

Chapter 7: Calculating the VOC Content of Coating and Inks

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	Calculating the VOC Content of Coatings and Inks

VOC Calculations

Using the calculation method for determining VOC content of coatings and inks is more convenient, and often more reliable, than it is to measure VOC emission directly.

- Calculation Information**
- Form of emission limitation
 - Data on the properties and compositions of coatings and inks
 - Transfer efficiency and performance specifications
 - Production rates and coating or ink usage

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Forms of Emission Limitations for Surface Coating

- Weight of VOC per volume of coating less water and exempt solvents
- Weight of VOC per area of surface covered
- Weight of VOC per volume of solids
- Weight of VOC per volume of applied solids

Forms of Emission Limitations for Graphic Arts

- Volume percent VOC in volatile fraction
- Volume percent water in volatile fraction
- Volume percent solids in ink less water

Coating and Ink Data

- Standard methods
- Data sheets
- Material safety data sheets (MSDS)

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Standard Methods

- Method 24
 - Weight fraction of volatile matter
 - Weight fraction of water
 - Volume fraction of solids
 - Coating density

- Method 24A
 - Weight fraction of VOC
 - Coating density
 - Solvent density

Manufacturer Data Sheet

Coating Manufacturer	_____
Coating Identification	_____
Batch Identification	_____
Supplied to	_____
A. Coating Density (D _{cs})	_____ Lbs./gal of coating ASTM D 1475 () Other _____ ()
B. Total Volatile Content (W _v)	_____ Lbs./lb of coating ASTM D 2369 () Other _____ ()
C. Water Content (W _w)	_____ Lbs./lb of coating ASTM D 3792 () ASTM D 4017 () Other _____ ()
Water Content (W _w)	_____ Gal./gal of coating Calculated _____ () Other _____ ()
D. Organic Volatiles (W _o)	_____ Lbs./lb coating
E. Nonvolatiles Content (W _n)	_____ Gal./gal of coating
F. VOC Content (VOC _a)	_____ Lbs./gal less water
G. VOC Content (VOC _b)	_____ Lbs./gal of solids
Signed: _____	Date: _____

User Data Sheet

Coating Manufacturer	_____
Coating Identification	_____
Batch Identification	_____
User	_____
User's Coating Identification	_____
A. Coating Density (D _c)	_____ Lbs./gal of coating ASTM D 1475 () Other _____ ()
B. Total Volatile Content (W _v)	_____ Lbs./lb of coating ASTM D 2369 () Other _____ ()
C. Water Content (W _w)	_____ Lbs./lb of coating ASTM D 3792 () ASTM D 4017 () Other _____ ()
Water Content (W _w)	_____ Gal./gal of coating Calculated _____ () Other _____ ()
D. Dilution Solvent Density (D _d)	_____ Lbs./gal solvent ASTM D 1475 () Handbook _____ () Formulation _____ ()
E. Dilution Solvent Ratio (R _d)	_____ Gal solvent/gal coating
F. Organic Volatiles (W _o)	_____ Lbs./lb coating
G. Nonvolatiles Content (W _n)	_____ Gal./gal of coating
H. VOC Content (VOC _a)	_____ Lbs./gal less water
I. VOC Content (VOC _b)	_____ Lbs./gal of solids
Signed: _____	Date: _____

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Coating and Ink Data

- Standard methods
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Transfer Efficiency

- Baseline transfer efficiencies are specified in some CTG documents and NSPS
- Enhanced transfer efficiencies are determined under actual operating conditions

Capture and Control Efficiencies

- Claimed efficiencies can be determined from manufacturer's information
- Actual efficiencies are determined by performance testing on the specific source

Process Records

- Coating formulation and analytical data
- Coating consumption data
- Capture and control equipment performance data
- Transfer efficiency data
- Process information

Emission Calculations

Consider the following coating:

Solids content	35% by weight
Water content	10% by weight
Solids density	29.7 lbs/gal
Solvent content (by volume)	83.3% xylene 16.7% MEK

Calculation of Mixed Solvent Density

$$\left(7.5 \frac{\text{lbs xylene}}{\text{gal xylene}} \right) \left(0.833 \frac{\text{gal xylene}}{\text{gal solvent}} \right) = 6.25 \frac{\text{lbs xylene}}{\text{gal solvent}}$$

$$\left(6.7 \frac{\text{lbs MEK}}{\text{gal MEK}} \right) \left(0.167 \frac{\text{gal MEK}}{\text{gal solvent}} \right) = 1.11 \frac{\text{lbs MEK}}{\text{gal solvent}}$$

$$\text{Solvent density} = 6.25 \frac{\text{lbs xylene}}{\text{gal solvent}} + 1.11 \frac{\text{lbs MEK}}{\text{gal solvent}}$$

$$= 7.36 \frac{\text{lbs solvent}}{\text{gal solvent}}$$

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Calculation of Coating Density

