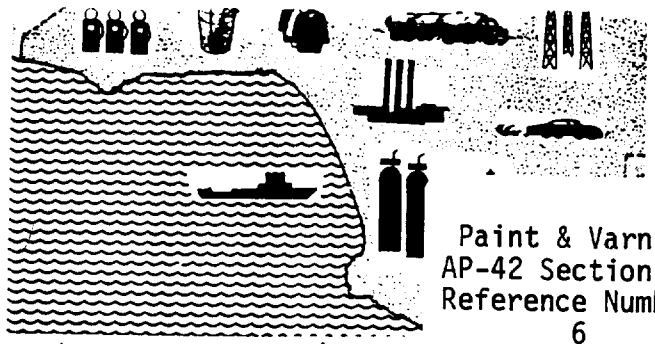
Organic-solvent usage in Los Angeles County approaching 600 tons daily has been revealed in the course of several surveys made by the Air Pollution Control District. It is estimated that only about 400 of the 600 tons are vaporized into the Los Angeles atmosphere. Information acquired through these surveys is detailed in the accompanying article in which the authors state that control may be achieved by adaptation of disposal equipment, reformulation of solvent-containing products so as to eliminate the solvents, and development of new techniques in surface-coating operations.



Paint & Varnish
AP-42 Section 5-10
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24 years ago !! what happened ?!

DISTRIBUTION SURVEY OF

PRODUCTS EMITTING ORGANIC VAPORS

IN LOS ANGELES COUNTY

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Air Pollution Control District,*
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The interest by the Los Angeles County Air Pollution Control District in organic solvent emissions to the atmosphere originated in 1949. At that time it was suggested that hydrocarbons were, in some way, participating in reactions leading to the formation of smog. These reactions consisted of the oxidation of organic material in the presence of sunlight in an oxidizing atmosphere (*6, 3*).

Considerable experimentation was undertaken in many laboratories to test the theory. Foremost among these were the experiments of A. J. Haagen-Smit, of the California Institute of Technology, and A.P.C.D. workers, who utilized the postulated reactions to prepare synthetic smog mixtures. The similarity between these synthetic smog mixtures and natural smog was demonstrated through their ability to produce eye irritation, damage to vegetation, rubber cracking, natural smog odor, and ozone (*1, 4*).

Since pure hydrocarbons or mixtures of hydrocarbons similar to those found in gasoline were used in these experiments, analogous reasoning indicated that organic solvents, which are hydrocarbons and hydrocarbon derivatives, would also be oxidized, such oxidation resulting in compounds with smog potential. Evidence confirming this has been published independently by A. J. Haagen-Smit and by A.P.C.D. workers, and the Franklin Institute Laboratories for Research and Development (*5, 2, 7*). Some of the organic compounds checked, other than pure hydrocarbons, were alcohols, aldehydes, ketones, acids, mercaptans, chlorinated hydrocarbons, and organic nitrogen compounds.

To assess the contribution of these and other organic solvents to the overall air pollution problem, the A.P.C.D. programmed a series of surveys to yield:

1. sources of supply for organic solvents
2. variety and volume of organic solvents marketed
3. consumers of organic solvents
4. sources of emissions of organic solvents
5. variety and volume of organic solvents emitted

Several of these surveys have already been conducted by mailing questionnaires, by making inspections of specific installations, and by conferring with representatives of industry. Company lists for the surveys were developed from District files, classified sections of telephone books, Chamber of Commerce listings, trade association membership rosters, and other governmental agency licensing and inspection records.

The initial survey which covered the organic solvent suppliers (manufacturers, distributors, jobbers, and brokers) identified the purchasers of solvents in Los Angeles County. From this, information was provided for "keying in" other surveys to the program and pinpointing the sources of solvent emissions. Additional surveys have been of:

1. dry cleaners
2. rotogravure plants
3. paint, varnish, enamel and lacquer manufacturers and distributors
4. Surface coatings users including:
   a. automobile assembly plants
   b. aircraft companies
   c. can and container manufacturers
   d. furniture manufacturers
   e. appliance manufacturers

In order that all information acquired through the surveys could be evaluated on a uniform basis, a definition of solvent was adopted. Classically, an organic solvent is an organic compound or mixture, usually liquid, which is capable of dissolving other solid, liquid, or gaseous substances. The definition adopted by the District required that for a substance to be considered an organic solvent, it had to be:

1. an organic liquid, capable of being evaporated or vaporized into the atmosphere at the conditions of its usage and storage, and
2. a substance used to dissolve, dilute, or disperse another substance (or substances) without itself being chemically changed.

