4.2.2.12 Metal Furniture Surface Coating

4.2.2.12.1 General

The metal furniture surface coating process is a multistep operation consisting of surface cleaning, coatings application, and curing. Items such as desks, chairs, tables, cabinets, bookcases, and lockers are normally fabricated from raw material to finished product in the same facility. The industry uses primarily solventborne coatings, applied by spray, dip, or flow coating processes. Spray coating is the most common application technique used. The components of spray coating lines vary from plant to plant, but generally consist of the following:

3- to 5-stage washer
Dryoff oven
Spray booth
Flashoff area
Bake oven

Items to be coated are first cleaned in the washer to remove any grease, oil, or dirt from the surface. The washer generally consists of an alkaline cleaning solution, a phosphate treatment to improve surface adhesion characteristics, and a hot water rinse. The items are then dried in an oven and conveyed to the spray booth, where the surface coating is applied. After this application, the items are conveyed through the flashoff area to the bake oven, where the surface coating is cured. A diagram of these consecutive steps is presented in Figure 4.2.2.12-1. Although most metal furniture products receive only 1 coat of paint, some facilities apply a prime coat before the topcoat to improve the corrosion resistance of the product. In these cases, a separate spray booth and bake oven for application of the prime coat are added to the line, following the dryoff oven.

The coatings used in the industry are primarily solventborne resins, including acrylics, amines, vinyls, and cellulosics. Some metallic coatings are also used on office furniture. The solvents used are mixtures of aliphatics, xylene, toluene, and other aromatics. Typical coatings that have been used in the industry contain 65 volume percent solvent and 35 volume percent solids. Other types of coatings now being used in the industry are waterborne, powder, and solventborne high solids coatings.

4.2.2.12.2 Emissions And Controls

Volatile organic compounds (VOC) from the evaporation of organic solvents in the coatings are the major pollutants from metal furniture surface coating operations. Specific operations that emit VOC are the coating application process, the flashoff area and the bake oven. The percentage of total VOC emissions given off at each emission point varies from one installation to another, but on the average spray coating line, about 40 percent is given off at the application station, 30 percent in the flashoff area, and 30 percent in the bake oven.

Factors affecting the quantity of VOC emitted from metal furniture surface coating operations are the VOC content of the coatings applied, the solids content of coatings as applied, and the transfer efficiency. Knowledge of both the VOC content and solids content of coatings is necessary in cases where the coating contains other components, such as water.

