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5.10 Paint & Varnish

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AIR POLLUTANT

EMISSION FACTORS

April 1970

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Public Health Service
Environmental Health Service
National Air Pollution Control Administration
Washington, D. C.

TRW
SYSTEMS GROUP OF TRW INC.

1. INTRODUCTION

This report represents a compilation of the latest atmospheric emission data available for a wide variety of selected processes. One-half of the 40 processes discussed in this report involve an updating or review of existing emission factors presented in Public Health Service Publication 999-AP-42, "A Compilation of Air Pollutant Emission Factors" by R.L. Duprey. The remaining factors represent new processes for which emission factors were not previously reported. All emission factors refer to uncontrolled processes unless otherwise stated.

Information for emission factors was gathered primarily from the technical literature up to November 1969, state and local air pollution control agencies, trade and professional associations, releasable portions of data obtained by TRW in various past studies, and individual companies and persons within the various industries under study. In all cases, attempts were made to obtain some idea of the validity of the information obtained, and thus place each bit of data relative to other data in the same area. Greatest weight was given to actual measured emission data, i.e., source tests, especially when the measuring technique was known. Estimates of emissions were also made when feasible by making material balances and process loss or yield calculations.

In general, it was found that except for the combustion and incineration fields, very little new emission factor data has been made public since Duprey's work in 1967. In the metallurgical and mineral industries, additional emission data has been obtained by various companies and control equipment manufacturers. This information has not been made public, however. Some emission data was available for most of the new factors developed in this report. Frequently, however, these data were in the form of concentrations only, not quantitative emission rates. Process weight rates were also frequently not given or reported. Considerable engineering calculations were thus required in order to put these data into a form usable for emission factors. These calculations, based on material balances, combustion reactions, humidity balances, and comparisons with similar processes with available emission data, allowed one to relate the reported data with process throughputs and develop a factor which is usable until better data are made available.

Detailed information used to obtain the emission factors is generally presented in an appendix to each section. Selection of a final emission factor depended on the amount and range of data available. Where considerable data existed a direct arithmetic average was used. Values on order of magnitude greater or less than the bulk of the data were not considered in determining the arithmetic average. Where limited data were available (1 to 5 values) and the values covered a wide range, the selected factor was based on our best judgment considering the factors affecting emissions. Whenever possible, the range or variation in emission factors was reported and shown in parenthesis following the factor. This range represents the range of values used in obtaining the factor and represents the expected variation in emissions. A lack of information sometimes prevented the reporting of a reasonable factor range.

Standard statistical deviations of the emission factors were not generally reported since insufficient or only widely scattered data were available and a significant deviation could not be calculated.

All emission factors in this report were ranked according to the available data upon which they were based. A system which weighted various information categories was used to rank the final factors. These categories were: measured emission data with a total possible weight of 20, process data with a weight of 10, and engineering analysis with a weight of 10. The highest possible score for any factor was thus 40. Any factor ranking less than 20 was considered questionable and those ranked 20 or greater were considered reliable.

The emission data category rated the amount of measured emission data, i.e., stack test data available with which to develop an emission factor.

The process data category included such factors as the variability of the process and its effect on emissions, and available data on the variables. The engineering analysis category included the data available upon which a material balance or related emission calculation could be based.

The range of values for many emission factors is large. However, when the factors are applied to a large number of sources, the calculated overall emissions should approximate the true value. When applied to a single isolated source, an emission factor may yield emissions that differ considerably from the true value. Measured emission data should therefore be used, if possible, for single sources.

4. CHEMICAL MANUFACTURING INDUSTRIES

This section deals with the emissions from the manufacture and/or use of chemicals or chemical products. Potential emissions from many of these processes are high, but due to the nature of these compounds, they are, in general, recovered as an economic necessity to the profitable operation of the process. In still other cases, the manufacturing operation is run as a closed system allowing little or no escape to the atmosphere of any of the reactants or by-products.

In general, the emission which can reach the atmosphere from these processes is primarily gaseous and is controlled by incineration, adsorption, or absorption. In some cases, however, particulate emissions are also a problem from the manufacturing processes. When these occur, they are generally particles of extremely small size and require very efficient treatment for removal.

In a few cases, such as carbon black, charcoal, and rayon manufacture, emission of various noxious gases is a major problem which could be controlled, but control is apparently not economically attractive.

For many chemical processes emission data is extremely sparse, or non existent. Emissions were therefore frequently estimated based on material balances, yields, or similar processes. These factors are,of course,not as reliable as measured emission data.

Since the major emissions from the processes presented in this section are gases, no particle size summary is presented.