Some idea of the diverse uses to which organic solvents are put can be observed in Table 1. It is evident that characterizing an organic chemical as a solvent in one instance does not guarantee that it can be considered always a solvent. To illustrate, xylene, when used as a paint thinner would be thought of as a solvent, but could not be so construed when used as a chemical intermediate for the manufacture of another product. This factor made knowledge of the ultimate uses of each organic chemical necessary in order to prepare solvent loss estimates.

Tabulation of survey data with respect to the variety and volume of solvents was facilitated by consolidating the more than 200 individual solvent and solvent mixtures marketed into eight classes. This classification is shown in Table 2. The general chemical formulae and examples of solvents for each class are also given.

The principal routes by which solvent vapors enter the atmosphere are natural evaporation or forced vaporization. Some operations or situations in which natural evaporation occurs are:

1. solvent storage vented to the atmosphere

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2. manufacture of surface coatings in equipment vented to the atmosphere
3. dry cleaning
4. atmospheric drying of surface coatings

Vaporization is used to rid a product of solvent in

1. baking and forced drying of surface coatings
2. forced drying of printing inks during rotogravure operations
3. recrystallizing and purifying pharmaceuticals.

Survey by Mail

PRODUCTION AND SALES OF ORGANIC SOLVENTS

This survey was conducted during the third quarter of 1956 and, for convenience, requested the information to be averaged over the year 1955. Statistically, the survey showed sales to the different categories amounting

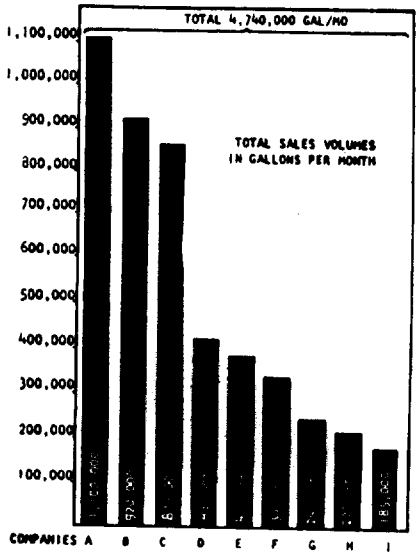


Fig. 1. Sales volumes of largest organic solvent suppliers in Los Angeles County, 1955-56. On request, company names are withheld to avoid disclosing competitive positions. (List includes all companies selling 100,000 gal./mo. or more in Los Angeles County.)

to 356 tons/day of aliphatic and aromatic hydrocarbons, 65 tons/day of halogenated hydrocarbons, and 171 tons/day of all other solvents for a total of 592 tons/day.

In all, seventy-six companies were contacted, covering, it is believed, all producers and distributors, including importers, making sales in Los Angeles County. All seventy-six companies responded with essentially complete information to the questionnaire form which was designed to solicit the following information for each organic solvent reported:

1. Trade name
2. Chemical name
3. Boiling range
4. Flash point
5. Vapor pressure
6. Density
7. Production rate, averaged for 1955
8. Sales volume to local buyers, averaged for 1955
9. Per cent of sales volume to individual buyer

Tabulation of data received reveals many interesting facts about solvent usage in Los Angeles County. The identities of the important solvents, solvent suppliers, and solvent purchasers, from the view of volumes sold, are all derived from this one survey. Table 3, Figure 1, Table 4, and Table 5 summarize these facts.*

Table 3 lists the most important solvents in order of sales volumes giving approximate sales volume only for the first, fifth, eighth, ninth, and eleventh ranking solvents. This method, although not definitive, does bracket the sales volume ranges for the other listed solvents.

In Figure 1 a comparison of volume of organic solvent sold by the principal suppliers is given, and in Table 4, an analysis of solvent usage is made. Figure 1 reveals that nine companies are responsible for sales of about 4,740,000 gal./mo. or 95% of the total solvent sales. All companies with sales above 100,000 gal./mo. of solvents were included in Figure 1. Table 4 shows that of the almost 600 tons of solvent sold daily in Los Angeles County (see Figure 4), the paint, varnish, enamel, and lacquer manufacturers purchase the lion's share in all organic solvent classes except that of halogenated hydrocarbons. In that class, the largest single share goes to degreasers. This is illustrated differently in Table 5, which ranks the categories by their percentage of total solvents marketed.

