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Characteristics of Solvents

Solvents have two major characteristics that influence their use in coatings. These are:

- Solvency power

  The ability to dissolve other chemical compounds (e.g., resins)

- Volatility largely governs the evaporation rate, which is the speed at which the solvent will leave the coating

Only the solvent specified in the coating specification should be used in reducing the coating for application.

Written permission to use a different solvent must be obtained from the owner, or from his or her representative. The agreement of the coating manufacturer is also important in this instance.

Evaporation Rate

Next to solvency, the most important property of a solvent is volatility, which largely governs the evaporation rate. The relationship is not direct, because a stronger solvency for the film former reduces the rate of solvent release. Evaporation rates influence leveling, flowing, sagging, wet-edge time, and gloss.

The optimum evaporation rate varies significantly with the method of application, from the fastest for spraying, to the intermediate for brushing, and finally to the slowest for flow coating and conveyor dipping. It also makes a difference if air or airless spraying is used.

If application is by dipping or flow coating, evaporation rates affect sagging, freedom from tears at the bottom, and color streaking.

In the case of baked finishes, the volatility of a solvent is a contributing factor in bubbling, cratering, and pinholing. For some purposes, solvents which have a narrow evaporation range give the best results, while a wide range is better for other purposes.

Tables I.3-1 to I.3-7 (pages 3:12 to 3:18) list some commonly used solvents according to their chemical group classifications and show their flash points and evaporation rates.

Evaporation rates are usually expressed relative to n-butyl Slide I.9-1acetate, which has a flash point of 38°C (100°F) and is assigned a value of one. The evaporation rate is determined under laboratory conditions by allowing a known amount of test solvent to evaporate, along with a known amount of n-butyl acetate. The evaporation time in minutes for n-butyl acetate divided by the time for the test solvent is the evaporation rate. A value of 0.5 means the test solvent evaporates half as fast as n-butyl acetate, and a value of 4.0 means it evaporates four times as fast.

The evaporation rates shown in the tables refer to the straight solvent only, not to the solvent in a coating film.

Aliphatic Hydrocarbon Solvents

Solvents of this group are also called *paraffins* and, chemically, they are open chain (also called *straight chain*). The most common of this group is mineral spirits and V. M. and P. (Varnish Makers and Painters) naphtha.

X Mineral spirits is known as the *painter's naphtha*. It is a high boiling petroleum product used to dissolve oils, asphalts, and alkyds. Table I.3-1 lists some common aliphatic hydrocarbons and some of their properties.

Table I.3-1

Aliphatic Hydrocarbon Solvents

Solvent	Evaporation Rate (n-Butyl Acetate = 1)	Flash Point °C (°F) Closed Cup
Lacquer diluent	4.0	6°C (43°F)
V. M. & P.	1.5	13°C (55°F)
Mineral spirits (odorless)	0.10	55°C (131°F)

Aromatic Hydrocarbon Solvents

These hydrocarbons have a closed-chain, six-carbon group (often called the *benzene-ring* structure) as a principal part of the molecule. The simplest chemical of this family is benzene; the family also includes toluene (toluol), xylene (xylol), and some higher boiling point homologs. They are active solvents for chlorinated rubber, coal tar, and certain alkyds and are used as diluents in combination with other solvents for epoxies, vinyls, and polyurethane materials. Table I.3-2 lists some solvents of the aromatic hydrocarbon group and some of their properties.

Table I.3-2

Aromatic Hydrocarbon Solvents

Solvent	Evaporation Rate (n-Butyl Acetate = 1)	Flash Point (closed cup)
Benzol	5.0	–12°C (10°F)
Toluol	2.0	5°C (41°F)
Xylol	0.6	28°C (82°F)
High-flash-point naphtha	–	38°C (100°F)

Ketone Solvents

These are oxygenated hydrocarbons of the acetone family and methyl ethyl ketone. They are the most effective solvents for vinyls and are often used in epoxies and other resin formulations. Table I.3-3 lists solvents of the ketone group and some of their properties.

