

Advantages of ShiraSol™

Purpose This document summarizes the enhanced safety and quality attributes of TBF Environmental's ShiraSol product as compared to Mineral Spirits and other organic solvents that are used in paint formulations and as paint thinners. ShiraSol can also be used as a replacement solvent or co-solvent for Aromatic 100, Methyl Amyl Ketone (MAK) and *n*-Butyl Acetate (nBAC).

Factors to consider When evaluating the safety and quality of the ShiraSol product, the following factors must be considered:

- environmental considerations - toxicity and regulatory controls
- safety - reduced hazard to the environment and workers
- performance - comparable physicochemical characteristics to Mineral Spirits

Environmental considerations The following table details the environmental considerations between ShiraSol, Mineral Spirits, Aromatic 100, MAK, and nBAC.

	ShiraSol	Mineral Spirits	Aromatic 100	MAK	nBAC
VOC Content: US EPA (outside SCAQMD)	0	100%	100%	100%	100%
VOC Content: SCAQMD	2.9* g/L	100%	100%	100%	100%
Maximum Incremental Reactivity (MIR, g O ₃ /g organics)	0.097	0.9-2.47	7.51	2.80	0.89

*ASTM Test Method 313-91. South Coast Air Quality Management District (SCAQMD) considers <5 g/L VOC content to be "zero VOC".

ShiraSol is 100% comprised of solvents considered to be VOC-exempt by the EPA, CEPA, NPRI and SCAQMD and as such is considered zero VOC.

ShiraSol is far less toxic to the environment than conventional organic solvent alternatives. Mineral Spirits, Aromatic 100, MAK and nBAC are all emitters of Volatile Organic Compounds (VOCs), which can engage in photochemical reactions in the atmosphere to form ground-level ozone and smog precursors, and are therefore harmful to the environment. ShiraSol is comprised of 100% VOC-exempt material and is not a Hazardous Air Pollutant (HAP).

Furthermore, ShiraSol has a very low Maximum Incremental Reactivity (MIR) value when compared to Mineral Spirits, Aromatic 100, MAK and nBAC. MIR is a quantifiable measure of relative ground-level ozone impacts of VOCs, and a low MIR value indicates less impact on the environment.

Safety The following table details the safety considerations between ShiraSol, Mineral Spirits, Aromatic 100, MAK, and nBAC.

	ShiraSol	Mineral Spirits	Aromatic 100	MAK	nBAC
Flash point (°C)	43.5	42	41 - 46	39	27
Toxicity: Oral LD₅₀ (rat) (mg/kg)	13,000	> 5000	3492	1600	14,130

The flash point of ShiraSol is higher than that of Mineral Spirits, MAK and nBAC, which indicate a less flammable and consequently safer product.

LD₅₀ values can be used to determine the safety and toxicity of a chemical. The oral LD₅₀ (rat) for Mineral Spirits is around 5000 mg/kg, while Aromatic 100 and MAK have lower LD₅₀ values and therefore carry higher oral toxicity. The ingredient present in the largest amount in ShiraSol, which also has the highest toxicity, has an oral LD₅₀ (rat) of 13,000 mg/kg which indicates that it has less oral toxicity than Mineral Spirits, Aromatic 100 and MAK.

Definition: LD₅₀ is the amount of a material, given all at once, which causes the death of 50% (one half) of a group of a test population. The LD₅₀ is one way to measure the short-term poisoning potential (acute toxicity) of a material. A larger LD₅₀ value correlates to a safer product.

Safety regulations

The following table summarizes regulatory exposure limits comparing ShiraSol, Mineral Spirits, Aromatic 100, MAK, and nBAC.