Tables 4 and 5 record purchases of raw solvents only and do not include solvents which are associated or contained in other products purchased such as paints, enamels, and adhesives. This note of caution is inserted so as to forestall the equating of purchases by various consumers with their solvent emissions, since in many cases they are not identical. This becomes clear when the losses of solvent from paint, varnish, enamel, and lacquer manufacturing are disclosed to approximate only 1 to 3% of the solvents purchased by them. The remaining 97 to 99% is lost at the point of use of such surface coatings and thus should be attributed to the automobile assemblers, aircraft companies, and the public. In such adjustments, it is important also to recognize that a significant percentage of products containing solvents may be exported from the local area so that evaporation of those solvents would occur elsewhere.

PRODUCTION AND SALE OF PAINTS, VARNISHES, ENAMELS, LACQUERS, AND OTHER SURFACE COATINGS

This survey was conducted during the latter half of 1956 and requested volumes as averaged for 1955. Production of all surface coatings was found to be about 2,700,000 gal./mo. requiring an organic solvent usage of about 1,300,000 gal./mo. About 40% of the surface coating production was exported out of Los Angeles County.

A total of 231 survey letters were sent to companies who classified themselves as manufacturers of one or more surface coatings, including those with a production as low as 200 gal./mo. Replies from these companies show that of the 231 contacted, 113 are actively engaged in manufacturing in Los Angeles County and the balance of 118 are either a warehousing operation, a sales office, or are out of business.

Previous information from a trade association that 90% of the total surface coating production could be credited to 10% of the companies was not substantiated by this survey. It was necessary to sum the production from approximately fifty of the largest plants in order to account for 90% of the total production. From this, the inference can be made that more than fifty of the manufacturing plants would have to be equipped with air pollution controls in order to realize any reduction in solvent emissions even approaching 90%. This is predicted on the assumption that surface coatings production and solvent usage are linearly related.

The questionnaire forms for this survey were mailed to each company with a request for the following information on the basis of average 1955 figures:

1. production, in gallons per month, individually for paints, varnishes, enamels, lacquers, and others.
2. production sold in Los Angeles County, in per cent, individually for paints, varnishes, enamels, lacquers, and others.
3. production sold as water-based types, in per cent, individually for paints, varnishes, enamels, lacquers, and others.
4. production sold for industrial spraying, in per cent, individually for paints, varnishes, enamels, lacquers, and others.
5. production sold for industrial dip and flow, in per cent, individually for paints, varnishes, enamels, lacquers, and others.

* In deference to the requests of several of the companies surveyed who supplied confidential data, precautions have been taken to avoid issuing competitive sales statistics.

6. name, volume, and estimated manufacturing loss individually of all organic solvents used in production of paints, varnishes, enamels, lacquers, and others, respectively.

Totals of production and sales volume of surface coatings manufactured in Los Angeles County during 1955 are given in Table 6.

The volumes summarized in Table 6 lead to the following conclusions:

1. **About 60% of the surface coatings produced in Los Angeles County are sold there and the remaining 40% are shipped out of the county.**
2. **About 20% of sales are destined for use in an industrial spraying operation.**
3. **About 4% of sales are destined for use in industrial dip-and-flow operations.**
4. **About 20% of total sales are made up of water-based paints.**

About 1,308,000 gal. of organic solvents was purchased for the manufacture of 2,684,000 gal./mo. of surface coatings shown in Table 6. As some of the companies reporting did not maintain itemized records of the amount of solvents used in each product, only total volumes of each class of solvent are shown. These volumes are presented in Figure 2.

If the assumption of a linear relationship between surface coating production and organic solvent usage is correct, then 60% of the 1,308,000 gal. of organic solvents used in the manufacture are present in the surface coatings sold in Los Angeles County. This would amount to about 784,000 gal. of solvent a month which possibly could be released into the atmosphere from surface coating usage.

Solvent losses during the manufacture of surface coatings arise from evaporation from open processing equipment, evaporation during actual processing such as milling, and evaporation from equipment cleaning operations. According to available knowledge, no control of solvent emissions is practiced except for varnish cooking where fumes (which are not principally solvents) from the varnish kettles are incinerated.

The over-all estimated loss of solvent in the manufacturing processes is 1.2% by volume, equal to a daily loss of 516 gal. or 1.7 tons, with the use of a weighted average density of 6.7 lb./gal.

Survey by Meeting

ROTOGRAVURE PRINTING OPERATIONS

Seven rotogravure printing plants are now in operation in Los Angeles County with an eighth plant being installed. The survey was conducted in the latter part of 1956, through a series of meetings with representatives of the rotogravure industry and by inspections of their operations. Two of the larger printing ink manufacturers also were visited to obtain more detailed information about the solvents used in rotogravuring inks.

