EASTMAN

# Evaluation of various Eastman™ solvents

## for use in dichloromethane-free paint strippers

The results of **insight**™

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## for use in dichloromethane-free paint strippers

Paint strippers have traditionally contained dichloromethane (also called methylene chloride or DCM) as the active ingredient in the preparation. The crucial properties that make this solvent ideal for paint-removing operations are its excellent solvating powers, high volatility, and low flammability. Although DCM has been used for many years, recent concerns about its impact on human health have led to new legislation being implemented to restrict its use within the European Union from 2011 (Commission Decision 455/2009/EC).

It has been observed that DCM-free products are generally less effective in their primary function of paint removal. Hence, much effort is underway by industry participants to find safe and equally effective alternatives to DCM to ensure compliance with the new legislation. In an ideal world, the perfect replacement solvent for DCM would be as follows:

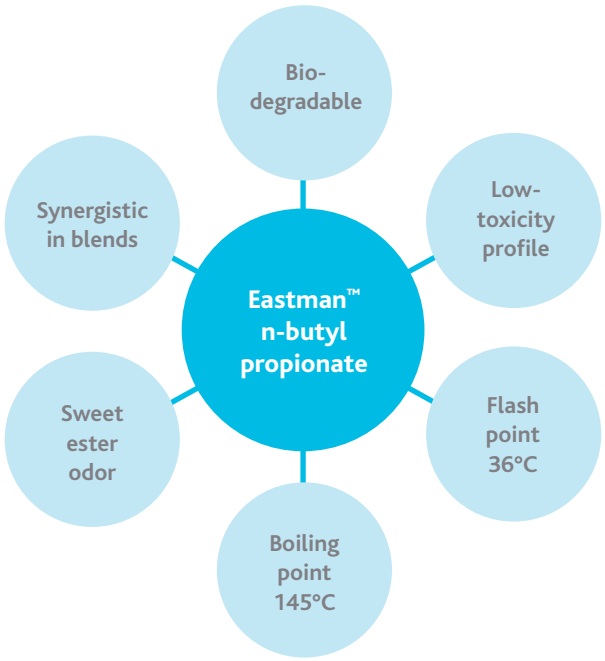
- As effective as DCM for paint removal
- Non-flammable and non-toxic
- Derived from a sustainable source
- Biodegradable
- No lasting impact on the environment

Eastman offers the paint-stripper formulator a wide choice of options to formulate effective DCM-free paint strippers (see Table 1).

The focus of this technical review is to highlight the benefits of Eastman™ n-butyl propionate in today's paint-stripper formulations, especially in combination with commonly used "active" paint-stripping solvents such as dimethylsulphoxide (DMSO), 1,3-dioxolane and 1-ethyl-2-pyrrolidone (NEP). This technical article also details the latest assessment methodology, Risk Characterization Ratio (RCR), an important ratio used to determine health and safety criteria.


## Summary

Eastman™ n-butyl propionate enhances the performance of paint-stripper formulations and shows very good synergistic effects in combination with typical "active" solvents such as DMSO or NEP. It also has a very good RCR value which is favorable to improved health and safety.


Wax helps to reduce the evaporation rate of volatile components of the paint-stripper formulation. Eastman™ EEP not only functions as an effective paint-stripper solvent but also is ideal for keeping the wax/hydrocarbon solvent blend in solution.

**Table 1** Eastman's solvent range for paint strippers

| | Bpt °C | Fpt °C | Properties |
|---|---|---|---|
| Eastman™ n-butyl propionate | 145 | 36 | Very good paint stripping on alkyd and acrylic multilayers. Synergistic action with DMSO and NEP. |
| Eastman™ EEP | 165 | 59 | Lower volatility. Very good paint stripping. Solubilizes wax in solution. |
| Eastman™ TEP | 209 | 99 | Lower volatility. Good paint stripping. Phosphate gives some flame retardency. |
| Eastman™ EP | 151 | 44 | Good paint stripping with the ability to couple solvent and water-soluble components to form a compatible system. |

## Health and safety assessment

The solvents selected for assessment were based on analysis of commercially available paint strippers. To perform health and safety (HSE) assessments, Eastman turned to an independent industrial-hygiene consultant using state-of-the-art exposure calculation tools.[1] The RCR values have been calculated for a given maximum single substance concentration (w/w %). RCR values <1.0 are generally considered to be safe. Table 2 lists the calculated RCR values and the general product-safety data.

