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Eastman TamiSolve™ NxG dipolar aprotic solvent as an effective alternative for NMP and other materials of concern

Solvents play a vital role in applications such as paint stripping, petrochemical processing and electronics cleaning. Incumbent solvents such as *N*-methyl-2-pyrrolidone (NMP), *N*-ethyl-2-pyrrolidone (NEP), dimethylformamide (DMF), methylene chloride and dimethyl sulfoxide are effective in dissolving and coalescing tough polymers such as fluorinated resins and polyurethanes, which are essential in many manufacturing processes.

The U.S. Environmental Protection Agency (EPA) reports that more than 184 million pounds of NMP are used annually in the United States alone. In Europe, NMP usage ranges between 10,000 and 100,000 tons each year.

However, the potential risks associated with these materials have prompted companies to reconsider their use. NMP has been labeled a substance of very high concern due to its reproductive toxicity, leading to proposed regulatory changes from the EPA under the Toxic Substances Control Act (TSCA). As industries navigate these challenges, the conversation around safer alternatives is becoming increasingly urgent.

The purpose of this white paper is to introduce Eastman TamiSolve™ NxG dipolar aprotic solvent as an alternative in a variety of applications for many solvents that may contain materials of concern (MOC). Unlike NMP, NEP and DMF, TamiSolve is not carcinogenic, mutagenic or toxic to reproductive health reprotoxic (CMR). In addition, it is not considered a substance of very high concern (SVHC) and is not on the CMR watch list in Europe. That makes it a safer, compliant option for solvent formulators, manufacturers and end users.

TamiSolve can, in many cases, replace NMP and NEP with little to no reformulation. It reduces the need for costly ventilation and safety equipment during manufacturing, and its biodegradability creates a more favorable environmental profile.

The case for replacement

Multiple regulatory agencies have proposed rules restricting NMP use. The EPA released a proposal as part of the TSCA in June 2024 that would limit exposure to NMP. The proposal would:

- Limit NMP content in glues and adhesives to 45%, restrict container sizes and require labels designating the products as hazardous
- Ban NMP in automotive care products, degreasers, metals and furniture care products as well as in antifreezes and deicers that have already stopped using NMP
- Require businesses working with paints, inks and other products using NMP to give employees personal protective equipment to limit exposure

The European Chemicals Agency (ECHA) has imposed exposure limits to NMP across the European Union since 2020. Suppliers there must limit NMP concentrations in mixtures and provide users an extended safety data sheet outlining exposure scenarios. These measures are in response to ECHA findings that NMP may damage/harm unborn children if they are exposed to the chemical. It can also cause serious eye, skin and respiratory irritation. Exposure can happen from inhaling vapors, touching droplets or contacting soiled surfaces.

The combination of these effects, subsequent safety measures needed to counteract them, and safety labeling needed on products containing NMP have left many manufacturers seeking safer alternatives. Among the impacted operations are polyurethane dispersion (PUD) synthesis, resin synthesis equipment cleaners and industrial paint strippers.

Benefits of TamiSolve

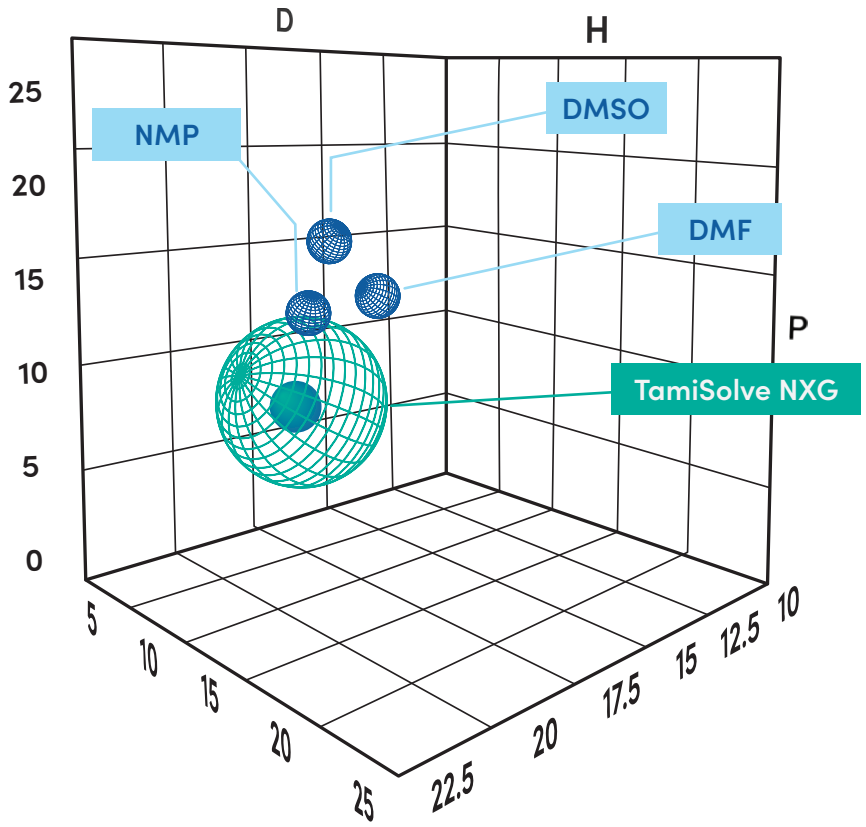
TamiSolve alleviates many of the safety issues created by NMP and similar solvents. It has a lower volatile organic compound (VOC) count and lower odor than traditional products, eliminating much of the health risk posed by NMP.

