

Notice

This Engineering Guide was recently converted to a PC format and it has not been proof read by our engineering staff. Therefore, it is subject to change at a later date.

Ohio EPA

Division of Air Pollution Control

Engineering Section

Engineering Guide #48

Question:

How do you determine compliance for a surface coating line which is subject to the emission limitations or control requirements contained in OAC Rule 3745-21-09? (This question was submitted by Vicki Saver of RAPCA in January, 1980 for purposes of clarification).

Answer:

The following table lists the surface coating categories regulated by OAC Rule 3745-21-09. Beside each category, the units of the respective emission limitation or control requirements are shown. The purpose of this Engineering Guide is to explain these emission limitations and control requirements and give examples for determining compliance with the regulations.

<u>Rule</u>	<u>Surface Coating Category</u>	<u>Units of Emission Limitation or Control Requirements</u>
3745-21-09	(C) Automobile and Light Duty Trucks	A or E
"	(D) Can	A or F
"	(E) Coil	A
"	(F) Paper	A
"	(G) Fabric	A
"	(H) Vinyl	A, B or C
"	(I) Metal Furniture	A or E
"	(J) Magnet Wire	A
"	(K) Large Appliance	A or E
"	(U) Misc. Metal Parts	A or B
"	(Y) Rotogravure/Flexographic Printing	B, C or D

A = pounds VOC/gallon of coating, excluding water*

B = percent capture and percent control for the add-on control equipment

C = percent VOC by volume of the volatile portion (for

waterborne coatings)

D = percent VOC by volume, excluding water* (for high solids coatings)

E = pounds VOC/gallon of coating, excluding water*, and the associated transfer efficiency (for an alternative emission limitation)

F = pounds VOC/day (alternative daily emission limitation or "bubble")

*Exempt organic compounds such as 1,1,1-trichloroethane (methylchloroform), methylene chloride and trichlorotrifluoroethane are considered in the same manner as water in determining compliance with the applicable emission limitations of OAC Rule 3745-21-09.

Pounds VOC/Gallon Coating, Excluding Water (A):

The emission limitation which is common to all surface coating operations (excluding the category of rotogravure/flexographic printing) is expressed as pounds VOC/gallon of coating, excluding water. In order to make a compliance determination, this value must be calculated for each coating. The following information is required for this calculation:

1. % by volume solids (or gal solids/gal coating)
2. % by volume VOC (or gal VOC/gal coating)
3. % by volume water (or gal water*/gal coating)
4. % by volume exempt organic compounds (or gal exempt organic compounds/gal coating)
5. Density of VOC (or lbs VOC/gal VOC)

Note: When the density of VOC is not specifically reported, it can be calculated from other coating material data as follows:

$$\text{Density of VOC} = \frac{(\text{lbs VOC/gal coating})}{(\% \text{ by volume VOC})} \quad (100\%)$$

or

$$= \frac{(\text{lbs VOC/gal coating, excluding water}) [100\% - (\% \text{ by volume water})]}{(\% \text{ by volume VOC})}$$

These numbers must represent the coating "as-employed" in order to account for any diluent. Data given on applications must be checked for accuracy. More often than not the information on the

appendices is incorrect (i.e., the numbers reflect "as-received" or a mixture of "as-received" and "as-employed"). If necessary, confirm the data by contacting the coating suppliers. Once the volume percentages are established, the VOC content may be calculated using either of the following formulas:

$$\frac{(\% \text{ by volume VOC})(\text{density of VOC})}{100\% - (\% \text{ by volume water} + \% \text{ by volume exempt organic compounds})}$$

= lbs VOC/gal coating, excluding water

or

$$\frac{\text{gal VOC/gal coating} \times \text{lbs VOC/gal VOC}}{1 - [(\text{gal water} + \text{gal exempt organic compounds})/\text{gal coating}]}$$

= lbs VOC/gal coating, excluding water

Example I provides an example calculation for "lbs VOC/gal coating, excluding water."

If the VOC content of every coating employed in a coating line is less than or equal to the allowable limitation, the source is in compliance. It should be noted that the allowable limitation is a daily, volume-weighted average of all coatings employed in the coating line. Hence, it is possible for a coating line to employ some coatings which exceed the allowable limitation on an individual basis yet still be in compliance with the rule. Example II demonstrates how to compute this. If the daily, volume-weighted average is greater than that allowed in the rule, the coating line is not in compliance.

Percent Capture and Percent Control (B):

OAC Rules 3745-21-09 (H), (U), and (Y) (vinyl, misc. metal parts, and graphic arts, respectively) address the option of utilizing add-on control equipment such as incineration, carbon adsorption, or condensing units. These rules specify capture and control efficiencies for the control equipment. The stated capture and control efficiencies must be demonstrated in accordance with OAC Rule 3745-21-10 (C).

