

4.2.2.10 Metal Coil Surface Coating

4.2.2.10.1 General¹⁻²

Metal coil surface coating (coil coating) is the linear process by which protective or decorative organic coatings are applied to flat metal sheet or strip packaged in rolls or coils. Although the physical configurations of coil coating lines differ from one installation to another, the operations generally follow a set pattern. Metal strip is uncoiled at the entry to a coating line and is passed through a wet section, where the metal is thoroughly cleaned and is given a chemical treatment to inhibit rust and to promote coatings adhesion to the metal surface. In some installations, the wet section contains an electrogalvanizing operation. Then the metal strip is dried and sent through a coating application station, where rollers coat one or both sides of the metal strip. The strip then passes through an oven where the coatings are dried and cured. As the strip exits the oven, it is cooled by a water spray and again dried. If the line is a tandem line, there is first the application of a prime coat, followed by another of top or finish coat. The second coat is also dried and cured in an oven, and the strip is again cooled and dried before being rewound into a coil and packaged for shipment or further processing. Most coil coating lines have accumulators at the entry and exit that permit continuous metal strip movement through the coating process while a new coil is mounted at the entry or a full coil removed at the exit. Figure 4.2.2.10-1 is a flow diagram of a coil coating line.

Coil coating lines process metal in widths ranging from a few centimeters to 183 centimeters (72 inches), and in thicknesses of from 0.018 to 0.229 centimeters (0.007 to 0.090 inches). The speed of the metal strip through the line is as high as 3.6 meters per second (700 feet per minute [ft/min]) on some of the newer lines.

A wide variety of coating formulations is used by the coil coating industry. The more prevalent coating types include polyesters, acrylics, polyfluorocarbons, alkyds, vinyls and plastisols. About 85 percent of the coatings used are organic solvent base and have solvent contents ranging from near 0 to 80 volume percent, with the prevalent range being 40 to 60 volume percent. Most of the remaining 15 percent of coatings are waterborne, but they contain organic solvent in the range of 2 to 15 volume percent. High solids coatings, in the form of plastisols, organosols, and powders, are also used to some extent by the industry, but the hardware is different for powder applications.

The solvents most often used in the coil coating industry include xylene, toluene, methyl ethyl ketone (MEK), Cellosolve AcetateTM, butanol, diacetone alcohol, CellosolveTM, Butyl CellosolveTM, Solvesso 100 and 150TM, isophorone, butyl carbinol, mineral spirits, ethanol, nitropropane, tetrahydrofuran, PanasolveTM, methyl isobutyl ketone, Hisol 100TM, Tenneco T-125TM, isopropanol, and diisoamyl ketone.

Coil coating operations can be classified in 1 of 2 operating categories, toll coaters and captive coaters. The toll coater is a service coater who works for many customers according to the needs and specifications of each. The coated metal is delivered to the customer, who forms the end products. Toll coaters use many different coating formulations and normally use mostly organic solvent-base coatings. Major markets for toll coating operations include the transportation industry, the construction industry, and appliance, furniture, and container manufacturers. The captive coater is normally 1 operation in a manufacturing process. Many steel and aluminum companies have their own coil coating operations, where the metal they produce is coated and then formed into end

