Category: 27 – Solids Applied/Transfer Efficiency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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SUBJECT: Procedure to Calculate Equivalency with the CTG Recommendations for Surface Coating

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TO: Chief, Air Programs Branch, Regions I-X

It has come to my attention that surface coaters, State agencies and vendors are having a difficult time performing the calculations necessary to determine equivalency when add-on control equipment is used to meet CTG type emission limits. This is partially because the units used for the CTG limits (mass VOC per volume of coating less water) cannot be used for equivalency calculations. Equivalency calculations must be based on mass of VOC per volume of solids consumed (or applied when transfer efficiency is considered).

An equivalency equation based on pounds of VOC per gallon of coating less water assumes that an equal volume of coating will be required to cover a given area regardless of the amount of solids in the coating. This reasoning is erroneous. A desk that can be painted with one gallon of a coating that is 50 percent solvent and 50 percent solids (1:1) will require two gallons of a coating that is 75 percent solvent and 25 percent solids (3:1) (transfer efficiency held constant). Since there is three times as much solvent used, a 66 percent reduction in VOC is required for the second coating to be equivalent to the first coating.

Procedures in the State regulations for calculating equivalence with the CTG type limits must contain equations that are stated on a pounds of VOC per gallon of solids basis.

The attached examples may be helpful in discussing the equivalency calculation with the State agencies, coating industries, and control equipment manufacturers. Please call Tom Williams (FTS 629-5226) for additional information.

Attachment

cc: VOC Contact - Regions I-X
Jim Berry, ESED

Attachment

SURFACE COATING EQUIVALENCE CALCULATIONS

The following two examples demonstrate calculation of the percent VOC emission reduction needed from add-on control equipment to meet CTG type (pounds of VOC per gallon of coating less water) emission limits when high solvent content coatings are used. In both examples, the percent reduction required is determined by comparing current emissions to the emissions that would result when a coating that exactly meets the applicable emission limit is used. All of the coatings in the examples are assumed to be solvent based, that is, they contain no water.

In Case I, transfer efficiency is not considered. The key item in case I is the volume (gallons) of coating solids consumed. Consumed solids are all solids that pass through the application equipment.

In Case II, transfer efficiency is considered. The key item in case II is the volume (gallons) of coating solids applied. Applied solids are those coating solids that remain on the coated part. The difference between applied and consumed solids is often referred to as "overspray." At 60 percent transfer efficiency, 60 percent of all solids consumed are applied and 40 percent are overspray.

In each case a density of 7.36 pounds per gallon is assumed for the VOC in the reference coating that exactly meets the CTG type emission limit. This is done because an average solvent density of 7.36 pounds per gallon was used in setting most CTG limits.

In each case a density of 7.36 pounds per gallon is used for the VOC in the coating currently in use. This is done for illustrative purposes only. For real coatings, the actual solvent density should be used.

CASE I

TRANSFER EFFICIENCY NOT CONSIDERED

SUMMARY

In Case I it is assumed that the coater currently uses a coating containing 5.9 pounds of VOC per gallon less water. The actual density of the VOC in the current coating is 7.36 pounds per gallon. It is desired to determine the percent reduction needed from add-on controls to meet a CTG type limit of 3.0 pounds of VOC per gallon of coating less water. The required percent reduction is found to be 83 percent. The effect of differences in transfer efficiency and coating thickness is not considered as a factor in Case I. All coatings are assessed to be solvent borne (no water).

ANALYSIS

CURRENT COATING

Given

1. Solvent (VOC) content: 5.9 pounds of VOC per gallon of coating less water
2. Solvent (VOC) density: 7.36 pounds per gallon
3. Daily coating usage: 300 gallons

Calculate

4. Volume percent solvent (VOC) in current coating:

$$\frac{5.9 \text{ pounds VOC/gallon coating less water}}{7.35 \text{ pounds VOC/gallon VOC}} \times 100 = 80\ \%$$

5. Volume percent solids in current coating:

$$100 - \text{volume percent solvent} = 100 - 80 = 20\ \%$$

Items 4 and 5 say that in every 100 gallons of coating there are 20 gallons of solids and 80 gallons of solvent.