**Table 2** HSE assessments

| Solvent | RCR outdoor brushing | RCR indoor brushing | Flammability class | Flash point (°C) | DSD classification 67/548/ EEC | CLP labeling EC 1272/2008 | Biodegradability (OECD 310) |
|---|---|---|---|---|---|---|---|
| Eastman™ n-butyl propionate | 0.11 | 0.72 | R10 | 36[a] | No | H226 | Readily |
| Eastman™ EEP | 0.00 | 0.03 | None | 59[a] | No | H226; H066 | Readily |
| Eastman™ EP | 0.07 | 0.47 | R10 | 44[a] | R21; R36 | H312; H319 | Readily |
| Eastman™ TEP | 0.12 | 0.79 | None | 99[b] | Xn; R22 | H302 | Not readily |
| Butyl acetate | 0.41 | 2.65 | R10 | 27[c] | R66; R67 | H226; H336 | Readily |
| Dibasic ester (di-methyl mixture) | 0.01 | 0.02 | None | 100[c] | No | | Readily |
| Dibasic ester (di-methyl, methyl) | 0.01 | 0.01 | None | 98[c] | No | | >60% |

[a] *Setaflash closed cup*
[b] *Pensky-Martens closed cup*
[c] *Tag closed cup*

[1] *Following REACH Guidance Document on Information Requirements and Chemical Safety Assessment recognized models such as ECETOC TRA, EASE, Consexpo, ART, Fugacity models, and SkinPerm have been applied to calculate the RCR. RCR is the ratio between calculated or measured exposure to a substance and the determined safe level of Derived No Effect Level (DNEL). Values below 1 are considered as safe, whereas values above 1 are considered unsafe. No difference between professional user and consumer has been taken as a position. Typical formulation concentration at 35% except for Eastman™ EP and Eastman™ EEP at 10%. Four-hour brushing with maximum 1 L of mixture. No risk-management measures have been assumed.*

## Synergistic paint-stripping comparisons

The paint-removal performance of Eastman™ n-butyl propionate was compared against DMSO and NEP paint-stripping solvents. The paint strippers were applied to a commercial multilayer alkyd or acrylic paint (3x 120µm WFT) and the stripping time in terms of softening and blistering was recorded. For alkyds, the time to blister down to the substrate was noted and for the acrylics, the time to soften down to the substrate was noted (Figures 1 and 2).

The evaluations show that there is a synergistic paint-stripping effect between DMSO and NEP with Eastman™ n-butyl propionate.

The paint-stripping efficiency of these solvents was significantly improved by mixing with Eastman™ n-butyl propionate.