Additionally, the owners or operators of other types of surface coating lines may elect to install controls as a means of achieving compliance, even though such an alternative is not specified in the rule. This, however, would require a demonstration that the reduction achieved by the control equipment is sufficient to meet the allowable emission limitation

for the coating line.

Percent VOC by volume of the Volatile Portion (C):

Vinyl coaters and rotogravure/flexographic printing presses have a control option specified in OAC Rule 3745-21-09 (H)(1)(b) and (Y)(1)(a)(ii), respectively, which states that the VOC content of the coating cannot exceed 25% by volume of the volatile portion, as determined through the use of a Method 24 analysis or from data submitted from the coating supplier. This requirement defines the formulation of a waterborne coating. The following four formulations are examples of complying coatings:

formulation: 60% solids
40% volatiles - 25% VOC
75% water

formulation: 10% solids
90% volatiles - 25% VOC
75% water

formulations: 5% solids
95% volatiles - 18% VOC
82% water

formulation: 5% solids
95% volatiles - 10% VOC
20% exempt organic compounds
70% water

Percent VOC by Volume, Excluding Water (D):

The rotogravure flexographic printing industry also has the option of achieving compliance with OAC Rule 3745-21-09 (Y)(1)(a)(i) through the use of high solids coatings. This rule limits the VOC content of high solids coatings to no more than 40% by volume of the coating, excluding water. Compliance is determined by means of a Method 24 analysis of from data submitted by the coating supplier. The next three examples are of two complying coatings and one noncomplying coating:

formulation: 60% solids - complying coating because the
40% VOC VOC content is 40% of the
coating, excluding water

formulation: 40% solids - noncomplying coating because
40% VOC VOC content is 50% of the
20% water coating, excluding water

formulation: 55% solids - complying coating because the
30% VOC VOC content of the coating,
15% exempt excluding water and exempt
organic organic compounds, is approx-
compounds imately 35%

Alternative Emission Limitation (E):

The categories of automobile and light duty trucks, metal furniture, and large appliances (OAC Rule 3745-21-09 (C), (I) and (K), respectively) each have a provision within the rule for an alternative emission limitation based upon a higher coating application transfer efficiency (TE). The emission limitations expressed in the rules are based on transfer efficiencies recognized for those industries, and the specific baseline TE's are given in the rules. Theoretically, as the TE increases more solids will be applied to the substrate, thereby requiring less coating to be used (i.e., less overspray). The case-by-case equivalency demonstration of an alternative emission limitation must be made on a pounds VOC/gallon of solids basis. Example III demonstrates how to determine pounds VOC/gallon of solids, and pounds VOC/gallon of solids applied.

Alternative Daily Emission Limitation or Bubble (F):

OAC Rule 3745-21-09 (D), for can coating, is the only rule that specifically provides for a facility bubble. The equations used in that calculation are defined by rule (D)(3)(b) and (D)(3)(c) and will not be covered by this Engineering Guide.

(Bubble variances are available to all existing surface coating operations pursuant to OAC Rule 3745-35-03 (E)(2)(d). For calculations of emission reductions necessary to demonstrate RACT equivalence for a bubble variance, see Example IV. Please note that unlike the bubble contained in OAC Rule 3745-21-09 (D), RACT equivalence for a bubble variance must be calculated on a constant-solids basis).

EXAMPLE I

The following calculations show how to determine "lbs VOC/gal coating, excluding water."

Coating formulation:

44.0% by volume solids
56.0% by volume volatiles

67% of the volatile portion is water or exempt organic

compounds

33% of the volatile portion is VOC

7.36 lbs/gal = density of the VOC for purposes of this example

Category: Coil coating line; emission limitation of 2.6 lbs
VOC/gal of coating, excluding water

Step 1: Determine the percent by volume of VOC and water in the
coating (skip this step if coating does not contain
water or exempt organic compounds):

$$\frac{.56 \text{ gal volatiles}}{\text{gal coating}} \times \frac{.33 \text{ gal VOC}}{\text{gal volatiles}} = \frac{.185 \text{ gal VOC}}{\text{gal coating}} = 18.5\% \text{ VOC}$$

$$\frac{.56 \text{ gal volatiles}}{\text{gal coating}} \times \frac{.67 \text{ gal water}}{\text{gal volatiles}} = \frac{.375 \text{ gal water}}{\text{gal coating}} = 37.5\% \text{ water}$$

Restated, the coating formulation is:

44.0% by volume solids
18.5% by volume VOC
37.5% by volume water (or exempt organic compounds, if
applicable)

Step 2: Determine the lbs/gal of coating, excluding water:

General formula:

$$\frac{\text{gal VOC/gal coating} \times \text{lbs VOC/gal VOC}}{1 - [(\text{gal water} + \text{gal exempt organic compounds})/\text{gal coating}]}$$
$$\frac{.185 \text{ gal VOC}}{\text{gal coating}} \times \frac{7.36 \text{ lbs VOC}}{\text{gal VOC}} = 2.18 \text{ lbs. VOC/gal, excluding water}$$
$$1 - \frac{.375 \text{ gal water}}{\text{gal coating}}$$

Therefore, this is a compliance coating.

EXAMPLE II

The following calculation shows how to determine the daily,
volume-weighted average of VOC emissions from a coating line.

Category: miscellaneous metal parts; extreme performance coating

emission limitation of 3.5 lbs VOC/gallons coating, excluding water.

Coating usage:

<u>Coating</u>	<u>E</u> <u>(lbs VOC/gal, -H2O)</u>	<u>GPD</u> <u>(gallons/day)</u>	<u>Total GPD</u>
A	2.5	20	97
B	4.3	15	
C	3.5	45	
D	3.0	17	

General Formula:

$$E = \frac{(E_a)(GPD_a) + (E_b)(GPD_b) + \dots + (E_n)(GPD_n)}{GPD_{total}}$$

where:

E = the daily, volume-weighted VOC content in lbs VOC/gallon of coating, excluding water

E_{a...n} = the VOC content of each individual coating in lbs VOC/gallon of coating, excluding water

GPD_{a...n} = gallons/day of each individual coating, excluding water

GPD_{total} = total number of gallons/day (all coatings employed in the coating line)

$$E = \frac{(2.4)(20) + (4.3)(15) + (3.5)(45) + (3.0)(17)}{97}$$

= 3.33 lbs. VOC/gallon coating, excluding water

Therefore, the coating line is in compliance on a daily, volume-weighted average basis.

(Note: The GPD values should represent the real usage for a day and not simply an average daily usage based on the annual usage divided by the number of operating days in a year. Calculations for several days may have to be performed in order to determine the "worst case" daily, volume-weighted average).

EXAMPLE III

The following calculations are used to determine the equivalency of an alternative emission limitation based on transfer

efficiency.

Existing formulation:

55.0% by volume solids
45.0% by volume VOC
7.40 lbs/gal - density of VOC
50% transfer efficiency (TE)

Category: Automobile and light duty truck top coat line;
emission limitation of 2.8 lbs VOC/gal, excluding
water

Step 1: Determine lbs VOC/gal, excluding water:

$$\frac{.45 \text{ gal VOC}}{\text{gal coating}} \times \frac{7.4 \text{ lbs VOC}}{\text{gal VOC}} = 3.33 \text{ lbs VOC/gal coating, excluding water*}$$

1 - 0% water (or exempt organic compound)

*The formulation is not a compliance coating.

Step 2: Determine the lbs VOC/gal coating (including water or exempt organic compounds)

$$\frac{.45 \text{ gal VOC}}{\text{gal coating}} \times \frac{7.4 \text{ lbs VOC}}{\text{gal VOC}} = 3.33 \text{ lbs VOC/gal coating}$$

Step 3: Determine lbs VOC/gal solids:

$$\frac{3.33 \text{ lbs VOC/gal coating}}{.55 \text{ gal solids/gal coating}} = 6.05 \text{ lbs VOC/gal solids}$$

Step 4: Determine lbs VOC/gal solids applied:

$$\frac{6.05 \text{ lbs VOC/gal solids}}{.50 \text{ transfer efficiency}} = 12.10 \text{ lbs VOC/gal solids applied}$$

Next, compare the value from Step 4 to the allowable emissions. Remember, the 2.8 lbs/gal limit is based on a TE of 30%.

Step 5: Determine complying coating formulation:

$$\frac{2.8 \text{ lbs VOC/gal coating}}{7.40 \text{ lbs VOC/gal VOC}} = .38 \text{ gal VOC/gal coating}$$

Therefore, the model (complying coating) formulation is:

38% by volume VOC
 63% by volume solids
 7.40 lbs/gallon - density of VOC
 30% transfer efficiency

Step 6: Determine lbs VOC/gal solids:

2.8 lbs VOC/gal coating = 4.53 lbs VOC/gal solids
 .62 gal solids/gal coating

Step 7: Determine lbs VOC/gal solids applied:

4.5 lbs VOC/gal solids = 15.10 lbs. VOC/gal solids applied
 .30 transfer efficiency

The model compliance coating has 15.10 lbs VOC/gal solids applied, and the existing coating has 12.10 lbs VOC/gal solids applied. Therefore the existing coating is in compliance, based upon a higher transfer efficiency. The alternative emission limitation and corresponding coating applicator TE should be stated in the special terms and conditions of the PTO for the coating line.