6. Volume of solids used daily:

$$300 \frac{\text{gallons coating}}{\text{day}} \times \frac{20 \text{ gallons solids}}{100 \text{ gallons coating}} = 60 \frac{\text{gallons solids}}{\text{day}}$$

The key item is that 60 gallons of coating solids are used daily. This is assumed to remain constant, no matter what coating is used, as long as production is unchanged since transfer efficiency and coating thickness are not considered factors in Case I.

7. Volume of solvent (VOC) used daily:

$$300\frac{\text{gallons coating}}{\text{day}} \times \frac{80 \text{ gallons VOC}}{100 \text{ gallons coating}} = 240\frac{\text{gallons VOC}}{\text{day}}$$

8. Mass of solvent (VOC) used daily (current uncontrolled VOC emissions):

$$240\frac{\text{gallons VOC}}{\text{day}} \times 7.36\frac{\text{pounds VOC}}{\text{gallon VOC}} = 1766\frac{\text{pounds VOC}}{\text{day}}$$

CTG COATING

Given

9.	Solvent (VOC) content	3.0 pounds of VOC per gallon coating less water
10.	Solvent (VOC) density	7.36 pounds per gallon
11.	Required daily solids usage (as determined in Item 6)	60 gallons

Calculate

12. Volume percent solvent (VOC) in CTG coating:

$$\frac{3.0 \text{ pounds VOC/gallon coating less water}}{7.36 \text{ pounds VOC/gallon VOC}} \times 100 = 40\ \%$$

13. Volume percent solids in CTG coating

$$100 - \text{volume percent solvent} = 100\text{-}40 = 60\%$$

14. Volume of CTG coating needed to meet daily solids requirement:

$$\frac{60 \text{ gallons solids/day}}{0.60 \text{ gallons solids/gallon coating}} = 100\frac{\text{gallons CTG coating}}{\text{day}}$$

15. Volume of solvent (VOC) in daily required gallons of CTG coating;

$$100\,\frac{\text{gallons coating}}{\text{day}} \times \frac{40\text{ gallons VOC}}{100\text{ gallons coating}} = 40\,\frac{\text{gallons VOC}}{\text{day}}$$

16. Mass of solvent (VOC) in daily required gallons of CTG coating (recommended CTG emissions):

$$40\,\frac{\text{gallons VOC}}{\text{day}} \times 7.36\,\frac{\text{pounds VOC}}{\text{gallon VOC}} = 294\,\frac{\text{pounds VOC}}{\text{day}}$$

REDUCTION NEEDED FROM ADD-ON CONTROLS

From previous calculations

17. Current VOC emissions 1766 pounds/day

18. Recommended CTG VOC emissions 294 pounds/day

Calculate

19. Required percent reduction from add-on controls:

$$\frac{\text{Current} - \text{Recommended}}{\text{Current}} \times 100 = \frac{1766 - 294}{1766} \times 100 = 83\,\%$$

CASE II

TRANSFER EFFICIENCY (T.E.) CONSIDERED

SUMMARY

In Case II it is assumed that the coater currently uses a coating containing 5.5 pounds of VOC per gallon less water and applies it at 40 percent transfer efficiency. New application equipment that will achieve 80 percent transfer efficiency is available. The actual density of the VOC in the current coating is 7.36 pounds per gallon. .It is desired to determine the percent reduction needed from add-on controls to meet a CTG type emission limit of 2.6 pounds of VOC per gallon of coating less water. A. reference transfer efficiency of 50 percent is assumed for this CTG coating. The required percent reductions are found to be 86 percent when the coater operates at 40 percent transfer efficiency and 71 percent when the coater operates at 80 percent transfer efficiency. The effect of differences in coating thickness is not considered as a factor in Case II. All coatings are assumed to be solvent borne (no water).

ANALYSIS

CURRENT COATING AT CURRENT T.E.