Chemical	Exposure Limit	Exposure Type and Governing Body
ShiraSol	None listed	Cal/OSHA, OSHA & ACGIH
Stoddard Solvent (Mineral Spirits)	100 ppm	Cal/OSHA PEL (8-Hour Time Weighted Average)
MAK	50 ppm	U.S. ACGIH TLV (8-Hour Time Weighted Average)
nBuAc	150 ppm	U.S. ACGIH TLV (8-Hour Time Weighted Average)
Aromatic 100	19 ppm	ExxonMobil OEL (8-Hour Time Weighted Average)

Permissible Exposure Limits (PEL) and Threshold Limit Values (TLV) are restrictions put in place by various regulatory organizations that quantify the maximum allowable exposure for a certain chemical. The California Division of Occupational Safety and Health (Cal/OSHA) limits the exposure of Stoddard Solvent (a type of Mineral Spirits) to 100 parts-per-million (ppm), and the American Conference of Governmental Industrial Hygienists (ACGIH) limit MAK and nBuAc exposure to 50ppm and 150 ppm, respectively. ExxonMobil Chemical, manufacturer of Aromatic 100, recommends an Occupational Exposure Limit (OEL) of 19 ppm.

Conversely, none of the ingredients present in the ShiraSol formulation are currently regulated by any exposure limits listed by Cal/OSHA, OSHA or ACGIH.

Physical properties

The following table summarizes the physical properties comparing ShiraSol and Mineral Spirits.

	ShiraSol	Mineral Spirits
Initial Boiling Point (°C)	147.5	140 - 158
Evaporation Rate (nBAC = 1)	0.1	0.1 - 0.13
Kauri Butanol (Kb) Value	54.5	33
Surface Tension (dynes/cm)	24.5	24.7

ShiraSol was carefully formulated to closely mimic many of Mineral Spirit's properties, including boiling point, evaporation rate, solvency and surface tension.

The boiling point, evaporation rate and surface tension for ShiraSol are very close to that of many types of Mineral Spirits, which easily allows a user to replace Mineral Spirits with ShiraSol.

The Kauri Butanol (Kb) value, which is an indicator of solvency and how well a solvent can dissolve certain substances, is considerably higher for ShiraSol than for Mineral Spirits. Thus, as ShiraSol has greater solvency and is a more effective dissolving agent, this can result in less solvent being required in certain purposes, which can positively impact the environmental, safety and cost considerations.

ShiraSol is currently the only replacement for Mineral Spirits that is zero-VOC, lower in toxicity than many current solvent alternatives, has a good safety profile, and mimics the physical properties of Mineral Spirits.

References

- California Division of Occupational Safety and Health. Table AC-1: Permissible Exposure Limits for Chemical Contaminants; https://www.dir.ca.gov/title8/5155table_ac1.html (Accessed July 16th, 2015)
- Carter, William P.L. Updated Maximum Incremental Reactivity Scale and Hydrocarbon Bin Reactivities for Regulatory Applications; <http://www.engr.ucr.edu/~carter/SAPRC/MIR10.pdf>. Updated January 28th, 2010. (Accessed July 16th, 2015).
- Occupational Safety & Health Administration. Annotated Table Z-1: Limits for Air Contaminants; <https://www.osha.gov/dsg/annotated-pels/tablez-1.html> (Accessed July 16th, 2015)
- Product Safety Summary for ExxonMobil Chemical Aromatic 100 Fluid; <https://www.exxonmobilchemical.com/Chem-English/Files/Resources/aromatic-100-product-safety-summary.pdf> (Accessed July 29th, 2015)
- Safety Data Sheet for ExxonMobil Chemical Aromatic 100 Fluid; <http://www.msds.exxonmobil.com/IntApps/psims/psims.aspx?brand=xomcc> (Accessed August 4th, 2015)
- Safety Data Sheet for Eastman™ Methyl Amyl Ketone; <http://www.eastman.com/Products/Pages/ProductHome.aspx?Product=71001054> (Accessed July 29th, 2015)
- Safety Data Sheet for Eastman™ Butyl Acetate; <http://www.eastman.com/Products/Pages/ProductHome.aspx?Product=71001046> (Accessed July 29th, 2015)
- Safety Data Sheet for Recochem Inc. Mineral Spirits; <https://web.chempliance.com/MSDS/OpenDoc.ashx?DocID=24445> (Accessed July 30th, 2015)