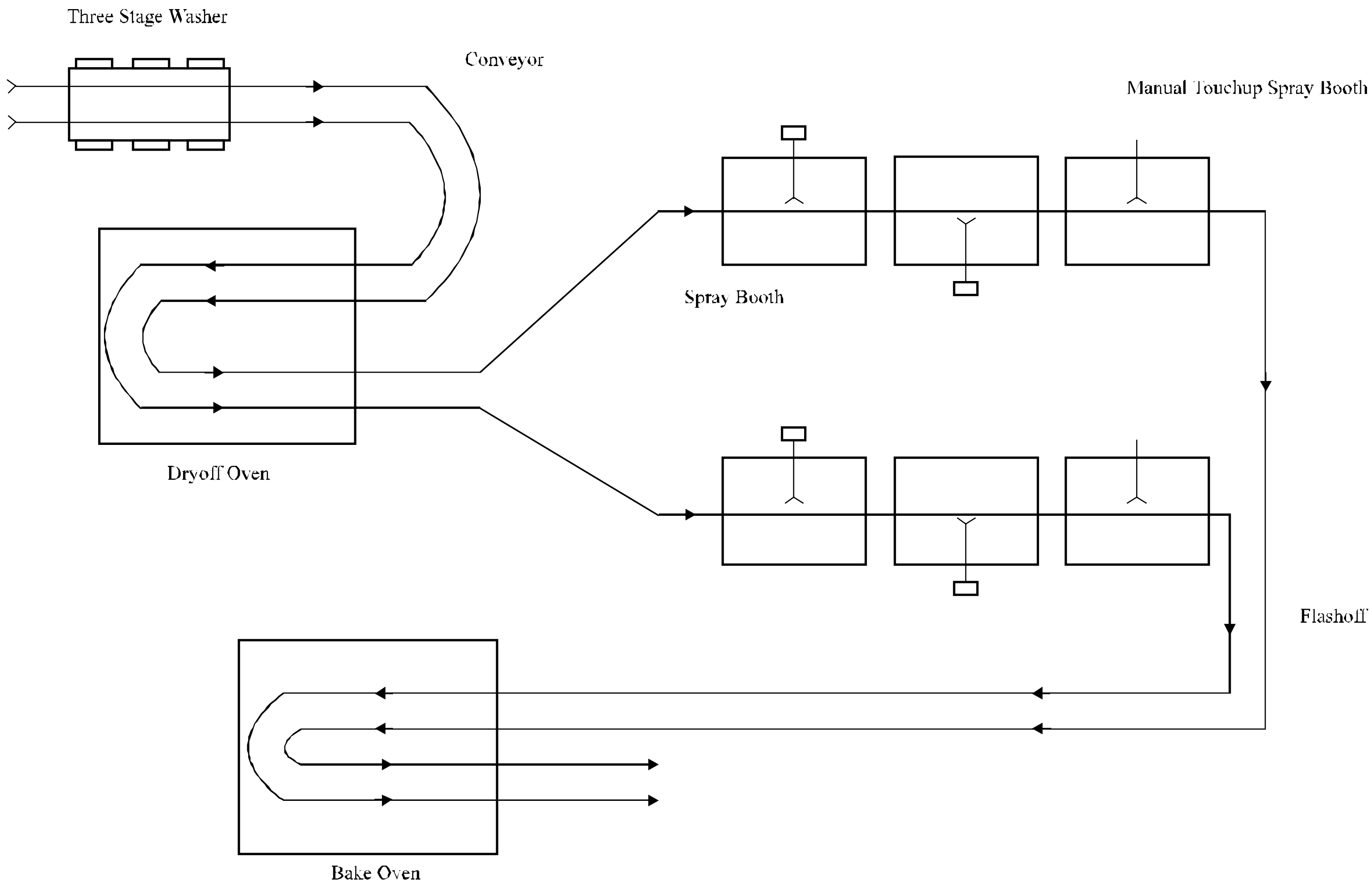

Figure 4.2.2.12-1. Example automated spray coating lines, with manual touchup.

The transfer efficiency (volume fraction of the solids in the total consumed coating that remains on the part) varies with the application technique. Transfer efficiency for standard (or ordinary) spraying ranges from 25 to 50 percent. The range for electrostatic spraying, a method that uses an electrical potential to increase transfer efficiency of the coating solids, is from 50 to 95 percent, depending on part size and shape. Powder coating systems normally capture and recirculate overspray material and, therefore, are considered in terms of a "utilization rate" rather than a transfer efficiency. Most facilities achieve a powder utilization rate of 90 to 95 percent.

Typical values for transfer efficiency with various application devices are in Table 4.2.2.12-1.

Table 4.2.2.12-1. COATING METHOD TRANSFER EFFICIENCIES

Application Methods	Transfer Efficiency (Te)
Air atomized spray	0.25
Airless spray	0.25
Manual electrostatic spray	0.60
Nonrotational automatic electrostatic spray	0.70
Rotating head electrostatic spray (manual and automatic)	0.80
Dip coat and flow coat	0.90
Electrodeposition	0.95

Two types of control techniques are available to reduce VOC emissions from metal furniture surface coating operations. The first technique makes use of control devices such as carbon absorbers and thermal or catalytic incinerators to recover or destroy VOC before it is discharged into the ambient air. These control methods are seldom used in the industry, however, because the large volume of exhaust air and low concentrations of VOC in the exhaust reduce their efficiency. The more prevalent control technique involves reducing the total amount of VOC likely to be evaporated and emitted. This is accomplished by use of low VOC content coatings and by improvements in transfer efficiency. New coatings with relatively low VOC levels can be used instead of the traditional high VOC content coatings. Examples of these new systems include waterborne coatings, powder coatings, and higher solids coatings. Improvements in coating transfer efficiency decrease the amount that must be used to achieve a given film thickness, thereby reducing emissions of VOC to the ambient air. By using a system with increased transfer efficiency (such as electrostatic spraying) and lower VOC content coatings, VOC emission reductions can approach those achieved with control devices.

