ENCLOSURE 2

AP-42 EMISSION FACTOR BACKGROUND DOCUMENTATION
PUBLICATION ROTOGRAVURE PRINTING

Section No. 4.9.2

This section contains the data and calculations used in determining the VOC emission factors for publication rotogravure printing presses. The emission factors are presented in Table 4.9-1 of AP-42. VOC emissons are the only air pollutants discussed. The reasoning and assumptions used in selecting the emission factors are presented in this documentation along with the references for the data.

For flexibility and user convenience, the emission factors are presented on a dual basis and expressed in both English and metric units. The more accurate emission factors are based on the total amount of solvent used. These factors are expressed as mass of VOC emitted per mass of total solvent used -- lb per lb or kg per kg. The second set of emission factors are based on the liquid volume of raw ink and related coatings used. This generalized raw ink basis is less accurate, but more convenient for users who do not know the amount of dilution and cleaning solvent used at the press. These factors are expressed as mass of VOC emitted per volume of raw ink and related coatings used - lb per gal or kg/liter.

Emission factors for both uncontrolled and controlled presses are discussed. Emissions from uncontrolled presses are described as occurring from the dryer exhausts and solvent retained in the product, as well as from fugitive solvent vapors. For controlled presses, the dryer exhaust emissions are replaced by much lower control device outlet emissions. Uncontrolled emission factors were derived from test data on controlled presses. Therefore, for ease of explanation, controlled press emission factors are discussed first.

I. Seventy-five Percent Controlled Emission Factors[1,2]

Emission Point	lb/lb (kg/kg)	lb/gal	kg/liter
Fugitive	0.13	1.61	0.19
Printed Product	0.03	0.37	0.05
Control Device	0.09	1.12	0.13
Total Emissions	0.25	3.10	0.37

Facility: Individual older-type design printing press controlled by a solvent vapor capture system combined with a fixed-bed carbon adsorption/solvent recovery system.

Control Performance:

- 84 percent capture of total solvent used - dryer exhaust control only
- 90 percent efficient carbon adsorption control device
- 75 percent overall VOC reduction efficiency

Emission factors representing 75 percent overall control are based on the least expensive, older-type design presses with the lowest cost, older-type design carbon adsorber control system. For this case, only dryer exhausts are captured. No test data are available for these type controlled presses. The capture efficiency and control device efficiency were obtained from the recommendations presented in EPA's control techniques guidelines (CTG). According to the CTG, carbon adsorption units are 90 to 95 percent efficient. The CTG also states that based on overall solvent material balances, a number of plants have reported that carbon adsorption controlled presses can recover 75 percent or more of the total solvent used. No method was available to directly calculate the efficiency of the solvent vapor capture system. However, from back calculating by dividing the overall recovery efficiency by the carbon adsorber efficiency, the CTG mentioned that a 75 to 85 percent capture efficiency should be expected.

When selecting the overall control performance level, the lower values of the reported ranges were chosen. Therefore, the 75 percent overall control level is based on 84 percent capture efficiency and 90 percent control device efficiency.

For 75 percent overall control, the total mass emission factor is 0.25. This factor is based on the assumption that 100 percent of the total solvent used is vaporized in the printing process. The corresponding generalized VOC emission factors for volume of raw ink used are based on a typical total solvent volume to raw ink (and coating) volume ratio of 2.0. The mass of VOC emissions is then determined by multiplying this volume ratio times the total mass emission factor and the solvent density.

There are three major emission points at which emissions occur from a press. The control device outlet emissions were determined by knowing the capture efficiency and the control device efficiency, as follows:

$$\text{Control Device Outlet Emissions} = \left[\text{Capture Efficiency}\right] \times \left[1 - \text{Control Device Efficiency}\right]$$

$$= (0.84) \times (1 - 0.90)$$

$$= \underline{0.09} \text{ mass VOC/mass total solvent}$$

The mass emission factor for the solvent retained in the printed product was determined from a combination of test data from two EPA emission tests and numerous industry sources. Results of the two tests showed that about 3.3 to 3.5 percent of the total solvent used was retained by the products. In addition, industry information suggests that from one to seven percent of the solvent used is product-retained. The 0.03 mass emission factor represents an industry average, considering the various types of products printed. The fugitive emission mass emission factor was determined simply by the difference between total emissions and the other point emissions. The corresponding mass emission factor per volume of raw ink (and coating) used for each point emission were determined using the same method described for the total emission factor.

II. Eighty-five Percent Controlled Emission Factors[1]

Emission Point	lb/lb (kg/kg)	lb/gal	kg/liter
Fugitive	0.07	0.87	0.10
Printed Product	0.03	0.37	0.05
Control Device	0.05	0.62	0.07
Total Emissions	0.15	1.86	0.22

Facility: Individual modern-design printing press controlled by a solvent vapor capture system combined with a fixed-bed carbon adsorption/ solvent recovery system.

Control Performance:

- 90 percent capture of total solvent used - fugitive vapors and dryer exhaust control
- 95 percent efficient carbon adsorption control device
- 85 percent overall VOC reduction efficiency

Emission factors representing 85 percent overall control are based on the best demonstrated control technology for modern-design presses. Fugitive VOC vapors as well as dryer exhausts are captured. The data base consists of short-term EPA test results and long-term plant data for two plants combined with long-term plant data from a third non-tested plant. The short-term test data results were based on overall solvent volume material balances and gas-phase analyses of the solvent laden air streams in and out of the carbon adsorbers. The results showed control device efficiencies range from about 94 to over 98 percent. The potential overall control efficiency results from the tests showed that 89 to 93 percent control is possible under the test conditions. However, the long-term plant data showed that overall control efficiency can range from about 84 to 91 percent. The long-term data were based on overall solvent volume and solvent mass material balances. Thus, 85 percent control represents an achievable, long-term average for the entire industry. The long-term average control device efficiency can be expected to be about 95 percent. The corresponding capture efficiency calculates out to be 90 percent.

