

New Method for Estimating Emissions from Thinning and Cleanup Solvents

Traditionally, for architectural coatings, ARB has estimated thinning and cleanup emissions by assuming that one pint of solvent (average density = 6.4 lb/gal) is used for each gallon of solventborne coating. The equation is provided below:

$$\text{Thinning/Cleanup Emissions, } \frac{\text{tons}}{\text{day}} = \left[\text{Sales, } \frac{\text{gals coating}}{\text{yr}} \right] * \left[\frac{1 \text{ pint solvent}}{\text{gal coating}} \right] * \left[\frac{1 \text{ gal solvent}}{8 \text{ pints solvent}} \right] * \left[\frac{6.4 \text{ lbs}}{\text{gal solvent}} \right] * \left[\frac{1 \text{ ton}}{2000 \text{ lbs}} \right] * \left[\frac{1 \text{ yr}}{365 \text{ days}} \right]$$

This traditional method is based on the assumption that no thinning or cleanup solvents are used when waterborne architectural coatings are applied. However, field surveys conducted by ARB staff revealed that this assumption may not be entirely correct. Waterborne coatings may be cleaned up with water, but some painters use organic solvents to conduct a final flush of their equipment to help prevent rusting. In addition, waterborne coatings may be thinned with water, but some painters use additives that contain VOCs to improve the coatings' performance (e.g., flow additives that extend open time and improve brushability and leveling.) Since waterborne coatings overwhelmingly dominate the architectural coating market, ARB staff believed that it was necessary to re-evaluate the methods used for estimating emissions from thinning and cleanup solvents.

In 2001, ARB sponsored a research project that was intended to improve ARB's emission inventory for a variety of coating categories, including the emission inventory for thinning and cleanup solvents associated with architectural coatings. The portion of the project that was related to architectural coatings included the following tasks:

Task 1: Conduct a telephone survey of California homeowners to determine the quantity and type of solvent that each homeowner used for thinning and cleanup of solventborne coatings only. This survey assumed that homeowners would not use organic solvents to clean up their equipment when they used waterborne coatings. More than 1,000 homeowners provided usable data for this survey. Results were used to develop emission factors for gallons of solvent used per homeowner for both thinning and cleanup.

Task 2: Conduct a written/telephone survey of commercial painters in California to determine the quantities and types of materials that each painter used for the following activities –

- thinning of solventborne coatings;
- cleanup of solventborne and waterborne coatings; and
- additives used with waterborne coatings.

Data were also gathered on the quantities of solventborne and waterborne coatings that were applied annually. More than 200

commercial painting companies provided usable data for this survey. Results were used to develop emission factors for gallons of solvent used per gallon of coating applied and gallons of additive used per gallon of coating applied.

The research project was completed in 2004 and the results for architectural coatings are summarized in Table 1 (MACTEC, 2004.) These results provide new emission factors for estimating the quantity of thinning solvents, cleanup solvents, and additives as well as the associated emissions of reactive organic gases (ROG).

The emission factor for homeowners was based on number of homeowner-occupied housing units and the emission factor for commercial painters was based on the gallons of coating used by commercial painting contractors. Therefore, it was necessary to determine which portion of coating usage in California could be attributed to commercial painters. ARB staff used results from the 2001 Architectural Coating Survey to apportion coating volumes based on the following assumptions:

- (1) 70% of architectural coatings in California are used by commercial painters (Detiveaux and Bangert, 2001)
- (2) For the following categories, it is assumed that all of the coating usage can be attributed to commercial painters, since homeowners don't typically use these types of coatings:

- Antenna
- Bituminous Roof
- Bituminous Roof Primer
- Bond Breakers
- Concrete Curing Compounds
- Dry Fog
- Fire Resistive
- Fire Retardant – Clear
- Fire Retardant – Opaque
- Flow
- Form Release Compounds
- Graphic Arts
- High Temperature
- Industrial Maintenance
- Magnesite Cement
- Metallic Pigmented
- Pre-Treatment Wash Primer
- Roof
- Swimming Pool
- Swimming Pool Repair and Maintenance
- Traffic Marking

Table 2 contains a detailed listing of the coating categories and the breakdown of sales volumes between homeowners and commercial painters.

For the 2001 survey data, the new method of estimating emissions for thinning, cleanup, and additives results in higher values than the traditional method, as shown below:

Traditional Method: 18.5 tpd
New Method: 24.1 tpd

ARB staff believes that the new method provides a more accurate estimate because it is supported by documented research which represents the current marketplace.

