CLEANING LABORATORY EVALUATION SUMMARY

SCL #:	2019
DateRun:	07/20/2019
Experimenters:	Kevin Smith, Othon Pagounes
ClientType:	Adhesive Manufacturer
ProjectNumber:	Project #3
Substrates:	Stainless Steel
PartType:	Coupon
Contaminants:	Adhesive
Cleaning Methods:	Manual Wipe
Analytical Methods:	Gravimetric, Visual
Purpose:	Determine a safer alternative for cleaning applications to remove solvent-based coatings using Hansen Solubility Parameters in Practice (HSPiP) off stainless steel surfaces.

Experimental Procedure:

The soil was applied to the stainless steel coupon as a spot with a glass stir rod. Then four drops of solvent were applied to the soil with a pipette and then wiped with a fresh Wypall. The coupons were given ratings based on the efficacy of the solvent at removing the soil

A rating system of zero to five was developed to the efficiency of the solvent in its ability to remove the coating from the substrate. If little to no soil was removed from the coupon, the solvent would receive a zero (0), and if most or all soil was removed from the coupon, the solvent would receive a five (5). The scoring was established based on the percent weight removal of the coating. The ratings were entered into the HSPiP software, and a sphere was generated from that data.

The HSPiP sphere has size parameters that associate with its solubility. These parameters were entered into the Database of Safe Solvents (DoSS), with a tolerance of +/- one value to create a range for identifying a safer solvent. DOSS provided a list of solvents that were within the values given and exported into the HSPiP optimizer option. The optimization evaluation found solvents and solvent blends that were closest to the parameters of the coating HSPiP sphere.

HSPiP Chemicals:

(1) Toluene (2) Dimethyl Carbonate, (3) Xylenes, (4) Benzyl Alcohol, (5) Ethylene Glycol, (6) Methyl Acetate, (7) Undecane, (8) Ethyl Lactate, (9) Acetone, (10) Ethyl Acetate, (11) Methanol, (12) Ethanol, (13) 1,3-Dioxolane, (14) Diethyl Carbonate, (15) 1-Propanol, (16) Iso-Propanol, (17) Propylene Carbonate, (18) Thiophene, (19) 1-Methoxy-2-Propanol, (20) Dimethyl Sulfoxide, (21) 1-Butanol, (22) Dimethyl Glutarate, (23) Anisole, (24) 2-Butoxyethyl Acetate

Results:

Results from HSPiP Test:

#	Solvent	Soils		
		Acrylic	Rubber	Silicone
1	Dimethyl Carbonate	5	4	3
2	Xylenes	3	5	3
3	Benzyl Alcohol	1	3	2
4	Ethylene Glycol	2	0	2
5	Methyl Acetate	4	3	4
6	Undecane	4	4	3
7	Ethyl Lactate	1	3	2
8	Acetone	3	3	2
9	Ethyl Acetate	2	4	3
10	Methanol	2	5	2
11	Ethanol	3	3	2
12	1,3 -Dioxolane	1	4	4
13	Diethyl Carbonate	4	4	2
14	1-Propanol	1	4	2
15	Iso-Propanol	3	3	2
16	Propylene Carbonate	0	0	0
17	Thiophene	1	4	3

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18	1-Methoxy-2Propanol	0	5	1
19	Dimethyl Sulfoxide	2	4	0
20	1-Butanol	2	5	1
21	Dimethyl Glutarate	0	2	1
22	Anisole	2	3	2
23	2-Butoxyethyl Acetate	1	2	2
24	Toluene	3	4	4

Results from HSPiP Software Results:

The sphere determined by the HSPiP software was defined as the following:

Soil	D-Value	P-Value	H-Value
Acrylic	15.13	6.21	11.11
Rubber	22.05	0.11	16.49
Silicone	16.15	3.14	14.040

EHS Hazard Profile Analysis

Potential alternative chemicals were identified using HSPiP. These chemicals were then evaluated for overall environmental health and safety (EHS) using the P2OASys database. The following solvents were reviewed:

Alternative:

1) Butyl Salicylate
2) Dipropylene Glycol Mono n-Propyl Ether
3) 2-Ethyl-1-Butanol

Solvent	D-Value	P-Value	H-Value
Toluene	18	1.4	2
Butyl Salicylate	17.90	4.80	11.70
Dipropylene Glycol Mono n-Propyl Ether	5.70	6.50	10.00
2-Ethyl-1-Butanol	15.80	4.30	13.50

A detailed review of the (8) Pollution Prevention Options Analysis System (P2OASys.turi.org) EHS categories was conducted for original blend (Toluene, Acetone, and Xylene) and compared to the potential alternative as seen figure below

Score	*Description*
7-10	High Hazards
5-6	Moderate Hazards
2-4	Low Hazards
	No Information Available
*Lower score = Lower toxicity/hazard.	

Categories	Toluene	Butyl Salicylate	Dipropylene Glycol Mono n-Propyl Ether	2-Ethyl-1-Butanol
Acute Human Effects	9	8	7	5
Chronic Human Effects	8	6	2	2
Ecological Hazards	8	4		
Environmental Fate & Transport	5			
Atmospheric Hazard	6	2	2	2
Physical Properties	10	2	6	6
Process Factors	7	2	2	2

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Life Cycle Factors	9	6	4	4
Weighted Average	7.8	4.3	3.8	3.5

Original Blend Cleaner:

1. Toluene: High hazard of exposure limits, oral toxicity, endocrine system, and chronic organ effects. High acute aquatic toxicity and a listed NESHAP chemical. Physical properties had a high hazard rating due to vapor pressure, high flammability, low flashpoint, and a noxious odor. Lifecycle factors had a high rating due to hazards to those working with this chemical upstream, as a consumer, and during disposal.

Proposed Identified Alternative:

1. Butyl Salicylate: High hazards for dermal and eye irritation.
1. Dipropylene Glycol Mono n-Propyl Ether: High hazard for eye irritation
1. 2-Ethyl-1-Butanol: No high hazards

Based upon this analysis, Butyl Salicylate, Dipropylene Glycol Mono n-Propyl Ether and 2-Ethyl-1-Butanol present the same or lower of multiple EHS hazards and VOC profile as the current solvent of Toluene. The majority of the high hazards listed above in the current solvent will be avoided with the identified alternative with exception of a high hazard ratings of eye, and dermal irritation. Which can be avoided with the correct personal protective equipment and engineering controls.

Summary:

Conclusion: Samples of the considered alternatives have been requested and tested for efficacy using the same methodology.