**Figure 1** DMSO and Eastman™ n-butyl propionate blends on multilayer alkyd and acrylic paint

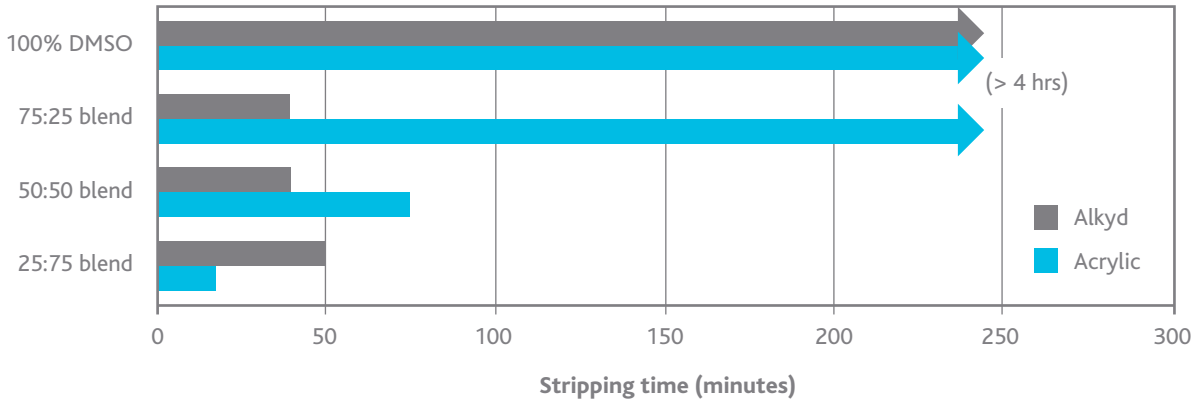
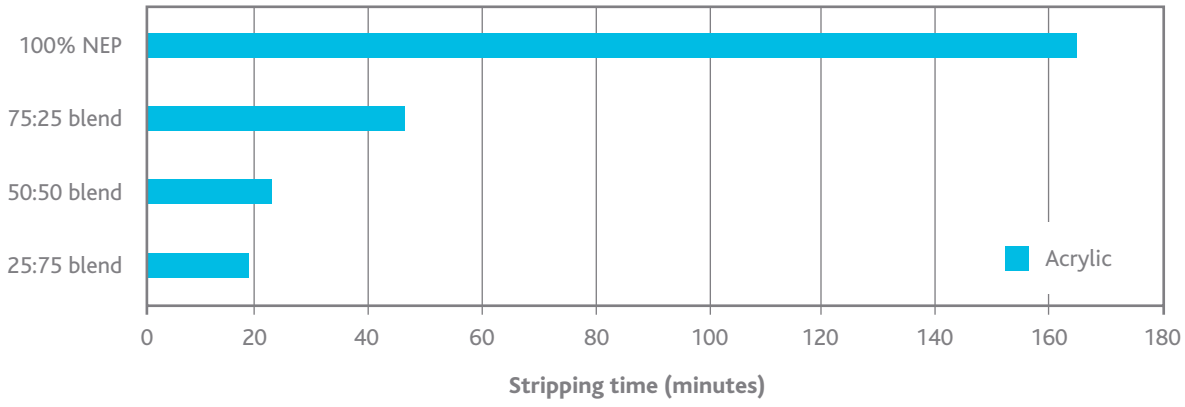



**Figure 2** NEP and Eastman™ n-butyl propionate blends on multilayer acrylic paint



## Performance evaluation of experimental paint strippers

A range of experimental products were formulated based on Eastman™ solvent(s) and compared to commercial products. To minimize solvent evaporation, a paraffin wax was incorporated into all three experimental removers. The use of Eastman™ EEP was found to help compatabilize the wax in solution and reduce phase separation. The benefits of the paraffin wax are as follows:

- Highly active solvent components remain in contact with the paint for longer.
- Less volatile solvent is emitted into the users' working environment.
- Wax additives can sometimes help a paint-remover composition achieve a lower flammability rating when tested for regulatory purposes.

To replicate "real-life conditions," the efficiency of the experimental and commercial paint strippers were evaluated on an old wooden door with an unknown number of paint layers. Evaluations were also carried out on a water-based acrylic, exterior facade plaster system (ref. Onip Grese RPE) that was applied by trowel at a thickness of 3.5 ± 0.5 mm to a standard gypsum board and fully dried for 8 weeks at 23°C.

The paint strippers were applied by brush application and a contact time of 60 minutes was allowed before physical stripping took place.

The starting-point formulations are shown in Table 3. The evaluations are in Figure 3 and show that the experimental systems with Eastman™ n-butyl propionate have a positive effect on paint-stripping efficiency that outperformed an average of seven commercial systems.