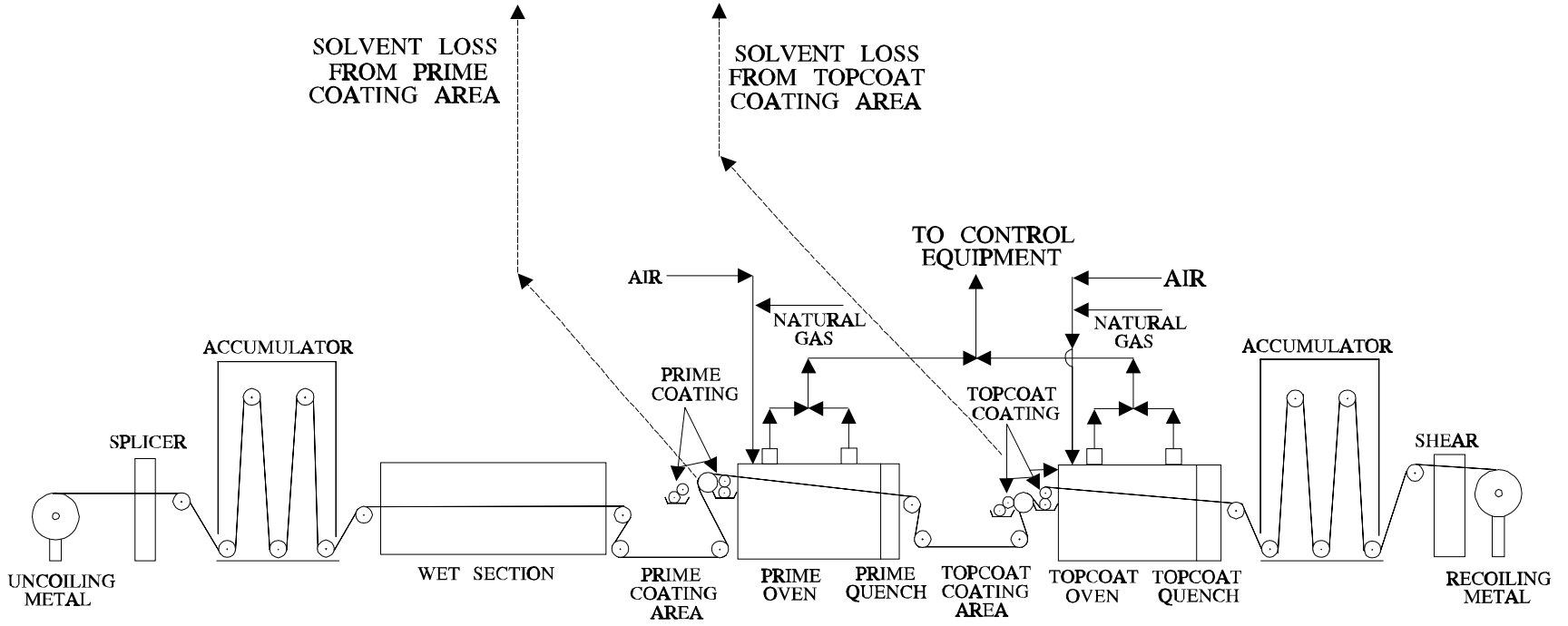


Figure 4.2.2.10-1. Flow diagram of model coil coating line.

products. Captive coaters are much more likely to use water-base coatings because the metal coated is often used for only a few end products. Building products such as aluminum siding are one of the more important uses of waterborne metal coatings.

4.2.2.10.2 Emissions And Controls¹⁻¹²

Volatile organic compounds (VOC) are the major pollutants emitted from metal coil surface coating operations. Specific operations that emit VOC are the coating application station, the curing oven and the quench area. These are identified in Figure 4.2.2.10-1. VOC emissions result from the evaporation of organic solvents contained in the coating. The percentage of total VOC emissions given off at each emission point varies from one installation to another, but, on the average, about 8 percent is given off at the coating application station, 90 percent the oven and 2 percent the quench area. On most coating lines, the coating application station is enclosed or hooded to capture fugitive emissions and to direct them into the oven. The quench is an enclosed operation located immediately adjacent to the exit end of the oven so that a large fraction of the emissions given off at the quench is captured and directed into the oven by the oven ventilating air. In operations such as these, approximately 95 percent of the total emissions are exhausted by the oven, and the remaining 5 percent escape as fugitive emissions.

The rate of VOC emissions from individual coil coating lines may vary widely from one installation to another. Factors that affect the emission rate include VOC content of coatings as applied, VOC density, area of metal coated, solids content of coatings as applied, thickness of the applied coating and number of coats applied. Because the coatings are applied by roller coating, transfer efficiency is generally considered to approach 100 percent and therefore does not affect the emission rate.

Two emission control techniques are widespread in the coil coating industry, incineration and use of low-VOC-content coatings. Incinerators may be either thermal or catalytic, both of which have been demonstrated to achieve consistently a VOC destruction efficiency of 95 percent or greater. When used with coating rooms or hoods to capture fugitive emissions, incineration systems can reduce overall emissions by 90 percent or more.