In rotogravure plants, organic solvents are used generally for two purposes: (1) to adjust the viscosities of the printing inks to the levels desired, and (2) to clean equipment.

Solvent emissions occur as a result of evaporation from storage, "fountains," "reservoirs," and equipment cleaning, and vaporization in the dryers. Some statistics on ink and solvent usage are totaled for the seven companies in Figure 3. From the data submitted it appears that about 25% of the organic solvents used in rotogravuring are associated with the purchased inks. The solvents used consist of 79% of aliphatic and aromatic hydrocarbons and 21% alcohols, ethers, and esters.

It is reasonable to assume that all the solvent used in rotogravure operations will be released into the atmosphere at the plant site, since the printed stock is dried immediately. No control of solvent emissions, other than some covering of solvent-containing equipment, is practiced.

To maintain consistency with other loss figures which are averaged over a 30-day month, the organic solvent emissions from rotogravure plants are computed as 7.3 tons per day. About 90 per cent of this amount is contributed by three of the seven plants.

ORGANIC SOLVENTS USED FOR DRY CLEANING

Surveys have been made to ascertain the volume of organic solvents used in dry cleaning operations. Questionnaire forms were mailed to groups of dry cleaning operators, selected at random. Of the 800 plus dry cleaning plants in the County, more than 300 have been surveyed.

Each plant was requested to supply the following information concerning its operations:

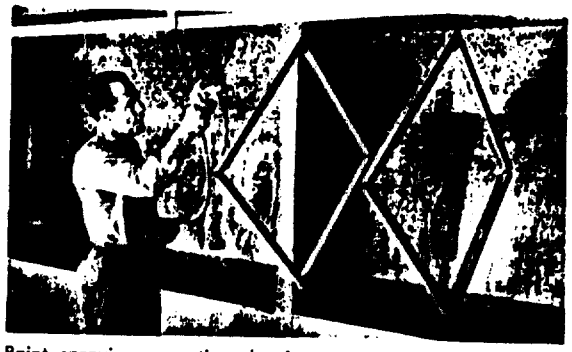
1. **Average monthly volume and type of organic solvent purchased**
2. **Solvent-reclaiming equipment**
3. **Disposal of spent solvent**
4. **Operating schedule for dry cleaning equipment**
5. **Weight of clothes cleaned per month**

Statistically, 60 per cent of the dry cleaning plants use chlorinated hydrocarbons and are known as synthetic

Milling of premixed paint paste for better dispersion is source of solvent vapor emission.

Rotogravure printing presses, showing dryers, steam lines to dryers, and exhaust systems.

Clothes being loaded into combination tumbler, extractor, and dryer of dry cleaning equipment designed for synthetic solvent usage.



Paint spraying operation showing spray cone and water curtain for capture of solid paint particles.

Height of solvent vapor in this vapor degreaser is controlled by water-cooled jacket near top of degreaser.

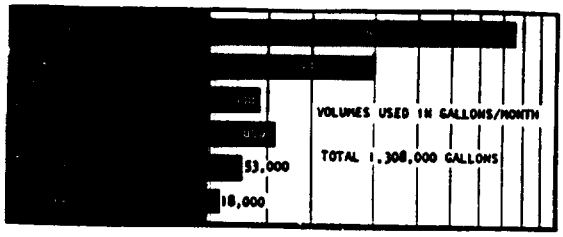


Fig. 2. Volumes of organic solvents used monthly for surface coating production in Los Angeles County, 1955.

plants, while the remaining 40 per cent use petroleum solvents and are referred to as petroleum plants. Nearly all of the "synthetic" plants have solvent-vapor condensation systems integral with the dry cleaning unit, while as a general rule petroleum plants do not have vapor collection. All the dry cleaning plants possess filtering systems and some operate "muck" (sludge accumulating from the dry cleaning) reclaiming equipment as well. Some of the larger petroleum plants also operate their own solvent reclaiming equipment.

The petroleum solvents used are aliphatic hydrocarbons, sometimes referred to as petroleum naphtha, and are either Stoddard Solvent, which is used in more than half the petroleum solvent plants or 140° F. safety solvent. The chlorinated solvents used are perchloroethylene (almost exclusively), trichloroethylene, and carbon tetrachloride (to a limited extent).