**Table 3** Starting-point formulations

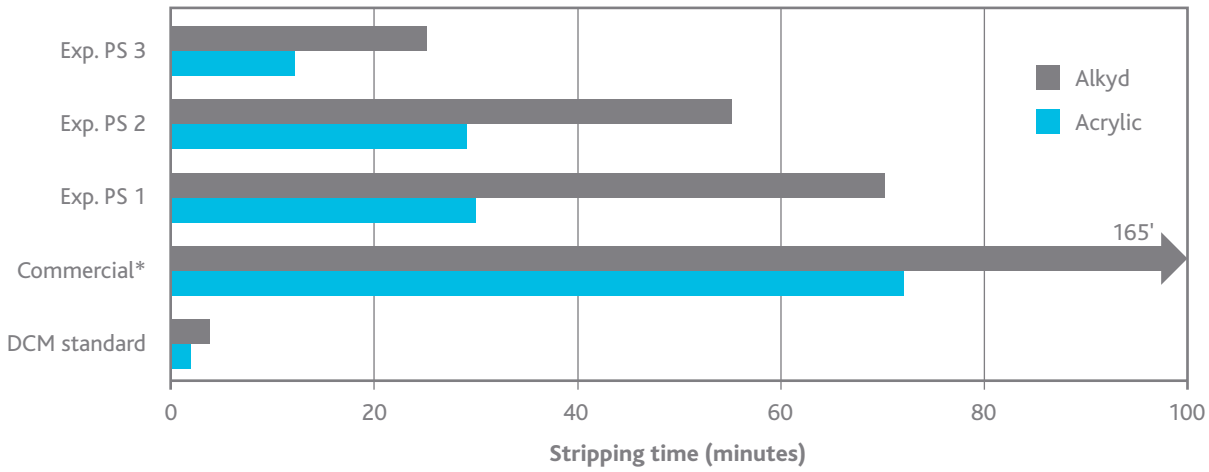
| Experimental paint stripper 1 (Exp. PS 1) | |
|---|---|
| **Ingredient** | **Weight** |
| Dimethylsulphoxide (DMSO) | 459.4 |
| Ethanolamine | 5.2 |
| Methocel 311[i] | 14.4 |
| Eastman™ n-butyl propionate | 347.4 |
| Eastman™ EEP Solvent | 105.9 |
| Empilan KTA 6[ii] | 5.2 |
| Paraffin wax solution<br>9.375 parts Sasolwax 2477<br>53.125 parts Exxsol D40 | 62.5 |
| **Total** | **1000.0** |

| Experimental paint stripper 2 (Exp. PS 2) | |
|---|---|
| **Ingredient** | **Weight** |
| 1-Ethyl-2-pyrrolidone (NEP) | 462.8 |
| Ethanolamine | 5.2 |
| Methocel 311[i] | 13.2 |
| Eastman™ n-butyl propionate | 350.0 |
| Eastman™ EEP Solvent | 106.8 |
| Empilan KTA 6[ii] | 4.8 |
| Paraffin wax solution<br>9.375 parts Sasolwax 2477<br>53.125 parts Exxsol D40 | 57.2 |
| **Total** | **1000.0** |

| Experimental paint stripper 3 (Exp. PS 3) | |
|---|---|
| **Ingredient** | **Weight** |
| 1,3-Dioxolane | 597.8 |
| Methocel 311[i] | 12.2 |
| Dimethoxymethane | 99.6 |
| Methyl ethyl ketone | 109.5 |
| Eastman™ n-butyl propionate | 129.5 |
| Paraffin wax solution<br>7.71 parts Sasolwax 2477<br>43.69 parts Exxsol D40 | 51.4 |
| **Total** | **1000.0** |

[i] *Dow Chemical's cellulose ether thickener*
[ii] *Huntsman's surfactant*

**Figure 3** Improved efficiency of experimental paint-stripper formulations containing Eastman™ n-butyl propionate




*Average of seven commercial products*

## Conclusion

Based on results of our experiments, we can conclude that Eastman™ n-butyl propionate can be used together with a wide range of solvents currently used in paint-stripper formulations.

- Eastman™ n-butyl propionate shows very good synergistic effects and reduces paint-stripping time significantly.
- Eastman™ n-butyl propionate has a very good RCR value which makes it a safe choice.
- Eastman™ EEP also works well as paint-stripper solvent. It was found to help compatabilize the wax in solution and reduce phase separation.
- Experimental formulations containing Eastman™ n-butyl propionate and EEP outperformed commercial paint strippers.

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M-EU569 12/10