4.6 PAINT AND VARNISH

Process Description[1,2]

The manufacture of paint involves the dispersion of a colored oil or pigment in a vehicle, usually an oil or resin, followed by the addition of an organic solvent for viscosity adjustment. Only physical processes of weighing, mixing, grinding, tinting, thinning and packaging are involved; there are no chemical reactions. These processes take place in large mixing tanks at approximately room temperature. Higher temperatures are also occasionally used depending on the product. Tinting pigments include lead and titanium oxides, and carbon black. Thinners and solvents include mineral spirits, turpentine, naphtha, xylol, etc.

The manufacture of varnish also involves the mixing and blending of various ingredients to produce a wide range of products. However, in this case chemical reactions are initiated by heating, to produce the desired product. Varnish cooking is accomplished in either open or enclosed gas-fired kettles for periods of 4 to 16 hours at a temperature of 200-650°F. The exact cooking time and temperature vary widely and depend on the ingredients and desired product.

Emissions, largely in the form of organic compounds, escape during the cooking process while the chemical reactions, such as polymerization, esterification and isomerization, and distillation occur.

Factors Affecting Emissions

The primary factors affecting emissions from paint manufacture are care in handling dry pigments, type of solvents used, and mixing temperature. Varnish cooking emissions depend on the cooking temperatures and time, solvent used, degree of tank enclosure, and type of air pollution controls used.

Emissions

In the manufacture of paint, about 1 to 2% of the solvents are lost even under well controlled conditions.[2,3] Particulate emissions amount to 0.5 to 1% of the pigment handled.[4]

Emissions from varnish cooking amount to 1 to 6% of the raw material and consist of both gaseous and condensed organic compounds.[1] Particle sizes in the 8 to 10 micron size range have been measured.[1] Table 4.6-1 lists the types of compounds which may be emitted from various varnish manufacturing operations.

Table 4.6-1. Typical Varnish Raw Materials and Emissions During Cooking[2]

RAW MATERIAL			
Bodying Oils	Running Natural Gums	Manufacturing Oleoresinous Varnish	Manufacturing Alkyd Varnish
EMISSIONS			
Water Vapor	Water Vapor	Water Vapor	Water Vapor
Fatty Acids	Fatty Acids	Fatty Acids	Fatty Acids
Glycerine	Terpenes	Glycerine	Glycerine
Acrolein	Terpene Oils	Acrolein	Phthalic Anhydride
Aldehydes	Tar	Phenols	Carbon Dioxide
Ketones		Aldehydes	
Carbon Dioxide		Ketones	
		Terpene Oils	
		Terpenes	
		Carbon Dioxide	

Based on information summarized in Appendix 4.6, the emission factors in Table 4.6-2 were developed.

Table 4.6-2. Uncontrolled Emission Factors for Paint and Varnish Manufacturing[b]

	PAINT	
Particulates	2 (1-4)	lbs/ton of pigment
Hydrocarbons[a]	30 (10-40)	lbs/ton of paint

VARNISH

Type of Varnish	Emission, lbs/ton of varnish[a]
Bodying Oil	40 (20-60)
Oleoresinous	150 (60-240)
Alkyd	160 (80-240)
Acrylic	20

a) Expressed as undefined organic compounds whose composition depends on the type of varnish or paint.

b) Control techniques used to reduce hydrocarbons include condensers and/or adsorbers on solvent handling operations, and scrubbers and afterburners on cooking operations. Afterburners can reduce gaseous hydrocarbon emissions by 99% and particulates by about 90%.[1] A water spray and oil filter system reduce particulate emissions from paint blending by 90%.

Reliability of Emission Factors

These factors are questionable due to lack of new data or source tests. The reported emissions are based on estimates or measurements of process weight loss and are considered to be all atmospheric losses. Table 4.6-3 presents the factor ranking.

The major assumption inherent in these factors is that the emissions as determined by process weight losses are essentially all atmospheric losses.

Table 4.6-3. Emission Factor Ranking for Paint and Varnish Manufacture

Emission Data 0-20	Process Data 0-10	Engineering Analysis 0-10	Total
8	5	5	18

APPENDIX 4.6

Emission Data from literature:

<u>Paint Mixing and Blending</u>

Type of Emission	Quantity	Reference
Particulates	1-4 lbs/ton of pigment	3, 4
	0.5-1.7 lbs/ton after a water spray and filter	6
Hydrocarbons	20-40 lbs/ton of paint	4
	36 lbs/ton of paint	5
	1-2% of solvent (20-40 lbs/ton)	2
	10 lbs/ton of paint	7

<u>Varnish (Reference 2)</u>

Hydrocarbons, lbs/ton of varnish		Type of Varnish
range	average	
20-60	40	Bodying Oils
60-240	150	Oleoresinous
80-240	160	Alkyd
20	-	Acrylic
1-5%	3% or 60 lbs/ton	- (Reference 1)

Note: Paints weigh 10-15 pounds/gallon; varnish weighs about 7 pounds/gallon.

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