Given

1.	Solvent (VOC) content	5.5 pounds VOC per gallon coating less water
2.	Solvent (VOC) density	7.36 pounds/gallon
3.	Daily coating usage	100 gallons
4.	Current transfer efficiency	40 percent

Calculate

5. Volume percent solvent (VOC) in current coating:

$$\frac{5.5 \text{ pounds VOC/gallon coating less water}}{7.36 \text{ pounds VOC/gallon VOC}} \times 100 = 75\%$$

6. Volume percent solids in current coating:

$$100 - \text{Volume percent VOC} = 100 - 75 = 25\%$$

Items 5 and 6 say that in every 100 gallons of the current coating there are 75 gallons of VOC and 25 gallons of coating solids.

7. Volume of solids used daily (factor in 40 percent T.E.):

$$100\,\frac{\text{gallons coating}}{\text{day}} \times \frac{25\text{ gallons solids}}{100\text{ gallons coating}} = 25\,\frac{\text{gallons solids}}{\text{day}}$$

8. Volume of solids applied daily:

$$25\,\frac{\text{gallons solids used}}{\text{day}} \times \frac{40\text{ gallons solids applied}}{100\text{ gallons solids used}} = 10\,\frac{\text{gallons solids applied}}{\text{day}}$$

Item 8 is the key calculation in Case II. No matter what coating and transfer efficiency combination is used, 10 gallons of solids must be applied each day to maintain the same level of production since coating thickness is not a factor in Case II.

9. Volume of solvent (VOC) used daily:

$$100\,\frac{\text{gallons coating}}{\text{day}} \times \frac{75\text{ gallons VOC}}{100\text{ gallons coating}} = 75\,\frac{\text{gallons VOC}}{\text{day}}$$

10. Mass of solvent (VOC) used daily:

$$75\,\frac{\text{gallons VOC}}{\text{day}} \times 7.36\,\frac{\text{poounds VOC}}{\text{gallon VOC}} = 552\,\frac{\text{poounds VOC}}{\text{day}}$$

CURRENT COATING AT IMPROVED T.E.

Given

11. New application equipment will achieve 80 percent T. E.

Calculate

12. Volume of solids needed daily to apply required vol actor in 80 percent T.E.):

$$10\,\frac{\text{gallons solids applied}}{\text{day}} \times \frac{100\text{ gallons solids used}}{80\text{ gallons solids applied}} = 12.5\,\frac{\text{gallons solids used}}{\text{day}}$$

13. Volume of coating needed daily at improved T. E.:

$$12.5\,\frac{\text{gallons solids used}}{\text{day}} \times \frac{100\text{ gallons coating}}{25\text{ gallons solids}} = 50\,\frac{\text{gallons coating}}{\text{day}}$$

14. Volume of solvent (VOC) used daily at improved T. E.:

$$50\,\frac{\text{gallons coating}}{\text{day}} \times \frac{75\text{ gallons VOC}}{100\text{ gallons coating}} = 37.5\,\frac{\text{gallons VOC}}{\text{day}}$$

15. Mass of solvent (VOC) used daily at improved T.E.:

$$37.5\,\frac{\text{gallons VOC}}{\text{day}} \times 7.36\,\frac{\text{pounds VOC}}{\text{gallon VOC}} = 276\,\frac{\text{pounds VOC}}{\text{day}}$$

CTG COATING

Given

16. Solvent (VOC) content	2.6 pounds of VOC per gallon of coating less water
17. Solvent (VOC) density	7.36 pounds per gallon
18. Assumed T. E. for CTG Coating	50 percent

Calculate

19. Volume percent solvent (VOC) in CTG coating:

$$\frac{2.6\text{ pounds VOC/gallon coating less water}}{7.36\text{ pounds VOC/gallon VOC}} \times 100 = 35\,\%$$

20. Volume percent solids in CTG coating:

$$100 - \text{volume percent VOC} = 100 - 35 = 65\,\%$$

21. Volume of CTG coating solids needed daily to apply required volume of solids (factor in 50 percent T.E..):

$$10\,\frac{\text{gallons solids applied}}{\text{day}} \times \frac{100\text{ gallons solids used}}{50\text{ gallons solids applied}} = 20\,\frac{\text{gallons solids}}{\text{day}}$$

22. Volume of CTG coating needed daily:

$$20\,\frac{\text{gallons solids}}{\text{day}} \times \frac{100\ \text{gallons coating}}{65\ \text{gallons solids}} = 30.8\,\frac{\text{gallons coating}}{\text{day}}$$