Table I.3-3

Ketone Solvents

Solvent	Evaporation Rate (n-butyl acetate = 1)	Flash Point (closed cup)
Acetone	9	–10°C (14°F)
Methyl ethyl ketone (MEK)	4	–4°C (25°F)
Methyl iso-butyl ketone (MIBK)	1.6	22°C (72°F)
Methyl iso-amyl ketone (MIAK)	0.5	40°C (104°F)
Cyclohexanone	0.2	54°C (129°F)
Diacetone alcohol	0.2	15°C (59°F)

Ester Solvents

These are also oxygenated hydrocarbons, but the ester solvents have a distinctive, pleasant, banana-like odor. The acetate esters are excellent solvents for several different kinds of synthetic resins, including cellulose esters, acrylics, polyvinyl acetate, and polyvinyl butyrate. Ethylene glycol monoethyl ether acetate (Cellosolve acetate [Note: Cellosolve is a trade name of Union Carbide Corp.]) is used in large volume in thermoplastic acrylic finishes and is noted as the best slow-evaporating solvent for these acrylics based on methacrylate resins.

The esters are also used as latent solvents for vinyls and are commonly used in epoxy and polyurethane formulations. Table I.3-4 lists some solvents in the ester group and some of their properties.

Table I.3-4

Ester Solvents

Solvent	Evaporation Rate (n-butyl Acetate = 1)	Flash Point closed cup
Ethyl acetate (95%)	4.1	13°C (55°F)
n-Propyl acetate	2.3	18°C (64°F)
n-Butyl acetate	1.0	38°C (100°F)
Amyl acetate (95%)	0.4	41°C (106°F)
Ethylene glycol monoethyl ether acetate (Cellosolve acetate)	0.2	57°C (134°F)

Alcohol Solvents

Alcohols are oxygenated hydrocarbons and are good solvents for highly polar binders, such as phenolics. Some alcohols are used with epoxies. Table I.3-5 lists various alcoho- type solvents and some of their properties.

Table I.3-5

Alcohol Solvents

Solvent	Evaporation Rate (n-butyl acetate = 1)	Flash Point (closed cup)
Methyl alcohol	6.0	16°C (61°F)
X Ethyl alcohol	2.3	24°C (75°F)
Propyl alcohol	1.0	31°C (88°F)
Isopropyl alcohol (91%)	1.6	19°C (67°F)
Butyl alcohol	0.5	46°C (115°F)
Cyclo-hexanol	<0.1	68°C (154°F)

Ethers Alcohol / Glycol Ethers

Ethers such as ethyl ether are not usually used as solvents for synthetic resins because they are very flammable, but they are excellent solvents for some of the natural resins, oils, and fats.

The usual form of ether used in protective coatings is alcohol ether, such as ethylene glycol monoethyl ether, commonly known as Cellosolve (a trade name of Union Carbide). A number of glycol ethers are sold under this designation.

Cellosolve is a good solvent for many oils, gums, natural resins, and such synthetic resins as alkyds, ethyl cellulose, nitro-cellulose, polyvinyl acetate (PVA), polyvinyl butyral, and phenolics. It is a slow solvent and is used in many lacquers to improve flow out and gloss. These materials are combined with other solvents to help achieve solvent formulations which have higher flash points. Table I.3-6 lists some glycol ethers and some of their properties.

Table I.3-6

Ether Alcohols (Glycol Ethers)

Solvent	Evaporation Rate (n-Butyl acetate = 1)	Flash Point (closed cup)
Ethylene glycol monomethyl ether (Cellosolve)	0.5	46°C (115°F)
Ethylene glycol monobutyl ether (Butyl Cellosolve)	0.06	74°C (165°F)
Ethylene glycol monoethyl ether (Cellosolve)	0.3	54°C (130°F)
Ethylene glycol	0.06	74°C (165°F)