CLEANING LABORATORY EVALUATION SUMMARY

SCL #:	2022
DateRun:	06/10/2022
Experimenters:	Zoe Lawson, Tatyanna Moreland Junior
ClientType:	Adhesive Manufacturer
ProjectNumber:	Project #3
Substrates:	Stainless Steel
PartType:	Coupon
Contaminants:	Adhesive
Cleaning Methods:	Manual Wipe
Analytical Methods:	Gravimetric, Visual, Wipe
Purpose:	To test the effectiveness of the removal of adhesives using HSPiP chemistries.
Experimental Procedure:	Pre-weighed stainless steel coupons, six for each chemical (three being tested with unheated and three being tested with heated), were soiled with the Phenolics adhesive soil. Approximately 0.25 g of the soil was applied using a hand held swab. Each set of coupons were manually wiped with a cloth of the same material, one set dipped into unheated and another set dipped into the heated chemical . During this process, any noticeable soil removal was observed and recorded. Coupons were allowed were wiped with a paper towel to ensure no residue of the cleaner, and afterwards final weights were recorded. The efficiency of removal was calculated for each coupon cleaned.
Results:	Heated Treatment Results

Cleaner	Treatment	Initial wt of cont.	Final wt of cont.	%Cont Removed	Average % Removal
Sec-butyl acetate	Heated (60-70F)	0.5784	0.0656	88.66	88.76
		0.5171	0.0764	85.23	
		0.6567	0.0500	92.39	
2-propanol		0.4138	0.4029	2.63	2.09
		0.3467	0.3435	0.92	
		0.3373	0.3282	2.70	
di-isobutyl ketone		0.5938	0.0907	84.73	77.76
		0.5272	0.1751	66.79	
		0.4301	0.0784	81.77	
2-phenoxy ethanol		0.3791	0.3688	2.72	4.00
		0.4380	0.4006	8.54	
		0.2870	0.2849	0.73	
t-butyl acetate		0.2700	0.1159	57.07	46.05
		0.2710	0.1391	48.67	
		0.2973	0.2010	32.39	
d-limonene		0.3751	0.0497	86.75	85.36
		0.3391	0.0504	85.14	
		0.4025	0.0636	84.20	
ektapro EEP		0.4124	0.0347	91.59	94.15
		0.2423	0.0072	97.03	
		0.2510	0.0155	93.82	
n-amyl acetate		0.3232	0.1351	58.20	51.73
		0.3006	0.1332	55.69	
		0.3046	0.1788	41.30	
dimethyl glutarate		0.3134	0.3016	3.77	42.47
		0.2018	0.1348	33.20	
		0.9639	0.0921	90.45	
diethylene glycol monobutyl ether		0.1727	0.1716	0.64	35.88
		0.5009	0.2581	48.47	
		0.4221	0.1751	58.52	
n-butyl acetate		0.3183	0.1138	64.25	58.14

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		0.3310	0.1281	61.30	
		0.3508	0.1793	48.89	
1-propanol		0.3743	0.3708	0.94	1.04
		0.2696	0.2667	1.08	
		0.3435	0.3397	1.11	
FAME		0.3678	0.3043	17.26	17.37
		0.4766	0.4438	6.88	
		0.3515	0.2532	27.97	

Unheated Treatment Results

Cleaner	Treatment	Initial wt of cont.	Final wt of cont.	%Cont Removed	Average % Removal
Sec-butyl acetate	Unheated	0.7258	0.0589	91.88	88.93
		0.5425	0.0725	86.64	
		0.4250	0.0499	88.26	
2-propanol		0.2266	0.2235	1.37	2.14
		0.2082	0.1985	4.66	
		0.2999	0.2987	0.40	
di-isobutyl ketone		0.2930	0.0867	70.41	76.09
		0.3587	0.1134	68.39	
		0.2443	0.0257	89.48	
2-phenoxy ethanol		0.6850	0.6632	3.18	3.16
		0.7704	0.7253	5.85	
		0.4024	0.4006	0.45	
t-butyl acetate		0.1787	0.0450	74.82	68.51
		0.1700	0.0821	51.71	
		0.1353	0.0284	79.01	
d-limonene		0.5954	0.0733	87.69	77.47
		0.3109	0.0660	78.77	
		0.3004	0.1023	65.95	
ektapro EEP		0.1711	0.0054	96.84	95.67
		0.2421	0.0182	92.48	
		0.2627	0.0061	97.68	
n-amyl acetate		0.2469	0.0892	63.87	69.86
		0.1964	0.0338	82.79	
		0.2402	0.0891	62.91	
dimethyl glutarate		0.4656	0.4376	6.01	5.88
		0.4333	0.4066	6.16	
		0.3385	0.3200	5.47	
diethylene glycol monobutyl ether		0.2791	0.2695	3.44	4.45
		0.3072	0.2950	3.97	
		0.3798	0.3573	5.92	
n-butyl acetate		0.2175	0.0765	64.83	53.39
		0.1949	0.0560	71.27	
		0.6194	0.4702	24.09	
1-propanol		0.3754	0.3694	1.60	1.08
		0.3848	0.3798	1.30	
		0.2827	0.2817	0.35	
FAME		0.4618	0.3827	17.13	16.91
		0.3756	0.3553	5.40	
		0.3010	0.2161	28.21	

Overall Average % Removals

Cleaner	Average % Removal - Unheated	Average % Removal - Heated	Overall Average % Removal for Cleaner
Sec-butyl acetate	88.93	88.76	88.84

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2-propanol	2.14	2.09	2.11
di-isobutyl ketone	76.09	77.76	76.93
2-phenoxy ethanol	3.16	4.00	3.58
t-butyl acetate	68.51	46.05	57.28
d-limonene	77.47	85.36	81.42
ektapro EEP	95.67	94.15	94.91
n-amyl acetate	69.86	51.73	60.79
dimethyl glutarate	5.88	42.47	24.18
diethylene glycol monobutyl ether	4.45	35.88	20.16
n-butyl acetate	53.39	58.14	55.77
1-propanol	1.08	1.04	1.06
FAME	16.91	17.37	17.14

Looking between the average % removal for unheated vs. heated there appears to be little difference in the effectiveness of the cleaner. The two exceptions to this are dimethyl glutarate (36.59% improvement) and diethylene glycol monobutyl ether (31.45% improvement) as they both were far more effective at removing the adhesive when heated. Overall the majority of the chemicals tested were found to be ineffective. The most promising cleaners to proceed with for testing include sec-butyl acetate (88.84%), d-limonene (81.42%), and ektapro EEP (94.91%). Di-isobutyl ketone (76.93%) may also be worth testing in the next trials.

Summary:

Conclusion: Further testing is needed to determine the efficiency of the chemicals on other types of adhesives. So far, the most promising cleaners to proceed with for testing include sec-butyl acetate (88.84% overall average removal), d-limonene (81.42% overall average removal), and ektapro EEP (94.91% overall average removal). Di-isobutyl ketone (76.93% overall average removal) may also be worth testing in the future.