For 85 percent control, the total mass emission factor is 0.15. The corresponding generalized VOC emission factors for volume of raw ink used were developd on the same basis as explained for 75 percent control. The control device outlet emissions were determined by knowing the capture efficiency and the control device efficiency, as follows:

$$\text{Control Device Outlet Emissions} = \left[\text{Capture Efficiency}\right] \times \left[1 - \text{Control Device Efficiency}\right]$$

$$= (0.90) \times (1 - 0.95)$$

$$= \underline{0.05} \text{ Mass VOC/Mass Total Solvent}$$

The emission factors for the product-retained solvent were assumed to be the same as for the 75 percent control case. The fugitive emission factors were determined by the difference between total emissions and the other point emissions.

III. Uncontrolled Emission Factors[1,2]

Emission Point	lb/lb (kg/kg)	lb/gal	kg/liter
Dryer Exhaust	0.84	10.42	1.24
Fugitives	0.13	1.61	0.19
Printed Product	0.03	0.37	0.05
Total Emissions	1.00	12.40	1.48

Facility: Individual printing press.

Emission factors for uncontrolled presses are based on the combination of information from EPA's CTG document and short-term EPA tests at one facility which capture dryer exhausts only. Also, it was assumed that 100 percent of the total solvent used is vaporized in the printing process. As previously mentioned, about 84 percent of the total solvent used is vented through the dryer exhausts. The emission factors for the printed product-retained solvent were assumed to be the same as for the two controlled press cases. The fugitive emission factors were determined by the difference between total emissions and the other point emissions. The corresponding generalized VOC emission factors for volume of raw ink used were developed on the same basis as explained for the two controlled press cases.

References

1. Publication Rotogravure Printing - Background Information for Proposed Standards. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA-450/3-80-031a. October 1980. 273 p.

2. Control of Volatile Organic Emissions from Existing Stationary Sources - Volume VIII: Graphic Arts - Rotogravure and Flexography. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA-450/2-78-033. December 1978. p. 1-2, and 3-9.

ENCLOSURE 3

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AP-42 EMISSION FACTOR RATING FOR TABLE 4.9-1

There are about 30 plants presently operating in the publication rotogravure printing industry. Emission control performance data were obtained from four of these plants.[1] In addition, EPA's CTG document for rotogravure printing was consulted.[1] The overall rating of the emission factors presented in Table 4.9-1 are based on the following itemized ratings for each data source:

Data Source[2]	Performance Averaging Period	Rating
EPA Emission Test - Texas Color Printers, Inc.	3 runs 13.4 hours total	B
EPA Emission Test - Meredith/Burda, Inc.	3 runs 26 hours total	B
Material Balance Test - Texas Color Printers, Inc.	27 hours	B
Material Balance Test - Meredith/Burda, Inc.	51.5 hours	B
Material Balance Test - Texas Color Printers, Inc.	82 hours	B
Plant Operating Data - World Color Press	4 months	A
Plant Operating Data - Texas Color Printers, Inc.	5 months	A
Monthly Plant Operating Data - Meredith/Burda, Inc.	10 months	A
Four-week Average Plant Operating Data - Standard Gravure Corp.	15 months	A
EPA CTG Document		C
Overall Rating:		C

The emission control performance results from each of the test and plant data sources were determined by an accurate overall liquid solvent volume balance. The data were reported in enough detail for adequate validation. As explained in Reference 2, short-term test results can be misleading because of variation in printing operations, the numerous types of publication products printed, and the solvent hold-up volume of fixed-bed carbon adsorption systems. Long-term plant operating data provide a better representation of achievable control levels because longer averaging times allow sufficient time for these variations to average-out. Therefore, the long-term data were given "A" ratings, while short-term data were given "B" ratings.

The emission factors derived from EPA's CTG document was not based on test data or long-term plant data. This data source was rated "C" because control performance information was based on engineering analysis and plant visits and may have been derived by averaging data from several plants where press operation and type of product printed varied. The uncontrolled and 75 percent controlled emission factors were based in part on this data source.

The emission factors for the 85 percent controlled case were based on a combination of the short-term test data and long-term plant data. These data show that about 90 percent overall control is achievable under some conditions; however, 90 percent control is not representative of all conditions for the entire publication rotogravure industry. Eighty-five percent control is a more realistic, achievable long-term control level.

Therefore, there are three reasons why the overall rating for the table of emission factors was only a "C." First, the uncontrolled and 75 percent controlled emission factors were based in part on the "C" rated CTG data source. Secondly, the emission factors were based on A and B rated data from a small number of facilities. Finally, the actual emission factors can vary widely depending on the type of product printed, frequency of press shutdowns, length of performance averaging period, efficiency of capture and control device systems, etc.

References

1. Control of Volatile Organic Emissions from Existing Stationary Sources - Volume VIII: Graphic Arts - Rotogravure and Flexography. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA-450/2-78-033. December 1978. p. 1-2, and 3-9.

2. Publication Rotogravure Printing - Background Information for Proposed Standards. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA-450/3-80-031a. October 1980. p. 4-1 to 4-9, 6-11 to 6-13, C-1 to C-38, and D-1 to D-3.