Waterborne coatings are the only low-VOC-content coating technology that is used to a significant extent in the coil coating industry. These coatings have substantially lower VOC emissions than most of the organic solventborne coatings. Waterborne coatings are used as an emission control technique most often by installations that coat metal for only a few products, such as building materials. Many such coaters are captive to the firm that produces and sells the products fabricated from the coated coil. Because waterborne coatings have not been developed for many coated metal coil uses, most toll coaters use organic solventborne coatings and control their emissions by incineration. Most newer incinerator installations use heat recovery to reduce the operating cost of an incineration system.

Emission factors for coil coating operations and the equations used to compute them are presented in Table 4.2.2.10-1. The values presented therein represent maximum, minimum, and average emissions from small, medium, and large coil coating lines. An average film thickness and an average solvent content are assumed to compute the average emission factor. Values for the VOC content near the maximum and minimum used by the industry are assumed for the calculations of maximum and minimum emission factors.

The emission factors in Table 4.2.2.10-1 are useful in estimating VOC emissions for a large sample of coil coating sources, but they may not be applicable to individual plants. To estimate the

emissions from a specific plant, operating parameters of the coil coating line should be obtained and used in the equation given in the footnote to Table 4.2.2.10-1. If different coatings are used for prime and topcoats, separate calculations must be made for each coat. Operating parameters on which the emission factors are based are presented in Table 4.2.2.10-2.

Table 4.2.2.10-1 (Metric And English Units). VOC EMISSION FACTORS FOR COIL COATING^a

EMISSION FACTOR RATING: C

Coatings	kg/hr (lb/hr)		kg/m ² (lb/ft ²)	
	Average	Normal Range	Average	Normal Range
Solventborne Uncontrolled	303 (669)	50 - 1,798 (110 - 3,964)	0.060 (0.012)	0.027 - 0.160 (0.006 - 0.033)
Controlled ^b	30 (67)	5 - 180 (11 - 396)	0.0060 (0.0012)	0.0027 - 0.0160 (0.0006 - 0.0033)
Waterborne	50 (111)	3 - 337 (7 - 743)	0.0108 (0.0021)	0.0011 - 0.0301 (0.0003 - 0.0062)

^a All nonmethane VOC. Factors are calculated using the following equations and the operating parameters given in Table 4.2.2.10-2.

$$(1) \quad E = \frac{0.623 \text{ ATVD}}{S}$$

where:

- E = Mass of VOC emissions per hour (lb/hr)
- A = Area of metal coated per hour (ft²)
= Line speed (ft/min) x strip width (ft) x 60 min/hr
- T = Total dry film thickness of coatings applied (in.).
- V = VOC content of coatings (fraction by volume)
- D = VOC density (assumed to be 7.36 lb/gal)
- S = Solids content of coatings (fraction by volume)

The constant 0.623 represents conversion factors of 7.48 gal/ft³ divided by the conversion factor of 12 in./ft.

$$(2) \quad M = \frac{E}{A}$$

where:

M = Mass of VOC emissions per unit area coated.

^b Computed by assuming a 90% overall control efficiency (95% capture and 95% removal by the control device).

Table 4.2.2.10-2 (English Units). OPERATING PARAMETERS FOR SMALL, MEDIUM, AND LARGE COIL COATING LINES^a

Line Size	Line Speed (ft/min)	Strip Width (ft)	Total Dry Film Thickness ^b (in.)	VOC Content ^c (fraction)	Solids Content ^c (fraction)	VOC Density ^b (lb/gal)
Solventborne coatings						
Small	200	1.67	0.0018	0.40	0.60	7.36
Medium	300	3	0.0018	0.60	0.40	7.36
Large	500	4	0.0018	0.80	0.20	7.36
Waterborne coatings						
Small	200	1.67	0.0018	0.02	0.50	7.36
Medium	300	3	0.0018	0.10	0.40	7.36
Large	500	4	0.0018	0.15	0.20	7.36

^a Obtained from Reference 3.

^b Average value assumed for emission factor calculations. Actual values should be used to estimate emissions from individual sources.

^c All three values of VOC content and solids content were used in the calculation of emission factors for each plant size to give maximum, minimum, and average emission factors.

References For Section 4.2.2.10

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