TamiSolve also carries sustainability benefits. Tests sanctioned by the Ministry of International Trade and Industry (MITI) in Japan found TamiSolve to be completely biodegradable. That means it won't leave contaminants or other remnants once a user disposes of it or a product it's used on.

TamiSolve has a lower solvent demand compared to NMP in certain applications such as PUD synthesis. This reduced demand not only helps stabilize the resin and formulations but can also lead to cost savings. By using less product in the formulation, users can lower their expenses. Additionally, with fewer VOCs in their products, companies can benefit from reduced liability. Once they achieve compliance, they no longer need to bear the costs associated with aligning their products with regulations.

These cost savings come without compromising quality. As demonstrated in the following graphs, TamiSolve has similar solubility parameters to NMP.

Figure 1. Hansen solubility parameters for TamiSolve NxG, NMP, DMF and DMSO



Physical properties

Property	TamiSolve NxG	NMP
Appearance	Liquid	Liquid
Color	Colorless	Colorless
Odor	Amine-like	Amine-like
pH 10% in water	7.65	8.5–10
Melting point (°C)	<-75	-24.2
Boiling point (°C)	241	204
Flash point (°C)	108	91
Vapor pressure (Pa @ 20°C)	13	32
Viscosity (mPa·s @ 25°C)	4.3	1.66
Hansen solubility (dispersive/polar/ hydrogen bonding)	17.8/8.2/5.9	18/12.3/7.2
Autoignition/ decomposition temperature (°C)	212	245
Evaporation rate (*n*-butyl acetate = 1)	0.004	0.04

Safety GHS label elements

TamiSolve NxG	Hazard pictograms :  Signal word : Warning Hazard statements : H302 Harmful if swallowed. H315 Causes skin irritation. H319 Causes serious eye irritation.
NMP	Hazard pictograms :  Signal word : Danger Hazard statements : H227 Combustible liquid. H315 Causes skin irritation. H319 Causes serious eye irritation. H335 may cause respiratory irritation.

TamiSolve's solubility parameters make it an effective non-CMR solvent for reformulating aggressive equipment-cleaner sand paint strippers in industrial applications.

Commercial graffiti remover

Solvent	% by weight
Acetone	55.1
NMP	29.4
Ethyl lactate	11.0
d-Limonene	4.5

TamiSolve NxG-based potential alternative

Solvent	% by weight
TamiSolve NxG	20
Acetone	55
Diethylene glycol monoethyl ether	25

Hansen solubility parameters

Formula	Dispersion	Polar	H bonding	Total
Current	16.4	10.3	7.6	34.3
TamiSolve NxG based	16.0	10.0	8.0	34.0

Note: The formulation substitutions were calculated using Hansen solubility software HSPiP, fifth generation.

Industrial paint stripper

Solvent	% by weight
Methylene chloride	69
Phenol	31

TamiSolve NxG-based potential alternative

Solvent	% by weight
TamiSolve NxG	53
Ethylene glycol butyl ether	46
Acetone	1

Hansen solubility parameters

Formula	Dispersive	Polar	H bonding	Total
Current	17.5	6.9	9.5	33.9
TamiSolve NxG based	16.9	6.8	8.9	32.6

Note: The formulation substitutions were calculated using Hansen solubility software HSPiP, fifth generation.

Waterborne paint stripper

Solvent	% by weight
Dipropylene glycol methyl ether	17
Tergitol 15-S-9 (ethoxylated nonylphenol)	3
Water	80

TamiSolve NxG-based potential alternative

Solvent	% by weight
TamiSolve NxG	5
Ethylene glycol butyl ether	17
Water	78

Hansen solubility parameters

Formula	Dispersive	Polar	H bonding	Total
Current	15.7	13.8	35.4	64.9
TamiSolve NxG based	15.7	13.8	35.4	64.9

Note: The formulation substitutions were calculated using Hansen solubility software HSPiP, fifth generation.

Nonylphenol ethoxylates are sometimes considered alternatives to NMP, but they are toxic to aquatic organisms and are therefore banned in the EU. They are also subject to EPA restrictions in the United States due to health issues they create.

Implementation

- Eastman has extensive experience creating specialty solvents and optimizing solvent blends for a variety of applications. TamiSolve can often serve as a drop-in option for formulators.
- Eastman provides training to customers on how to incorporate TamiSolve into their operations.
- TamiSolve is backed by Eastman's technical experts who can help with reformulation, production and other concerns users may have.
- Eastman has digital tools, such as a solvent comparison tool, available to customers and helps with reformulation tests and solvent evaluations.
- Eastman works with customers to improve solvent blends and optimize product performance.
- Eastman enables customers to rapidly substitute solvents and solvent blends for regulatory compliance, VOC reduction, resin synthesis efficiency and improved solubility.
- In addition, Eastman's global footprint and large production capacity ensures adequate TamiSolve supply is available when needed.

Conclusion

TamiSolve high-performing solvents alleviate many safety and regulatory problems created by NMP and other traditional products. They're flexible enough to meet the demands of formulators and users in a variety of industries, including PUD, industrial cleaners and inks. TamiSolve also helps improve product solvency, productivity, compliance, cost and safety.

Incorporating TamiSolve allows users to create a biodegradable, low-VOC product that works as well as traditional products. TamiSolve can often act as a drop-in additive, and Eastman experts are available to guide formulators through the process.

Industries that rely on solvents like NMP are driving the conversation toward non-SVHC solvents. Current and pending regulations around the world are forcing companies to rethink what goes into their solvents so that safer, effective products can be produced that don't require labeling or additional measures for use. Incorporating TamiSolve would allow conversion to compliant solvents that don't compromise quality.

Eastman experts stand ready to help get customers started. Contact your Eastman representative for details.

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