The smaller dry cleaning establishments, located usually in or near residential shopping areas, use synthetic solvents while the larger operators, usually located in industrial or commercial areas, use petroleum solvents. Wide variations have been found to exist in the relationship between weight of materials dry cleaned and volume of solvent used, especially amongst the smaller operators. It is quite possible that quantities of solvents in excess of that required are being used and wasted daily into the atmosphere.

Table 2.—Classification of Organic Solvents

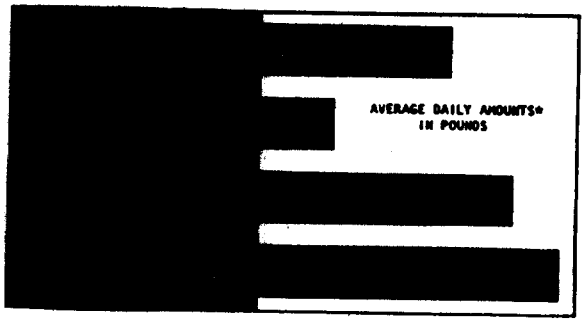
Class name	General formula	Examples
1. Aliphatic hydrcarbons	R — H	Hexane, Stoddard Solvent, naphtha, mineral spirits
2. Aromatic hydrocarbons	Φ — H	Benzene, toluene, xylene
3. Halogenated hydrocarbons	R — X, Φ — X	Ethylene dichloride, trichloroethylene, perchloroethylene
4. Ketones	R — C(=O) — R′	Methyl ethyl ketone, acetone, methyl iso-butyl ketone
5. Alcohols (and glycols)	R — OH	Methanol, iso-propanol, sec-butanol
6. Ethers	R — O — R′	Ethyl ether
7. Esters	R — C(=O) — O — R′	Ethyl acetate, butyl acetate
8. Miscellaneous Aldehydes, terpenes, sulfur compounds, nitrogen compounds, mixtures	.....	Turpentine, carbon disulfide, nitromethane

R or R′—Any straight or branched chain hydrocarbon radical.
Φ—Any benzene ring-type hydrocarbon radical.
O—Oxygen atom X—Halogen atom
C—Carbon atom H—Hydrogen atom

Approximate monthly consumption of chlorinated solvents is 25,000 gal. and of petroleum solvents, 435,000 gal. It is assumed that the amount of solvent purchased and used represents the amount of solvent emitted into the atmosphere. On this basis, solvent emissions from dry cleaning operations are estimated as 5 tons of chlorinated and 45 tons of aliphatic hydrocarbons daily.

The adjustment to be made to these data for the amount of solvent sewered or discarded has not yet been determined. An interesting fact brought out during the survey is that some of the synthetic plant operators dilute their chlorinated solvent with petroleum solvent purchased at retail outlets in order to reduce costs.

Fig. 3. Ink and solvent usage in rotogravure plants in Los Angeles County, 1956. (*Based on two 8-hr. shifts/day.)



SURFACE COATING USERS

The purpose of this survey was to determine the locations of the major surface coating operations and the volume of coatings and organic solvents used in such operations. In planning this survey, eight industrial categories plus a ninth miscellaneous category for a variety of smaller industries were chosen on the basis of suspected extensive spray painting, dipping- or flow-coating operations. Data collected for this survey covered 1955 for the selected industrial companies in the categories of automobile assembly plants, aircraft companies, can and container manufacturers, furniture manufacturers, appliance manufacturers, job enamelers, automobile repainters, plastic products manufacturers, and miscellaneous.

A total of 442 individual plant locations in these nine categories who were contacted by mail and requested to complete a questionnaire form made reply. Of those, only 343 companies were actually engaging in coating processes requiring the use of organic solvents. The companies on the survey list were so chosen as to have, at least, the major companies in each category represented.

Answers to the questionnaire allowed the following data to be accumulated:

1. number and types of coating equipment.
2. hours of operation.
3. air pollution control devices.
4. methods of drying.
5. coatings applied.
6. solvents consumed.

By comparison with data from the Survey of Surface Coating Manufacturers and the, as yet, unreported data from surface coating importers, the 343 companies in this survey who are engaged in coating operations involving approximately 436,000 gal./mo., account for 84% of the industrial surface coatings used in Los Angeles County.

Table 7 is a tabulation by category of industry of the type and volume of surface coatings and organic solvent containing materials used. It also includes the total volume of surface coatings used by each category and per cent of total coatings used by all the 343 companies reporting surface coating operations. Table 8 shows some typical compositions of surface coatings.

