

N-Methyl Pyrrolidone

(NMP)

Paint Stripper Formulations

General

NMP and NMP-based formulations are the leading methylene chloride substitutes for paint stripping, graffiti removal, and industrial cleanup. NMP's advantages over methylene chloride include:

- Low odor.
- Low evaporation rate - no readhesion of paints.
- Non-carcinogenic
- Completely water soluble and rinseable.

Depending on the application, we recommend either straight NMP or a blend of NMP and a co-solvent or co-solvents. Straight NMP is recommended for applications where high performance is critical or users require recovery and recycling of the NMP. Used NMP can be recycled in-house using commercial vacuum distillation equipment or sent to a recycler for recovery.

Adding a small amount of non-ionic surfactant to the straight NMP, such as Union Carbide's Triton X-100, is recommended to improve wetting and reduce stripping time. For immersion stripping of small painted parts, heating NMP to 63°C can reduce stripping times. Although NMP is only slightly combustible, heated NMP baths should be explosion-proof, equipped with over temperature-controllers, and properly vented to minimize the risk of fire and worker exposure. For consumer and industrial applications where the NMP is not recovered or high performance is not required, NMP can be blended with co-solvents to reduce cost and be further modified with surfactant and thickeners. The following blends are useful starting formulations with good performance in a range of paints and varnishes:

Component	Low Flash Formulation Wt%	High Flash Formulation Wt%	Function
NMP ¹	40	40	Paint Remover
PMA ²	57	--	Ink Remover/ Degreaser
DPMA ³	--	57	Ink Remover/ Degreaser
Surfactant ⁴	0-2	0-2	Compatibilizer /Rinsing Aid
Klucel-H ⁵	1	1	Thickener
Flash Point (SETA°F)	>110	>180	See footnote 6.

1. N-Methyl-2-Pyrrolidone (Lyondell Chemical Company 1-888-777-0232)
2. Propylene Glycol Methyl Ether Acetate (Lyondell Chemical Company)
3. Dipropylene Glycol Methyl Ether Acetate (Lyondell Chemical Company)
4. e.g. Triton™ X-100 (Dow Chemical Company)
5. Klucel® Hydroxypropylcellulose (Aqualon, a division of Hercules, Inc., (302) 594-6786)
6. Flash points were determined without added surfactant or hydrocarbons.

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Low VOC Formulations

Up to 30% water or *TBAc* solvent can also be added to these formulations to meet new VOC regulations. A small amount of t-butanol must also be added to the water-reducible formulation to prevent phase separation. The water based formulation is slightly less effective than the *TBAc*-based formulation, but is safer to use because of its higher flash point.

A very effective, water-based paint stripper can also be formulated using GBL (gamma-

Component	Low-VOC Formulation Wt%	Function
NMP	32	Ink & Paint Remover
DPMA or PMA	32	Ink Remover/Degreaser
Water or <i>TBAc</i> Solvent ¹	30	non-VOC solvent
<i>Tebol</i> 99 ²	3.5	Compatibilizer/Rinsing Agent
Surfactant	2.0	Compatibilizer/Rinsing Agent
Klucel-H	0.5	Thickener

butyrolactone). The following formulation is more aggressive than NMP-based formulations on chemically resistant two-part polyurethane paints (< 40 min strip time) but cannot be used on corrodable metals because of the high formic acid content.

Component	Low-VOC Formulation Wt%	Function
GBL	50	Ink & Paint Remover
Formic Acid	20	Ink Remover/Degreaser
Water	30	non-VOC diluent

Green Formulations

NMP can also be formulated with organically-derived solvents such as terpenes and soy esters to give cost effective formulations with low flammability and made predominantly from natural and renewable resources.

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Component	No Flash Formulation Wt%	High Flash Formulation Wt%	Function
NMP	36	36	Paint/Ink Remover
Methyl Soyate ¹	56	---	Degreaser
Florasolv™ LHF ³	-	56	Degreaser
Triton X-100	2	2	Compatibilizer/ Rinsing Aid
PVC, Bentonite, or Aerosil ²	6	6	Thickener
Flash Point (SETA°F)	>200	>140	
Viscosity (cps)	2777	318	

1. Soy-bean oil-derived ester (Twin Rivers Technologies, (617) 472-9200; Ag Environmental Products (913)-599-6911).
2. Polyvinylchloride powder or bentonite clay or fumed silica.
3. Florachem Corporation

Hydrocarbons such as aromatics or mineral spirits can also be blended with NMP to lower cost. Flammable aromatics such as xylene and toluene are effective co-solvents but are listed on the EPA's list of hazardous air pollutants (HAPs list) and increase the formulation's flammability. The disadvantages of using hydrocarbon co-solvents include higher odor and flammability (aromatics), storage stability (mineral spirits), and water rinseability.

Storage stability and water rinseability can be improved by adding surfactants and using a non-cellulosic thickener. The following formulation combines low cost and performance comparable to straight NMP on alkyds and other low-resistance paints and coatings:

NMP	36
Mineral Spirits or Aromatic 150	60
Triton X-100	1
Styrene/Isoprene Polymer	3

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Application Procedure

Apply the formulation using a paint brush, roller, or spray pump, depending on the thickness of the formulation. Let stand 5-10 minutes for alkyd paints, 20-30 minutes for epoxies, and 2-3 hours minimum for polyurethanes. Wipe off with a rag or paper towel or scrape off with a wood or plastic spatula. Reapply if necessary.

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