Solvent content = 100 lbs coating - 35 lbs solids - 10 lbs water = 55 lbs

$$\frac{35 \text{ lbs solids}}{29.7 \frac{\text{lbs solids}}{\text{gal solids}}} = 1.18 \text{ gal solids}$$

$$\frac{10 \text{ lbs water}}{8.34 \frac{\text{lbs water}}{\text{gal water}}} = 1.20 \text{ gal water}$$

$$\frac{55 \text{ lbs solvent}}{7.36 \frac{\text{lbs solvent}}{\text{gal solvent}}} = 7.47 \text{ gal solvent}$$

Calculation of Coating Density (Continued)

1.18 gal solids + 1.20 gal water + 7.47 gal solvent = 9.85 gal c coating

$$\text{Coating density} = \frac{100 \text{ lbs coating}}{9.85 \text{ gal coating}} = 10.15 \frac{\text{lbs coating}}{\text{gal coating}}$$

Coating composition by volume:

Solids	12.0%
Water	12.2%
Solvent	75.8%

Calculation of VOC Emissions on the Basis of Coating Volume

$$\text{Emissions} = \left(7.36 \frac{\text{lbs solvent}}{\text{gal solvent}} \right) \left(0.758 \frac{\text{gal solvent}}{\text{gal coating}} \right) = 5.58 \frac{\text{lbs solvent}}{\text{gal coating}}$$

$$\text{Emissions} = \left(0.55 \frac{\text{lbs solvent}}{\text{lb coating}} \right) \left(10.15 \frac{\text{lbs coating}}{\text{gal coating}} \right) = 5.58 \frac{\text{lbs solvent}}{\text{gal coating}}$$

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Calculation of VOC Emissions on the Basis of Coating Volume (Continued)

$$1 \frac{\text{gal coating}}{\text{gal coating}} - 0.122 \frac{\text{gal water}}{\text{gal coating}}$$

$$\frac{1 \text{ gal coating} - 0.122 \text{ gal water}}{\text{gal coating}}$$

$$\frac{(1 - 0.122) \text{ gal coating less water}}{\text{gal coating}}$$

Calculation of VOC Emissions on the Basis of Coating Volume (Continued)

$$\text{Emissions} = \frac{\left(7.36 \frac{\text{lbs solvent}}{\text{gal solvent}} \right) \left(0.758 \frac{\text{gal solvent}}{\text{gal coating}} \right)}{\frac{(1 - 0.122) \text{ gal coating less water}}{\text{gal coating}}} = 6.35 \frac{\text{lbs solvent}}{\text{gal coating less water}}$$

Calculation of VOC Emissions on the Basis of Solids Volume

$$\text{Emissions} = \frac{\left(7.36 \frac{\text{lbs solvent}}{\text{gal solvent}} \right) \left(0.758 \frac{\text{gal solvent}}{\text{gal coating}} \right)}{0.12 \frac{\text{gal solids}}{\text{gal coating}}} = 46.49 \frac{\text{lbs solvent}}{\text{gal solids}}$$

or

$$\text{Emissions} = \frac{\left(0.55 \frac{\text{lbs solvent}}{\text{lb coating}} \right) \left(10.15 \frac{\text{lbs coating}}{\text{gal coating}} \right)}{0.12 \frac{\text{gal solids}}{\text{gal coating}}} = 46.52 \frac{\text{lbs solvent}}{\text{gal solids}}$$

Calculation of VOC Emissions on the Basis of Solids Volume (Continued)

Assume a transfer efficiency of 75%:

$$\text{Emissions} = \frac{46.49 \frac{\text{lbs solvent}}{\text{gal solids}}}{0.75 \frac{\text{gal solids applied}}{\text{gal solids}}} = 61.99 \frac{\text{lbs solvent}}{\text{gal solids applied}}$$

Graphic Arts Calculations

Consider the following ink:

Solids content	10% by volume
Water content	70% by volume
Solvent content	20% by volume

Volume Percent VOC in the Volatile Fraction

$$\text{VOC content} = \frac{0.20 \frac{\text{gal solvent}}{\text{gal ink}}}{(1 - 0.10) \frac{\text{gal volatiles}}{\text{gal ink}}} = 0.222 \frac{\text{gal solvent}}{\text{gal volatiles}} \text{ or } 22.2\% \text{ of the volatiles}$$

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Volume Percent Water in the Volatile Fraction

$$\text{Water content} = \frac{0.70 \frac{\text{gal water}}{\text{gal ink}}}{(1 - 0.10) \frac{\text{gal volatiles}}{\text{gal ink}}} = 0.778 \frac{\text{gal water}}{\text{gal volatiles}} \text{ or } 77.8\% \text{ of the volatiles}$$

Volume Percent Solids in the Ink Less Water

$$\text{VOC content} = \frac{0.10 \frac{\text{gal solids}}{\text{gal ink}}}{(1 - 0.70) \frac{\text{gal ink less water}}{\text{gal ink}}} = 0.333 \frac{\text{gal solids}}{\text{gal ink less water}} \text{ or } 33.3\%$$