Table 9 is a tabulation by category of industry of the classes of organic solvents utilized. The original information in gallons per month is shown as well as the corresponding calculated result in tons per day and percentage of the total. The calculations were made on the basis of a 30-day month. For the 343 companies, an average of 62 tons of organic solvents is employed

PERTINENT DISTRIBUTION DATA ON ORGANIC SOLVENT USAGE IN LOS ANGELES COUNTY

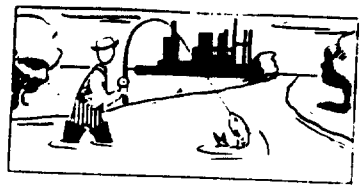


Table 3.—Identity and Sales Volume of Most Used Solvents

Solvent	Approximate sale volume gal./mo.
1. Aliphatic hydrocarbons boiling between 300 to 400° F.	1,000,000
2. Isopropyl alcohol	*
3. Ethyl alcohol	*
4. Methyl ethyl ketone	*
5. Trichloroethylene	200,000
6. Acetone	*
7. Methyl alcohol	*
8. Toluene	100,000
9. Xylene	100,000
10. Methyl isobutyl ketone	*
11. Perchloroethylene	50,000
Total for the eleven solvents.	2,650,000

* These volumes withheld to avoid release of confidential, competitive data.

Table 5.—Most Important Purchasers, by Percentages, of Organic Solvents

Category of purchaser	Percentage of total solvents purchased
1. Paint, varnish, enamel, and lacquer mfrs.	36.8
2. Dry cleaners	8.5
3. Rubber products mfrs.	5.6
4. Aircraft companies	6.1
5. Degreasing operators	8.7
6. Service station and misc. retail outlets	4.3
7. Plastics, resins, shellac, and putty mfrs.	4.3
8. Automobile assemblers	3.4
9. Paint and hardware stores	1.7
10. Gasoline additive mfrs.	2.7
11. Drum, can, and container mfrs.	1.7
12. Drug and pharmaceutical mfrs.	1.7
13. Insecticide mfrs.	1.0
14. Lithographers and printing ink mfrs.	0.8
15. Adhesives mfrs.	1.0
16. All others	11.7
Total	100.0

Table 1.—Typical Organic Solvent Uses

Uses			Class of solvents used	Type of solvent action
Manufacture of: Paints, Varnishes, Enamels, Stains, Resins, Shellac	Adhesives, Printing inks, Printing pastes, Plastics, Rubber, Gums	Rubber cements, Photographic chemicals, Insecticides, Toilet preparations, Other surface coatings	Aliphatic, aromatic, and halogenated hydrocarbons; Alcohols, Ketones, Ethers, Esters, Misc.	Dissolving, Thinning, Diluting, Dispersing, Plasticizing
Cleaning of: Fabrics, Metal surfaces			Halogenated hydrocarbons; Aliphatic hydrocarbons	Cleaning, Degreasing
Manufacture of: Paint and varnish removers			Halogenated hydrocarbons	Surface renovating
Manufacture of: Pharmaceuticals, Glandular extracts		plant extracts, food extracts	Alcohols, Ketones, Ethers, Esters	Extraction, Purification

Table 7.—Consumption of Surface Coatings Containing Organic Solvents *

Category of industry	Type of Surface Coating (gal./mo.) Paints	Varnishes	Enamels	Lacquers	Primers	Misc.**	Total surface coatings gal./mo.	%
Automobile assemblers	2,300	4,500	54,600	65,100	61,000	12,900	180,700	41.4
Aircraft companies			400	10,000	800		30,900	7.1
Can and container mfrs.		9,400	21,500	18,000		17,900	66,800	15.3
Furniture mfrs.		3,800	10,200	27,500	600	10,100	52,200	12.0
Appliance mfrs.		400	22,100	800	12,000		35,300	8.1
Job enamelers			12,600	1,300	400	400	14,700	3.4
Plastic product mfrs.			1,200	600			1,800	0.4
Automobile repainters			5,900	2,000			7,900	1.8
Miscellaneous ***	1,600	11,400	9,100	12,900	2,700	7,900	45,600	10.5
Totals	3,900	29,500	137,600	138,200	77,500	49,200	435,900	100.0

* Tabulation of data for the 343 companies using organic solvents.
** Glazes (700), resins (10,200), sealer (6,800), shellac (300), stain (3,000), zinc chromate (10,000), special coating (17,900).
*** Electronics, adhesives, plating, and machinery manufacturers.

