



# EPP Rapid Research

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## EPP Rapid Research

### Solvent Replacement for MEK in Parts Washing

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#### Request

Is methyl acetate a useful alternative to the use of MEK for surface cleaning purposes?

#### Key Findings

- Methyl acetate will likely work well in replacing methyl ethyl ketone (MEK) for removing oils from silicone-based elastomer parts.
- Methyl acetate probably interacts in a similar fashion to MEK with the silicone elastomer, however, compatibility testing is strongly advised to avoid any unpleasant surprises.
- Methyl acetate has a lower boiling point and flash point, and is more volatile than MEK, so there may be a need to take more precautions to protect workers and to avoid inhalation exposures. MEK and methyl acetate have similar airborne permissible exposure limits (PELs), but the limit may be more easily reached with methyl acetate.
- Methyl acetate is not considered a hazardous waste on its own, so a switch away from MEK may reduce the volume of hazardous waste produced during the parts the cleaning process.
- Methyl acetate has low atmospheric reactivity (VOC-exempt), so a switch away from MEK will reduce the production of ground-level ozone associated with parts-cleaning emissions.

#### Background

Methyl ethyl ketone (MEK) is currently used in a manufacturing process in small-lot quantities to clean minor production dirt and oils off of silicone-based elastomer parts. The parts manufacturer is working to reduce volatile organic carbon (VOC) emissions. Replacing MEK with methyl acetate, a VOC-exempt substance, would eliminate one source of regulated VOCs. A short list of factors affecting the choice of solvent replacement might include:

- Ability of the solvent to dissolve or wash-away the soil (dirt, oil)
- Chemical compatibility of the solvent with the parts that must be washed
- Safety of the solvent as used and risks of exposure to workers
- Environmental considerations, such as environmental toxicity and regulatory controls.

Cost and a variety of other factors could be considered, but such an exhaustive study is beyond the scope of this Rapid Response.

#### Suitability of Methyl Acetate vs MEK for Washing Dirt and Oil

The best way to judge the suitability of a solvent for washing is to perform some simple lab-based washing experiments. Short of this direct data, there are several theoretically-based models that can be used to predict solvent performance. One of the most useful of these models characterizes solvents with Hansen Solubility Parameters (HSPs) (1). The HSPs work on the idea of like-dissolves-like, but add some detail to what it means to be "alike." The overall behavior of a solvent is characterized by three terms: a non-polar (dispersive) term, a polar term and a hydrogen-bonding term. Solvents that have similar values of the three descriptive terms will

likely behave similarly in practice. Since the oily soils or contaminants are likely to be non-polar, it's probably more important for the MEK and any potential replacement to have similar values of the *non-polar* HSP term.

Table 1 gives the HSP values for MEK, methyl acetate and some selected solvents. The first three solvents have similar HSPs, especially for the important non-polar term, and may be expected to perform similarly for cleaning common oils. Roughly speaking, isopropanol, with its stronger H-bonding component, would not dissolve oils as well, due to an increased tendency to hydrogen-bond with itself. In other words, isopropanol's interaction with other isopropanol molecules competes with its interaction with the oily soil materials.

Solvent	Non-Polar HSP	Polar HSP	H-Bonding HSP
Methyl ethyl ketone	7.6	4.4	2.5
Methyl acetate	7.8	3.5	3.7
Methyl n-propyl ketone	7.8	3.7	2.3
Isopropanol	7.7	3.0	8.0

Table 1. Hansen solubility parameters from Eastman Chemical Company (2).

Methyl acetate has a higher vapor pressure and evaporates more quickly than MEK. As a result, changes in cleaning procedures may be required to account for more rapid solvent drying.

### Compatibility of Methyl Acetate with the Part Material

The parts undergoing cleaning are a silicone-containing elastomer. HSPs can also be used to understand how solvents may interact with solid materials. Without additional information on the make-up of the parts, it's not possible to determine whether methyl acetate would swell or otherwise interact with the elastomers used by the manufacturer. In any case, given the similar HSPs, methyl acetate should interact with the parts in a very similar fashion to MEK. This HSP theoretical model is not perfect, so it would be wise to perform some basic compatibility testing before changing solvents in the current system.

