regal Select Waterborne Interior	Pearl	Y	106.02	ND	331.94	ND	ND
	Regal Select Waterborne Interior	Matte	Y	133.86	ND	343.05	ND	ND
	Satin IMPERVO*	Satin	Y	14.53	13.05	ND	ND	ND
	Super Hide	Semigloss	Y	104.28	ND	219.85	ND	ND
	ULTRA SPEC 500	Flat	Y	156.23	ND	270.7	ND	ND
California Paints 150 Dascomb Rd, Andover, MA 01810 Phone: 1-800-225-1141 http://www.californiapaints.com	PRIMECHOICE Muralo 563 Low VOC* Enamel Undercoater Primer & Sealer		N	39.78	ND	28.6	ND	ND
	Flawless ELEMENTS	Pearl	N	38.63	ND	52.33	ND	ND
	Flawless ELEMENTS	Eggshell	N	43.48	ND	1110.74	ND	ND
	Storm System Step 3 Control White Mold Resistant Paint		N	22.13	ND	33.82	ND	ND
	Stopz Mold & Mildew Resistant All Purpose Primer		N	60.43	ND	31.23	ND	ND
	Super-Scrub	Matte	N	36.06	ND	108.39	ND	ND
	Super-Scrub	Semigloss	N	24.82	ND	94.22	ND	ND
	Ultra Aquaborne Ceramic Interior Paint	Satin	N	28.87	ND	262.11	ND	ND
	Ultra Aquaborne Ceramic Interior Paint	Semigloss	N	22.21	ND	183.29	ND	ND
	Ultraplate Cabinet and Trim Enamel	Satin	N	25.79	ND	36.67	ND	ND
Dutch Boy Group 101 Prospect Ave, Cleveland, OH 44115 Phone: 1-800-828-5669 http://www.dutchboy.com	Dura Clean	Satin	Y	154.93	ND	294.28	ND	ND
	Platinum Plus	Eggshell	Y	37.73	ND	49.44	ND	ND
Go Green World Products, LLC 11460 N Cave Creek Rd, Phoenix, AZ 85020 Phone: 1-866-995-4442 http://www.greenplanetpaints.com	Green Planet Paints Premium	Flat	Y	ND	ND	71.47	ND	ND
Masterchem Industries LLC 3400 W Segerstrom Ave, Santa Ana, CA 92704 Phone: 1-866-977-3711 http://www.kilz.com	KILZ Original Primer*	NA	N	1.024	8.23	ND	ND	ND
	KILZ Premium Primer	NA	N	40.29	ND	128.61	ND	ND

(Continued on next page)

TABLE 3. *(Continued)*

Company	Product	Sheen	Pigmented (Y/N)	MI, ppm	MCI, ppm	BIT, ppm	BBIT, ppm	OIT, ppm
PPG Industries, Inc One PPG Pl, Pittsburgh, PA 15272 Phone: 1-888-774-4332 http://www.glidden.com	Glidden Diamond Interior Paint + Primer	Eggshell	N	357.89	ND	73.13	ND	ND
	Glidden Premium Interior Paint + Primer	Eggshell	N	242.3	ND	50.33	ND	ND
http://www.olympic.com	Olympic Assure	Flat	Y	283.05	ND	92.88	ND	ND
http://www.pittsburghpaintsandstains.com	Olympic One	Flat	Y	170.12	ND	65.64	ND	ND
	Pittsburgh Paints & Stains Grand Distinction	Eggshell	N	28.52	ND	63.07	ND	ND
	Pittsburgh Paints & Stains Paramount	Satin	Y	345.97	ND	87.95	ND	ND
	Pittsburgh Paints & Stains Ultra	Flat	Y	17.1	ND	106.49	ND	ND
Rust-oleum Vernon Hills, IL 60061 Phone: 1-877-385-8155 http://www.rustoleum.com	Zinsser Perma-White Mold & Mildew Proof Interior Paint	Eggshell	N	44	ND	118.67	ND	ND
Sherwin Williams 101 W Prospect Ave NW, Cleveland, OH 44115 Phone: 1-800-474-3794 http://www.sherwin-williams.com	Cashmere	Flat	Y	21.5	ND	82.46	ND	ND
	Duration Home	Matte	Y	27.75	ND	ND	ND	ND
	HGTV HOME by Sherwin Williams Showcase	Flat	Y	36.95	ND	43.33	ND	ND
	SHERScrub Supreme	Eggshell	Y	19.17	ND	67.12	ND	ND
	SuperPaint	Flat	Y	ND	ND	192.8	ND	ND
Valspar Corporation 1 Stiles Rd Suite 300 Salem, NH 03079 Phone: 1-877-825-7727 http://www.valsparpaint.com	Aspire	Eggshell	Y	126.21	ND	55.86	ND	ND
	Renew	Flat	Y	90.45	ND	70.52	ND	ND
	Reserve	Flat	Y	32.94	ND	59.64	ND	ND
	Signature	Satin	Y	116.22	ND	97.75	ND	ND

**Oil.*

NA indicates not applicable; ND, not detected.

2.78×10^{-6} mm Hg (it is a solid at room temperature) and 327.6°C, respectively (http://ec.europa.eu/health/ph_risk/committees/sccp/documents/out289_en.pdf). Thus, MI is much more volatile than BIT; using the European Union definition of VOC (boiling point < 250), MI, but not BIT, is a VOC.

One paint claimed to be preservative free. That paint had a BIT concentration of 71.5 ppm. It is possible that BIT was used as a preservative in one of the raw materials and not intentionally added by the manufacturer.

Future Considerations

Efforts to mitigate isothiazolinone allergic effects using sodium bisulfite have been reported. Gruvberger and Bruze[43] evaluated MI and MCI concentrations at various time intervals after the addition of sodium bisulfite and found a significant decrease in MI and MCI concentrations after 30 seconds. Furthermore, patch testing of MCI/MI-sensitive patients with MCI/MI-bisulfite mixtures revealed a decrease in positive reactions the longer the mixture was allowed to react (30 seconds vs 30 minutes vs 48 hours) before application.[43] Aside from inactivation of MCI/MI in liquid form, sodium bisulfite has also been shown to eliminate the emission of MCI/MI in paints after application on dry, painted surfaces.[24] Although these data are promising, it is also important to recognize that sulfites may also cause allergic contact dermatitis.[44]

LIMITATIONS

There are a number of limitations associated with this study. First, methodology involved convenience (not true random) sampling of paints. In addition, all materials—aside from 1 online sample—were purchased in the state of Minnesota. Therefore, the study findings could be region specific and thus may not be generalizable to other regions. We also did not verify that the SDSs that were acquired corresponded to the production lots of the paint. Therefore, there is potential that the paint (or SDS) was outdated.

CONCLUSIONS

Isothiazolinones were present in all 47 paints, including a product specifically advertised as being preservative free. Methylisothiazolinone and BIT were the most common. Most SDSs did not declare specific preservatives; those that listed an isothiazolinone did not correspond with isothiazolinone found on analysis. Nonpigmented and low VOC claims correlated with lower MI, but not BIT, concentrations.

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