Table 1: Results of Thinning & Cleanup Solvent Study (MACTEC, 2004)

HOMEOWNERS SURVEY		[1]		[2]		= [1]x[2]		
	Coating Type	Reported Solvent Usage Ratio		Multiplier		Calculated Statewide Solvent Use (gals/yr)	Reported SWA ROG (lb ROG/gal) ¹	Calculated Statewide ROG Emissions (tons/yr)
Thinning	SB	0.0043	gal thinning solvent per household per year	Statewide # of Owner-Occupied Households	6,546,344 households ²	28,149	5.46	76.85
Cleanup	SB	0.0150	gal cleanup solvent per household per year		6,546,344 households ²	98,195	5.46	268.07
COMMERCIAL PAINTERS SURVEY								
Thinning	SB	0.0692	gal thinning solvent per gallon SB coating	Statewide Coating Volumes from ARB 2001 Survey (portion used by commercial painters only)	14,176,051 gals SB coating ³	980,983	5.93	2,908.61
Additives	WB	0.0061	gal additive per gallon WB coating		59,237,432 gals WB coating ⁴	361,348	0.92	166.22
Cleanup	SB + WB	0.0246	gal cleanup solvent per gallon SB + WB coating		73,413,483 gals SB + WB coating ⁵	1,805,972	5.95	5,372.77

COMBINED HOMEOWNERS & COMMERCIAL PAINTERS								
	Coating Type	Calculated Solvent Usage Ratio ⁶				Total Statewide Solvent Use (gals)	Calculated ROG (lb ROG/gal) ⁷	Total Statewide ROG Emissions (tons/yr)
Thinning	SB	0.0597	gal thinning solvent per gallon SB coating	Total Statewide Coating Volumes from ARB 2001 Survey	16,906,211 gals SB coating	1,009,132	5.92	2,985.46
Additives	WB	0.0044	gal additive per gallon WB coating		81,548,961 gals WB coating	361,348	0.92	166.22
Cleanup	SB + WB	0.0193	gal cleanup solvent per gallon SB + WB coating		98,455,172 gals SB + WB coating	1,904,167	5.92	5,640.84
							Total TPD	24.1

CALCULATION WITH (1 Pint/Gal SB Coating) RATIO								
Thinning & Cleanup	SB	0.125	gal thinning & cleanup solvent per gallon SB coating	Total Statewide Coating Volume	16,906,211 gals SB coating	2,113,276	6.4	6,762.48
							Total TPD	18.5

NOTES:

1. SWA ROG: Sales-Weighted Average Reactive Organic Gases content, based on data gathered from the Homeowners Survey and the Commercial Painters Survey.
2. The number of owner-occupied housing units in California was 6,546,344 in 2000. (U.S. Census, 2000)
3. In ARB's 2001 Architectural Coating Survey, respondents reported 16,906,211 gallons of solventborne coatings. ARB staff estimates that 14,176,051 gallons of solventborne coatings are used by commercial painters and the remaining 2,730,160 gallons of solventborne coating are used by homeowners (see Table 2).
4. In ARB's 2001 Architectural Coating Survey, respondents reported 81,548,961 gallons of waterborne coatings. ARB staff estimates that 59,237,432 gallons of waterborne coatings are used by commercial painters and the remaining 22,311,529 gallons of waterborne coating are used by homeowners (see Table 2).
5. In ARB's 2001 Architectural Coating Survey, respondents reported 98,455,172 gallons of architectural coatings (solventborne and waterborne combined.) ARB staff estimates that 73,413,483 gallons of architectural coatings are used by commercial painters and the remaining 25,041,689 gallons of architectural coating are used by homeowners (see Table 2). The commercial painter data for cleanup solvent did not allow for clear differentiation between solventborne and waterborne coatings. Therefore, we developed a ratio that could be applied to all architectural coatings.
6. [Calculated Ratio] = [Total Statewide Solvent Use, gal]/[Total Statewide Coating Volume from ARB Survey, gal]
7. [Calculated ROG, lb/gal] = [Total Statewide Emissions, tons]*[2000 lbs/ton]/[Total Statewide Solvent Use, gals]

Table 2: Apportionment of Architectural Coating Sales Between Commercial Painters and Homeowners (ARB, 2003)