### Safety of Solvent in Use and Risks of Exposure to Workers

Methyl acetate is more volatile than MEK, so it may cause worker exposures or reach dangerous vapor concentrations more quickly than MEK. Like MEK, methyl acetate is flammable, but it is more easily ignited (has a lower flash point) than MEK.

Permissible exposure limits (PELs) are similar for MEK and methyl acetate, and both solvents are respiratory irritants, may cause central nervous system depression, and are in other ways unhealthy if workers should become overexposed by dermal contact or vapor inhalation. All solvent safety data should be reviewed prior to use in any facility, including: NIOSH recommendations for protective equipment, MSDSs, and human health impact data (e.g., information at the Hazardous Substances Data Bank). Some links to information are provided in the Resource section below.

### Environmental Regulation

While on the original 1990 list of hazardous air pollutants (HAPs), MEK was removed from the list in 2005. MEK is still regulated as a VOC. Methyl acetate has a lower chemical reactivity in the air environment and is considered VOC-exempt.

When disposed of, MEK must be treated as a hazardous waste and is also a TRI listed chemical. Methyl acetate is not regulated as a hazardous waste.

### Conclusions

Methyl acetate will likely work well to replace MEK in parts cleaning. While theories of solvent behavior are not flawless, they are a reasonable guide to solvency in the absence of specific experimental data. Similarly, the same solvent theories suggest that methyl acetate will interact with the plastic material of the parts in much the same manner as does MEK.

Like MEK, methyl acetate is flammable and can be hazardous to workers, especially from vapor exposures. Methyl acetate is substantially more volatile than MEK, so it will build up more quickly in the air environment. Given the high volatility, methyl acetate will also dry more quickly and this may require changes in cleaning practices.

Methyl acetate is not considered a hazardous waste, so switching away from MEK may permit a reduction in the quantity of hazardous waste generated by cleaning operations. Furthermore, given methyl acetate's low atmospheric reactivity (VOC-exempt), switching from MEK will also reduce the production of ground-level ozone associated with emissions from parts cleaning.

### Items for Further Research

- There are a variety of proprietary cleaning solvents that are offered as environmentally-friendly and may be worth exploring.
- Eastman Chemical Company suggests methyl n-propyl ketone (MPK), both as a pure substance and in mixtures with methyl acetate, as a potential replacement for MEK. The advantage is lower vapor pressure of MPK when compared with pure methyl acetate. Unfortunately, MPK may contain up to 10% methyl isobutyl ketone, a hazardous air pollutant. MPK is also a regulated VOC, but as it is less volatile than MEK, it would probably lead to reduced VOC emissions in a direct replacement for MEK.

### Resources

- Eastman Chemical Company provides good information comparing methyl acetate with MEK and other similar solvents for cleaning applications: [http://www.eastman.com/Literature\\_Center/T/TT24.pdf](http://www.eastman.com/Literature_Center/T/TT24.pdf)
- Eastman Chemical Company information on MEK replacement: [http://www.eastman.com/Literature\\_Center/T/TT33.pdf](http://www.eastman.com/Literature_Center/T/TT33.pdf)
- Hazardous Substances Data Bank entry for MEK (also known as 2-butanone): <http://toxnet.nlm.nih.gov/cgi-bin/sis/search/r?dbs+hsdb:@term+@r+78-93-3>
- Hazardous Substances Data Bank entry for methyl acetate: <http://toxnet.nlm.nih.gov/cgi-bin/sis/search/r?dbs+hsdb:@term+@r+79-20-9>
- NIOSH pocket guide to chemical hazards entry for MEK (also known as 2-butanone): <http://www.cdc.gov/niosh/npg/npgd0069.html>
- NIOSH pocket guide to chemical hazards entry for methyl acetate: <http://origin.cdc.gov/niosh/npg/npgd0391.html>

### Works Cited

1. Anonymous. Hansen solubility parameter. Wikipedia. [Online] [http://en.wikipedia.org/wiki/Hansen\\_Solubility\\_Parameters](http://en.wikipedia.org/wiki/Hansen_Solubility_Parameters).
2. Eastman Chemical Company. Solvent Selector Chart. Eastman Chemical Company. [Online] [http://www.eastman.com/Literature\\_Center/M/M167.pdf](http://www.eastman.com/Literature_Center/M/M167.pdf).