The data presented in Tables 4.2.2.12-2 and 4.2.2.12-3 are representative of values which might be obtained from existing plants with similar operating characteristics. Each plant has its own combination of coating formulations, application equipment, and operating parameters. It is recommended that, whenever possible, plant-specific values be obtained for all variables when calculating emission estimates.

Table 4.2.2.12-2 (Metric Units). OPERATING PARAMETERS FOR COATING OPERATIONS

Plant Size	Operating Schedule (hr/yr)	Number Of Lines	Line Speed[a] (m/min)	Surface Area Coated/yr (m^2)	Liters Of Coating Used[b]
Small	2,000	1 (1 spray booth)	2.5	45,000	5,000
Medium	2,000	3 (3 booths/line)	2.4	780,000	87,100
Large	2,000	10 (3 booths/line)	4.6	4,000,000	446,600

[a] Line speed is not used to calculate emissions, only to characterize plant operations.
[b] Using 35 volume % solids coating, applied by electrostatic spray at 65% transfer efficiency.

Table 4.2.2.12-3 (Metric Units). EMISSION FACTORS FOR VOC FROM SURFACE COATING OPERATIONS[a,b]

Plant Size And Control Techniques	VOC Emissions		
	kg/m^2 Coated	kg/yr	kg/hr
Small			
Uncontrolled emissions	0.064	2,875	1.44
65 Volume % high solids coating	0.019	835	0.42
Waterborne coating	0.012	520	0.26
Medium			
Uncontrolled emissions	0.064	49,815	24.90
65 Volume % high solids coating	0.019	14,445	7.22
Waterborne coating	0.012	8,970	4.48
Large			
Uncontrolled emissions	0.064	255,450	127.74
65 Volume % high solids coating	0.019	74,080	37.04
Waterborne coating	0.012	46,000	23.00

[a] Calculated using the parameters given in Table 4.2.2.12-2 and the following equation. Values have been rounded off.

$$E = \frac{0.0254\ ATVD}{S\ Te}$$

where:

E = Mass of VOC emitted per hour (kg)
A = Surface area coated per hour (m^2)
T = Dry film thickness of coating applied (mils)

Table 4.2.2.12-3 (cont.).

V = VOC content of coating, including dilution solvents added at the plant (fraction by volume)
D = VOC density (assumed to be 0.88 kg/L)
S = Solids content of coating (fraction by volume)
T_e = Transfer efficiency (fraction)

The constant 0.0254 converts the volume of dry film applied per m^2 to liters.

Example: The VOC emission from a medium size plant applying 35 volume % solids coatings and the parameters given in Table 4.2.2.12-3.

$$E_{\text{kilograms of VOC/hr}} = \frac{(0.0254)\ (390\ m^2/hr)\ (1\ mil)\ (0.65)\ (0.88\ kg/L)}{(0.35)\ (0.65)}$$

$$= 24.9 \text{ kilograms of VOC/hr}$$

[b] Nominal values of T, V, S, and Te:

T = 1 mil (for all cases)
V = 0.65 (uncontrolled), 0.35 (65 volume % solids), 0.117 (waterborne)
S = 0.35 (uncontrolled), 0.65 (65 volume % solids), 0.35 (waterborne)
Te = 0.65 (for all cases)

Another method that also may be used to estimate emissions for metal furniture coating operations involves a material balance approach. By assuming that all VOC in the coatings applied are evaporated at the plant site, an estimate of emissions can be calculated using only the coating formulation and data on the total quantity of coating used in a given time period. The percentage of VOC solvent in the coating, multiplied by the quantity of coating used yields the total emissions. This method of emissions estimation avoids the requirement to use variables such as coating thickness and transfer efficiency, which are often difficult to define precisely.

Reference For Section 4.2.2.12

1. *Surface Coating Of Metal Furniture—Background Information For Proposed Standards*, EPA-450/3-80-007a, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1980.