The following equation can also be used in determining the acceptability of an alternative emission limitation based on transfer efficiency:

$$L_e = \frac{E_e L_{op}}{E_o (p - L_0) + E_e L_0}$$

where

- E_e = transfer efficiency for equivalent VOC emission limit, in %
- E_o = transfer efficiency for original VOC emission limit, in %
- L_e = equivalent VOC emission limit, in lbs per gallon, excluding water
- L_0 = original VOC emission limit, in lbs per gallon, excluding water
- p = density of organic solvent, in lbs per gallon

If the VOC content of the proposed coating material is less than L_e for a given transfer efficiency, the proposed coating material is in compliance.

For the above example,

$$L_e = \frac{(50)(2.8)(7.40)}{(30)(7.40-2.8) + (50)(2.8)} = 3.73 \text{ lbs VOC/gal, excluding water}$$

From Step 1 above it can be seen that the existing coating material contains 3.33 lbs VOC/gal coating, excluding water. Since 3.33 is less than 3.73, the existing coating is in compliance, based upon a 50% transfer efficiency.

EXAMPLE IV

The following calculations illustrate how to determine RACT equivalence for a "bubble" variance.

Existing coating formulation:

35.0% by volume solids
55.0% by volume VOC
10.0% by volume water
8.1 lb/gal - density of VOC
228 gallons coating/day maximum - per PTO application

Category: Paper coating line; emission limitation of 2.9 lbs VOC/gal, excluding water

Step 1: Determine lbs VOC/gallon of coating, excluding water:

$$\frac{.55 \text{ gal VOC} \times 8.2 \text{ lbs VOC}}{\text{gal coating} - \frac{.10 \text{ gal water}}{\text{gal coating}}} = 4.96 \text{ lbs VOC/gal coating, excluding water*}$$

*Note, this formulation is not a compliance coating.

Step 2: Determine the lbs VOC/gallon coating:

$$\frac{.55 \text{ gal VOC} \times 8.1 \text{ lbs VOC}}{\text{gal coating}} = 4.46 \text{ lbs VOC/gal coating}$$

Note: Do not subtract the water. This calculation is not to establish an emission factor; it is used only for determining actual emissions.

Step 3: Determine the percent solids for a complying coating

(excluding water or exempt organic compounds):

$$2.9 \text{ lbs VOC/gal coating} = \frac{X \text{ gal VOC}}{\text{gal coating}} \times \frac{8.10 \text{ lbs VOC}}{\text{gal VOC}}$$

$$\frac{X \text{ gal VOC}}{\text{gal coating}} = \frac{2.9 \text{ lbs VOC/gal coating}}{8.1 \text{ lbs VOC/gal VOC}} = \frac{.358 \text{ gal VOC}}{\text{gal coating}}$$

$$1 \text{ gal coating (solids and VOC)} - \frac{.358 \text{ gal VOC}}{\text{gal coating}} = \frac{.642 \text{ gal solids}}{\text{gal coating}}$$

Therefore, the complying coating formulation is:

35.8% VOC
64.2% solids

Step 4: Determine the lbs VOC/gal solids for the existing (noncomplying) coating and a complying coating:

Noncomplying:

$$\frac{.55 \text{ gal VOC}}{\text{gal coating}} \times \frac{8.1 \text{ lbs VOC}}{\text{gal VOC}} = 12.73 \text{ lbs VOC/gal solids}$$
$$\frac{.35 \text{ gal solids}}{\text{gal coating}}$$

Complying:

$$\frac{.358 \text{ gal VOC}}{\text{gal coating}} \times \frac{8.1 \text{ lbs VOC}}{\text{gal VOC}} = 4.52 \text{ lbs VOC/gal solids}$$

Step 5: Determine the maximum amount of noncomplying emissions per day from the use of the existing coating:

$$\frac{(12.73 - 4.52) \text{ lbs VOC}}{\text{gal solids}} \times \frac{.35 \text{ gal solids}}{\text{gal coating}} \times \frac{228 \text{ gal coating}}{\text{day}}$$
$$= 655 \text{ lbs VOC/day}$$

Therefore, any "bubble" variance must provide offsetting emissions of 655 lbs VOC/day or more in order to meet the RACT equivalence requirement.

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