Statewide Sales (gallons)	Solventborne	Waterborne	Total
	16,906,211	81,548,961	98,455,172
COMMERCIAL PAINTERS ONLY			
Antenna	PD	PD	PD
Bituminous Roof	1,608,033	1,637,364	3,245,397
Bituminous Roof Primer	69,993	100,527	170,520
Bond Breakers	0	93,896	93,896
Concrete Curing Compounds	32,395	660,024	692,419
Dry Fog	243,047	216,709	459,756
Fire Resistive	0	PD	PD
Fire Retardant – Clear	0	PD	PD
Fire Retardant – Opaque	PD	26,690	PD
Flow	0	PD	PD
Form Release Compounds	223,634	32,090	255,724
Graphic Arts	13,667	12,722	26,389
High Temperature	18,621	PD	PD
Industrial Maintenance	4,126,134	613,946	4,740,079
Magnesite Cement	PD	0	PD
Metallic Pigmented	513,541	112,402	625,944
Pre-Treatment Wash Primer	4,188	71,154	75,342
Roof	89,448	1,047,906	1,137,354
Swimming Pool	12,399	9,687	22,086
Swimming Pool Repair and Maintenance	15,266	0	15,266
Traffic Marking	799,677	2,539,241	3,338,918
Subtotal Commercial Painter Only	7,805,677	7,177,199	14,982,876
Remaining (see Table 3)	9,100,534	74,371,762	83,472,295
Commercial Painter Portion (70%)	6,370,374	52,060,233	58,430,607
Homeowner Portion (30%)	2,730,160	22,311,529	25,041,689
Total Commercial Painter Only	14,176,051	59,237,432	73,413,483
Total Homeowner Only	2,730,160	22,311,529	25,041,689

Table 3: Apportionment of Architectural Coating Sales Used by Commercial Painters and Homeowners (ARB, 2003)

HOMEOWNER AND COMMERCIAL PAINTERS	Solventborne	Waterborne	Total
Clear Brushing Lacquer	PD	0	PD
Faux Finishing	6,948	166,789	173,737
Flat	11,952	34,798,306	34,810,257
Floor	149,939	1,275,125	1,425,064
Lacquers	374,503	72,849	447,352
Low Solids	0	13,413	13,413
Mastic Texture	210,143	418,447	628,590
Multi-Color	PD	7,517	PD
Nonflat - High Gloss	596,788	1,329,648	1,926,436
Nonflat - Low Gloss	24,525	6,570,365	6,594,890
Nonflat - Medium Gloss	567,173	17,535,565	18,102,739
Other	15,971	1,494,345	1,510,316
Primer, Sealer, and Undercoater	1,369,924	6,755,899	8,125,823
Quick Dry Enamel	607,372	PD	PD
Quick Dry Primer, Sealer, and Undercoater	1,259,524	400,703	1,660,227
Recycled	0	323,216	323,216
Rust Preventative	166,748	43,151	209,899
Sanding Sealers	20,452	7,816	28,268
Shellacs - Clear	PD	0	PD
Shellacs - Opaque	PD	0	PD
Specialty Primer, Sealer, and Undercoater	21,461	355,060	376,521
Stains - Clear/Semitransparent	1,690,513	481,082	2,171,595
Stains - Opaque	224,925	862,448	1,087,373
Varnishes - Clear	715,117	372,743	1,087,860
Varnishes - Semitransparent	58,300	3,205	61,505
Waterproofing Concrete/Masonry Sealers	225,227	482,694	707,921
Waterproofing Sealers	442,989	574,622	1,017,611
Wood Preservatives	166,982	10,462	177,444
Subtotal	9,100,534	74,371,762	83,472,295

REFERENCES

ARB, 2003: California Air Resources Board. "2001 Architectural Coating Survey Final Report", October 2003.

Detiveaux and Bangert, 2001: Scott Detiveaux and Chuck Bangert, "Regional Variation in the Architectural Coatings Market – It Is Not One Market!", Paint and Coatings Industry Magazine, September 2001.

MACTEC, 2004: MACTEC Engineering and Consulting, Inc., "Improvement of Emissions Inventories For Industrial Coatings and Thinning and Cleanup Solvents", Final Report, Contract No. 00-314, prepared for the California Air Resources Board, May 2004.

U.S. Census, 2000: United States Department of Commerce, Bureau of the Census. Census 2000 Summary File 1, Table H-3 (Internet: <http://factfinder.census.gov>).