Table 4.—Solvent Usage Distribution

Category of user	Usage in tons/day: Aliphatic and aromatic hydrocarbons	Halogenated hydrocarbons	Ketones, ethers, alcohols, esters, misc.	Total
Paint, varnish, lacquer, and enamel mfrs.	150	1	65	216
Dry cleaners	45	5	(Less than 1)	50
Rubber products mfrs.	30	1	2	33
Aircraft companies	15	1	20	36
Degreasing operators	5	45	(Less than 1)	50
Service station retail outlets	25	0	0	25
Plastics, resins, shellac, putty mfrs.	10	(Less than 1)	15	25
Automobile assemblers	20	(Less than 1)	(Less than 1)	20
Paint and hardware store outlets	10	0	0	10
Gasoline additive mfrs.	0	1	15	16
Drum, can, and other container mfrs.	10	0	3	13
Drug and pharmaceutical mfrs.	1	1	10	12
Insecticide mfrs.	5	0	0	5
Lithographers and printing ink mfrs.	5	0	1	6
Adhesive mfrs.	0	0	5	5
All others	25	10	35	70
TOTAL	356	65	171	392

Table 8.—Examples of Surface Coating Formulae on an As Purchased Basis

Type of surface coating	Composition of surface coating %: Nonvolatile portion	Hydrocarbons aliphatic	Hydrocarbons aromatic	Alcohols	Ketones	Esters and others
Paint	44	56	..	..	..	..
Varnish	50	45	5	..	..	..
Enamel	58	10	30	2	..	..
Lacquer	23	7	30	9	22	9
Metal primer	34	33	33	..	..	..
Glaze	80	..	20	..	..	..
Resin *	50	..	..	..	..	..
Sealer	50	40	..	..	10	..
Shellac	50	..	..	50	..	..
Stain	20	..	80	..	..	..
Zinc chromate	60	..	40	..	..	..

* Contains 50% of solvent of an unspecified type.

Table 6.—Production and Sales Volume of Manufactured Surface Coatings

Name of surface coating	Production gal./mo.	Sales in L.A. County gal./mo.	Sales for industrial spraying gal./mo.	Sales for industrial dip & flow gal./mo.	Sales of water base types gal./mo.
Paints	1,050,000	596,000	42,000	12,000	322,000
Varnishes	407,000	210,000	4,000	1,000	**
Enamels	305,000	208,000	80,000	17,000	**
Lacquers	450,000	288,000	127,000	6,000	**
Others *	472,000	303,000	69,000	26,000	**
Totals	2,684,000	1,605,000	322,000	62,000	322,000

* "Others" comprises stains, sealers, shellac, vinyls.
** None or no substantial water-base production reported.

Table 9.—Consumption of Organic Solvents in Surface Coating Operations

Category of industry	Total of organic solvents used in surface coating operations: Gallons per month	Tons per day	Per cent by weight
Automobile assemblers	213,000	25	40.4
Aircraft companies	82,000	9	14.5
Can and container mfrs.	66,000	8	13.0
Furniture mfrs.	57,000	7	11.3
Appliance mfrs.	25,000	3	4.7
Job enamelers	12,000	2	3.2
Automobile repainters	9,000	1	1.6
Plastic product manufacturers	3,000	< 1	0
Miscellaneous **	61,000	7	11.3
Totals	528,000	62	100.0

* Tabulation of data for the 343 companies using organic solvents.
** Electronics, adhesives, plating and machinery manufacturers.

daily of which 15 tons are aliphatic hydrocarbons; 29 tons, aromatic hydrocarbons; 5 tons, alcohols; 9 tons, ketones; and 4 tons, esters and ethers.

This survey indicates that the six automobile assembly plants rank first in usage of surface coatings and associated organic solvents with 41.5% of the total surface coatings and 40.4% of the organic solvents tabulated for all the categories. Three other categories of industries showing substantial usages are aircraft companies, can and container manufacturers, and furniture manufacturers. If the additional organic solvents used by these categories of industries for other purposes were added to the results of this survey, aircraft companies would probably show the largest consumption of any of the categories. It is estimated that all the organic solvents consumed in the surface-coating operations of these companies would be emitted to the atmosphere except for the minor amounts now being controlled.

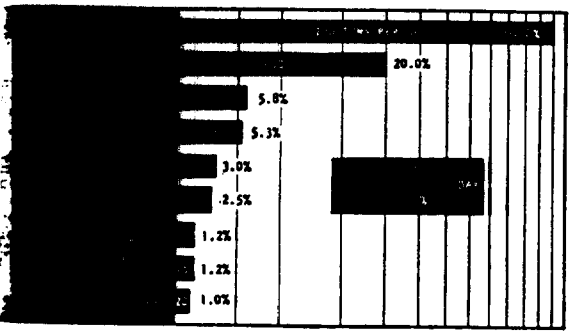
Sources of losses are the evaporation and vaporization of organic solvent during the surface coating application (most commonly by spraying) and subsequent baking or drying. In applying surface coatings by spraying, solvent losses are unnecessarily excessive because of overspray which never impinges on the surface being coated, and so, with its accompanying solvent is wasted. Overspray can amount to as much as 80% or more of the volume sprayed, depending upon the shape and dimensions of the object being sprayed.

Spraying and other surface-coating applications are uncontrolled and the solvent vapors are exhausted to the atmosphere. Use of water curtains in some spray booths is not considered to furnish control for solvent vapors although a small percentage of the solvent might be dissolved in the water and eventually sewered. The only controls so far adopted for surface-coating operations are catalytic combustion units and direct-fired incinerators for baking and drying oven exhaust gases. There have not been enough installations of this kind to achieve any significant reduction in total solvent emissions although local nuisance problems have been alleviated.

Comment

- Approximately 400 of the 600 tons of organic solvents marketed daily in Los Angeles County are released into the atmosphere. This daily emission as shown in Figure 4, represents 20 per cent of all the organic vapors emitted daily into the Los Angeles County atmosphere. Although later refinements proceeding from other scheduled surveys might alter this relationship by a few per cent, the smog-forming potential and quantity of this large mass of air pollution demand the expenditure of intensive control efforts.
- The major sources of organic solvent emissions in Los Angeles County are the aircraft companies, automobile assemblers, rubber products manufacturers, and dry cleaners, and the public. If these are classified by type of operation, then the major sources are in the application and drying of surface coatings, degreasing or metal cleaning, and dry cleaning of clothes.
- No controls are employed for the organic solvents vaporized during the brushing, rolling, spraying or otherwise applying a surface coating, unless the water wash systems used with some spray booths are considered. The primary purpose of such water wash systems is to remove pigment particles from the spray booth exhaust gas stream and no significant collection of solvent is accomplished.
- There are several obstacles to the development of satisfactory control devices or systems. For spray booths, low-solvent concentrations and high effluent volumes as well as small amounts of emissions per individual booth present a real economic barrier. For brushing and rolling, the enormous number of small emitters, not located permanently in any one spot, effectively cancel any real hope of an individual control device. For baking and drying ovens, however, a more optimistic attitude can be taken. Some control installations, operating on a combustion principle, have been made for baking and drying ovens and others are expected. The efficiencies of these are high, better than 90%, where temperatures of the control unit are maintained at a sufficiently high level.
- Some types of industrial degreasers may be said to be operating under semicontrolled conditions, in that they employ cooling coils to condense the solvent vapors which might otherwise overflow the equipment. Nevertheless, a portion of the vapors do escape. The multitude of small operations with individual small losses, widespread locations, and infrequency of many operations hamper quick control.
- Synthetic solvent dry cleaning plants are so designed as to condense and recover for reuse a considerable portion of the solvent. Some of the larger petroleum solvent dry cleaning plants also are so equipped.
- With regard to new techniques, suggestions have been made to employ heat or pressure to create the flowability of surface coatings ordinarily supplied by solvents. Electrostatic spraying has been recommended as a means of reducing overspray and consequent wastage. Another technique, not yet explored, would require enclosure of spraying operations and subsequent reduction of effluent volume and raising of solvent concentration above its explosive limit to make the standard methods of control economically more feasible.
- Reformulated products, eliminating the use of organic solvents and replacing them with water, have been in use for many years for household or architectural structure painting. More extensive use of these products, and development of sister products for industrial coatings, would yield returns not only of less air pollution but also of fewer hazards and possibly lower operating, investment, and insurance costs.
- Besides reformulation of surface coatings to exclude the use of organic solvents, there are other operations involving the use of organic solvents which would be benefited from an air pollution standpoint. Introduction of nonorganic solvent-based degreasing compounds would be one example.
- The enumeration of possible control devices and methods gives hope that a reduction of organic solvent losses in Los Angeles County can be attained. With this in mind, studies are being made of legislation applicable to spraying and baking operations of industrial surface coatings.

Fig. 4. Organic vapor emissions (hydrocarbons, aldehydes, ketones, acids, alcohols, esters, ethers), Los Angeles County, 1955-56. (*Surface coaters, dry cleaners, degreasers, etc.)



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